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Fifth Five-Year Remedy Review Report for Savannah River Site Operable Units with Operating Equipment (U)

Aiken, South Carolina

SRNS-RP-2017-00567

Revision 1

July 2018

DISCLAIMER

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Prepared for
U.S. Department of Energy
and
Savannah River Nuclear Solutions, LLC
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EXECUTIVE SUMMARY

This document presents the results of a technical evaluation of eleven environmental remedies implemented using operating equipment at Savannah River Site (SRS). The remedies are evaluated to determine whether they are functioning as designed and whether they are protective of human health and the environment. This evaluation is required under Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986. CERCLA requires that remedial actions that result in any hazardous substances, pollutants, or contaminant remaining at the site be subject to a remedy review every five years.

Previous five-year remedy review reports combined all SRS operable units (OUs) that had implemented a remedial action into a single document. A recommendation was made by SRS in the Fourth Five-Year Remedy Review Report that future reviews should be conducted in phases based on OU groupings with similar remedies. This phased approach not only reduces the volume of future remedy reports, but also is more effective in identifying and resolving issues for similar remedies. For this reason, the Fifth Five-Year Remedy Review Report will be conducted in five phases with OUs grouped by the following remedy types: (1) native soil covers and/or land use controls; (2) groundwater; (3) engineered cover systems; (4) geosynthetic or stabilization/ solidification systems; and (5) operating equipment. This report presents the fifth phased review for eleven SRS OUs that selected remedial actions with operating equipment as the final remedy.

Based on the data reviewed and the site inspections, the eleven remedies evaluated in this report are functioning as intended. The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection are still valid. No new information has come to light that calls into question the protectiveness of any of the remedies evaluated. Ten remedies have been determined to be protective of human health and the environment while the remedy for the A/M Groundwater OU is determined to be protective in the short-term. For the remedy to be protective in the long-term, optimization of the M-1 recovery system and/or other remediation technologies must be implemented to treat the high concentration areas of the plume located outside the recovery well zone of capture.

This report presents the issues and recommendations that have resulted from the remedy review. SRS identified the following recommendations:

- SRS recommends shutdown of the A-Area Miscellaneous Rubble Pile OU passive soil vapor extraction (SVE) system if soil remedial goals for trichloroethylene and tetrachloroethylene have been achieved. Additional characterization of the ash layer and vadose zone soils will be conducted to verify that the remedial goals have been met. If the remedial goals have been achieved, the results will be submitted to the U.S. Department of Energy, U.S. Environmental Protection Agency, and South Carolina Department of Health and Environmental Control for consensus to justify discontinuing operation of the passive SVE system.

- SRS recommends shutdown of the D-Area Operable Unit Bubble Tower MicroBlower™ SVE system due to the minimal removal of contaminants for at least the last four years. Confirmation soil samples will be collected to determine whether the tetrachloroethylene soil remedial goal (20 µg/kg) has been met. If the remedial goal has been achieved, the results will be submitted to the Core Team for consensus to justify discontinuing operation of the SVE system.

Five-Year Review Summary Form

SITE IDENTIFICATION				
Site Name: Savannah River Site				
EPA ID: SC1890008989				
Region: 4	**State:** SC	**City/County:** Aiken/Aiken		
SITE STATUS				
NPL Status: Final				
Multiple OUs?: Yes	**Has the Site achieved Construction Completion?:** No			
REVIEW STATUS				
Lead Agency: Other Federal Agency **If "Other Federal Agency" was selected above, enter Agency Name:** U.S. Department of Energy				
Author Name (Federal or State Project Manager: N/A				
Author Affiliation: Savannah River Nuclear Solutions, LLC				
Review Period: May 1, 2017 – January 21, 2019 (Phase 5: SRS OUs with Operating Equipment)				
Date of Site Inspections: August 2017 - November 2017 (Phase 5: SRS OUs with Operating Equipment)				
Type of Review: Statutory				
Review Number: 5				
Triggering Action Date: January 21, 2014				
Due Date (Five Years after Triggering Action Date): January 21, 2019 (includes all 5 Phases)				
ISSUES/RECOMMENDATIONS				
OU(s) without Issues/Recommendations Identified in the Five-Year Review				
CERCLIS #: 8, 9, 19, 21, 28, 29, 31, 36, 59, 92				
Issues and Recommendations Identified in the Five-Year Review				
OU(s): CERCLIS # 30, 63	**Issue Category:** Monitoring			
	Issue: The passive SVE systems have been successful in treating volatile organic compound (VOC) contamination.			
	Recommendation: SRS recommends shutdown of the AMRP passive SVE system and the DAOU Bubble Tower MicroBlower™ SVE system if remedial goals have been achieved.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	EPA/SCDHEC	2018

Five-Year Review Summary Form *(continued)*

PROTECTIVENESS STATEMENT(S)		
Operable Unit: A-Area Burning/Rubble Pits (731-A and 731-1A) and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A) (ABRP/MCB/MBP) OU, CERCLIS #28	***Protectiveness Determination:*** Protective	***Addendum Due Date (if applicable):*** N/A
Protectiveness Statement: The remedy at the ABRP/MCB/MBP is protective of human health and the environment.		
Operable Unit: A-Area Miscellaneous Rubble Pile (731-6A) (AMRP) OU, CERCLIS #30	***Protectiveness Determination:*** Protective	***Addendum Due Date (if applicable):*** N/A
Protectiveness Statement: The remedy at the AMRP is protective of human health and the environment.		
Operable Unit: A/M-Area Groundwater OU, CERCLIS #36	***Protectiveness Determination:*** Short-Term Protective	***Addendum Due Date (if applicable):*** N/A
Protectiveness Statement: The remedy at the A/M-Area Groundwater currently protects human health and the environment because groundwater removal and treatment, in situ treatment, and contaminant source treatment have been successful in removing VOC contamination in groundwater and exposure pathways that could result in unacceptable risks are being controlled through land use controls. For the remedy to be protective in the long-term, optimization of the M-1 recovery system and/or other remediation technologies must be implemented to treat the high concentration part of the plume located outside of the recovery well zone of capture.		
Operable Unit: C-Area Burning/Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) (CBRP) OU, CERCLIS #31	***Protectiveness Determination:*** Protective	***Addendum Due Date (if applicable):*** N/A
Protectiveness Statement: The remedy at the CBRP is protective of human health and the environment.		
Operable Unit: D-Area Operable Unit (DAOU), CERCLIS #63	***Protectiveness Determination:*** Protective	***Addendum Due Date (if applicable):*** N/A
Protectiveness Statement: The remedy at the DAOU is protective of human health and the environment.		
Operable Unit: F-Area Groundwater OU, CERCLIS #8	***Protectiveness Determination:*** Protective	***Addendum Due Date (if applicable):*** N/A
Protectiveness Statement: The remedy at the F-Area Groundwater OU is protective of human health and the environment.		

Five-Year Review Summary Form *(continued/end)*

PROTECTIVENESS STATEMENT(S)		
Operable Unit: H-Area Groundwater OU, CERCLIS #9	***Protectiveness Determination:*** Protective	***Addendum Due Date (if applicable):*** N/A
Protectiveness Statement: The remedy at the H-Area Groundwater OU is protective of human health and the environment.		
Operable Unit: M-Area Settling Basin Inactive Process Sewer Lines to Manhole 1 (081-M) (MIPSL) OU, CERCLIS #19	***Protectiveness Determination:*** Protective	***Addendum Due Date (if applicable):*** N/A
Protectiveness Statement: The remedy at the MIPSL OU is protective of human health and the environment.		
Operable Unit: M-Area Operable Unit (MAOU), CERCLIS #92	***Protectiveness Determination:*** Protective	***Addendum Due Date (if applicable):*** N/A
Protectiveness Statement: The remedy at the MAOU is protective of human health and the environment.		
Operable Unit: P-Area Burning/Rubble Pit (131-P) OU, CERCLIS #59	***Protectiveness Determination:*** Protective	***Addendum Due Date (if applicable):*** N/A
Protectiveness Statement: The remedy at the PBRP OU is protective of human health and the environment.		
Operable Unit: TNX Area OU, CERCLIS #21, 29	***Protectiveness Determination:*** Protective	***Addendum Due Date (if applicable):*** N/A
Protectiveness Statement: The remedy at the TNX Area OU is protective of human health and the environment.		

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LIST OF ACRONYMS AND ABBREVIATIONS

%	percent
1,1-DCE	1,1-dichloroethene
ABRP	A-Area Burning/Rubble Pits (731-A and 731-1A) and Rubble Pit (731-2A)
AMRP	A-Area Miscellaneous Rubble Pile (731-6A)
ARRA	American Recovery and Reinvestment Act of 2009
ARAR	applicable or relevant and appropriate requirement
ARW	airlift recirculation wells
AS	air sparging
bgs	below ground surface
BRA	Baseline Risk Assessment
CBRP	C-Area Burning/Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN)
cDCE	cis-1,2-Dichloroethylene
CPRB	D-Area Coal Pile Runoff Basin (489-D)
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CFR	Code of Federal Regulations
Ci	Curies
cm	centimeter or centimeters
CM	contaminant migration
cm/s	centimeter per second
CMI/RAIP	Corrective Measures Implementation/Remedial Action Implementation Plan
CMIR	Corrective Measures Implementation Report
CMS/FS	Corrective Measures Study/Feasibility Study
COC	constituent of concern
cVOC	chlorinated volatile organic compounds
+D	plus daughter
DAOU	D-Area Operable Unit
DCE	1,1-Dichloroethylene
DCM	dichloromethane (methylene chloride)
DHWF	D-Area Heavy Water Facility
DIPSL	D-Area Inactive Process Sewer Lines
DNAPL	Dense non-aqueous phase liquid
DUS	Dynamic Underground Stripping
DWPF	Defense Waste Processing Facility
EAROD	Early Action Record of Decision

LIST OF ACRONYMS AND ABBREVIATIONS *(continued)*

EC&ACP	Environmental Compliance and Area Completion Projects
ECO	ecological
EE/CA	Engineering Evaluation/Cost Analysis
EMP	Effectiveness Monitoring Plan
EMR	Effectiveness Monitoring Report
ESD	Explanation of Significant Difference
ESV	ecological screening value
FFA	Federal Facility Agreement
FML	flexible membrane liner
FRR	Final Remediation Report
ft	foot or feet
ft^3	cubic foot or cubic feet
FY	fiscal year
g/L	grams per liter
gal	gallon or gallons
gpm	gallons per minute
GWPS	groundwater protection standards
HAZWOPER	hazardous waste operations
HGCA	Hybrid Groundwater Corrective Action
HH	human health
HpCDD	1,2,3,4,6,7,8-Heptachlordibenozo-p-dioxin
HQ	hazard quotient
HWMF	Hazardous Waste Management Facility
in	inch or inches
IOU	Integrator Operable Unit
IPSL	Inactive Process Sewer Line
IRA	interim remedial action
IROD	Interim Record of Decision
ISCO	In-situ chemical oxidation
KBRP	K-Area Burning/Rubble Pit (131-K)
kg	Kilogram or kilograms
kg/yr	kilogram per year
km	kilometer or kilometers
km^2	square kilometer or square kilometers
KRP	K-Area Rubble Pile (631-20G)
L	Liter or liters
L/min	Liters per minute
LBRP	L-Area Burning/Rubble Pit (131-L)
lbs	pounds
lbs/yr	pounds per year
LDG	Lower Discharge Gully
LLC	Limited Liability Company

LIST OF ACRONYMS AND ABBREVIATIONS *(continued)*

LRP	L-Area Rubble Pile (131-3L)
LUC	land use control
LUCAP	Land Use Controls Assurance Plan
LUCIP	Land Use Controls Implementation Plan
m	meter or meters
m^3	cubic meter or cubic meters
MAOU	M-Area Operable Unit
MCB	Miscellaneous Chemical Basin (731-4A)
MBP	Metals Burning Pit (731-5A)
Met Lab	Metallurgical Laboratory
MH	manhole
mi	mile or miles
mi^2	square mile or square miles
µg/kg	microgram per kilogram
µg/L	microgram per Liter
mg/kg	milligram per kilogram
MCL	maximum contaminant level
MIPS	M-Area Inactive Process Sewer
MIPSL	M-Area Settling Basin Inactive Process Sewer Lines to Manhole 1 (081-M)
MNA	monitored natural attenuation
msl	mean sea level
MZ	mixing zone
N/A	not applicable
NBN	no building number
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	non-detect
NFA	No Further Action
NPL	National Priorities List
NRDC	National Resources Defense Council
NTCR	non-time critical removal
NTSB	New TNX Seepage Basin (904-102G)
O&M	operation and maintenance
OCDD	octachlorodibenzo-p-dioxin
ODA	Overflow Discharge Area
OTSB	Old TNX Seepage Basin (904-076G)
OU	operable unit
PAH	polyaromatic hydrocarbons
PBRP	P-Area Burning/Rubble Pit (131-P)
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
ρCi/g	picoCuries per gram

LIST OF ACRONYMS AND ABBREVIATIONS *(continued)*

ρCi/L	picoCuries per liter
ρCi/mL	picoCuries per milliliter
PCR	Post Construction Report
PER	Performance Evaluation Report
ppb	parts per billion
ppmv	parts per million vapor
PRG	Preliminary Remediation Goal
psi	pounds per square inch
PTSM	principal threat source material
PW	production well
RAO	remedial action objective
RAR	Removal Action Report
RBC	risk-based concentrations
RCOC	refined constituent of concern
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RG	remedial goal
RGO	remedial goal option
RI	Remedial Investigation
ROD	Record of Decision
RSER	Removal Site Evaluation Report
RSL	regional screening level
S/S	Stabilization/Solidification
SARA	Superfund Amendments and Reauthorization Act of 1986
SCDHEC	South Carolina Department of Health and Environmental Control
SPRG	Surface Preliminary Remediation Goals
SRS	Savannah River Site
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions, LLC
SSHASP	site-specific health and safety plan
SVE	soil vapor extraction
SVEU	soil vapor extraction unit
SWM	Solid Waste Management
TAOU	T-Area Operable Unit
TA	Temporary authorization
TBC	To be considered
TBG	TNX Burying Ground (643-5G)
TCE	trichloroethylene
TSCA	Toxic Substances Control Act, 1976
TNXGW	TNX Groundwater (082-G)
TNXOD	TNX Outfall Delta

LIST OF ACRONYMS AND ABBREVIATIONS *(continued/end)*

UDG	Upper Discharge Gully
USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency
VC	vinyl chloride
VOC	volatile organic compound
WOF	D-Area Waste Oil Facility (484-10D)
WTU	Water treatment unit
WSRC	Washington Savannah River Company
WSRC	Westinghouse Savannah River Company
yd	yard or yards
yd^3	cubic yard or cubic yards

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SAVANNAH RIVER SITE SUMMARY

I. INTRODUCTION

Section 121 of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), requires that remedial actions which result in any hazardous substances, pollutants, or contaminant remaining at the site be subject to a five-year remedy review. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) further provides that remedial actions which result in any hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure be reviewed every five years to ensure protection of human health and the environment. The purpose of five-year remedy reviews is to evaluate the implementation and performance of the selected remedy at an operable unit (OU) to determine if the remedy is protective of human health and the environment. The evaluation of the remedy and the determination of protectiveness should be based on and sufficiently supported by data and visual inspections. The methods, findings, and conclusions of remedy reviews are documented in Five-Year Remedy Review Reports. The reports also identify any issues found during the review and provides recommendations to address the issues.

The U.S. Department of Energy (USDOE) prepared this fifth five-year remedy review for Savannah River Site (SRS) OUs that selected remedies with operating equipment as the remedial action pursuant to CERCLA Section 121 and as amended by SARA and the NCP. During implementation of the five-year remedy review process at the SRS, the U.S. Environmental Protection Agency (USEPA), the South Carolina Department of Health and Environmental Control (SCDHEC), and the USDOE recognized that remedial action decision document(s) would be issued for multiple OUs. Rather than generate individual five-year remedy review reports for each OU, the USDOE and regulatory agencies determined that it would be more cost effective to conduct a remedy review for all applicable OUs on the same five-year cycle. The First Five-Year Remedy Review was issued in August 1997 (WSRC 1997) and evaluated 23 remedy decision documents. The Second Five-Year Remedy Review was issued in February 2004 (WSRC 2003) and evaluated 30 remedy decision documents. Forty-five remedy decision documents were evaluated in the Third Five-Year Remedy Review issued in January 2009 (WSRC 2008). The Fourth Five-Year Remedy Review was issued in February 2014 (SRNS 2014) and evaluated 52 remedy decision documents.

The size of each report has grown considerably since 1997 due to the increasing number of OU remedies evaluated, and the level of detail required for data reviews, site inspection reporting, and document formatting based on USEPA guidance. To allow for a more even distribution of resources, a recommendation was made by SRS in the Fourth Five-Year Remedy Review Report (SRNS 2014) that future reviews should be conducted in phases based on OU groupings with similar remedies. In addition to a reduction in the total volume for future remedy review reports, evaluating similar remedies in the same review period would support easier identification and resolution of similar issues and allow for more efficient implementation of similar initiatives. The USDOE, USEPA, and SCDHEC agreed to segregate the Fifth Five-Year Remedy Review Report into five OU groupings (grouped by remedy similarity) with a different group submitted annually on a five-year cycle. The SRS OUs are grouped by the following remedy types:

(1) Native Soil Covers and/or Land Use Controls (LUCs);
(2) Groundwater;
(3) Engineered Cover Systems;
(4) Geosynthetic or Stabilization/Solidification Cover Systems; and
(5) Operating Equipment.

The trigger date for submittal of the next five-year remedy review report to the regulatory agencies is based on the USEPA signature date of the previous report. The final signature for the last grouping of Fifth Five-Year Remedy Review Report is due no later than January 21, 2019. Prior to implementing the five annual remedy review submittals, a transitional period is necessary to prevent exceeding the five-year limit required between decision document reviews to remain in compliance with CERCLA and the NCP. Issuance dates for the Fifth Five-Year Remedy Review Report during the transitional period will occur over a four-year period (2016 to 2019). The first five-year phased report for native soil covers and/or LUCs was issued in 2015 (SRNS 2015a). The second five-year phased report for groundwater remedial actions was issued in 2017 (SRNS 2017). The third five-year phased report for engineered cover systems will be issued in 2018 (SRNS 2018a). The fourth five-year phased report for geosynthetic or stabilization/solidification cover systems will be issued in 2018 (SRNS 2018b). A more detailed discussion of the phased reviews and transition schedule are provided in Appendix A.

This report documents the Fifth Five-Year Remedy Review for the fifth OU grouping, i.e., OUs with operating equipment selected as the remedy, and includes a review of eleven remedy decision documents for twelve USEPA Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) units at the SRS. CERCLIS is a database maintained by the USEPA as part of the Superfund program that assigns a unique tracking number to hazardous waste sites considered for cleanup under CERCLA. Remedy decision documents may include more than one CERCLIS unit and/or SRS OU (i.e., two CERCLIS units are reported in the TNX Area OU Record of Decision). For this remedy review, the twelve CERCLIS units are equivalent to the eleven remedy decision documents reviewed.

The SRS OUs evaluated in this document were grouped together because of similar remedies. Table 1 identifies the OU name, CERCLIS number, remedial action(s), and issuance date of the remedy decision document for each of the OUs reviewed in this document. The issuance date represents the date the public was notified that the signed remedy decision document was available. Figure 1 identifies the location of the SRS OUs evaluated in this document. The data evaluation and visual inspections for the SRS OUs remedies with operating equipment were conducted from August 2017 through November 2017.

This report was prepared using the Comprehensive Five-Year Review Guidance (USEPA 2001) and is supplemented by the Recommended Evaluation of Institutional Controls: Supplement to the “Comprehensive Five-Year Review Guidance”

(USEPA 2011a) and Clarifying the Use of Protectiveness Determinations for Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Reviews (USEPA 2012). The updated USEPA Five-Year Review Summary Form was implemented (USEPA 2011b). This report summarizes common elements for the entire SRS. The eleven remedy reviews are included as Appendix C through Appendix M.

II. SITE CHRONOLOGY

A summary of the regulatory history of the SRS is provided below beginning with the 1988 National Resources Defense Council (NRDC) Consent Decree (Civil Action No. 1:85-2583-6). The Consent Decree was an agreement between the NRDC and other interested parties, SCDHEC, and USDOE to amend Parts A and B of the Resource Conservation and Recovery Act (RCRA) Permit Application to include the Metallurgical Laboratory Basin (904-11G) and associated Carolina Bay, the Acid/Caustic Basin (904-74G, 904-75G, 904-78G, and 904-80G), and the Mixed Waste Management Facility (904-28G) to include closure, groundwater monitoring and post-closure activities. The Savannah River Laboratory Seepage Basins (904-53G, 904-54G, and 904-55G) and New TNX Basin (904-120G) were also included in the Consent Decree for closure in a RCRA-like manner. The Consent Decree was signed on May 26, 1988. 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 program with CERCLA requirements to provide for a focused environmental program. In accordance with Section 120 of CERCLA 42 U.S. Code Section 9620, the USDOE has negotiated a Federal Facility Agreement (FFA) (FFA 1993) with the USEPA and the SCDHEC to coordinate remedial activities at SRS into one comprehensive program which 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.

A chronology of site events including the effective dates for the Consent Decree, the FFA, and the NPL Listing is provided in Appendix A. Table 1 provides a chronology of the decision documents for the SRS OUs with operating equipment evaluated in this report.

Chronologies of significant activities and regulatory milestones for individual OUs are included in the site-specific remedy review reports (Appendix C through Appendix M).

III. BACKGROUND

The SRS was constructed during the 1950s to produce the basic materials used in the fabrication of nuclear weapons, primarily tritium and plutonium, in support of 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 (e.g., seepage basins, pits and piles, landfills, etc.) 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 SCDHEC operating or post-closure permits under RCRA. SRS received a RCRA hazardous waste permit from the SCDHEC, which was most recently renewed on February 11, 2014. Module VIII of the Hazardous and Solid Waste Amendments portion of the RCRA permit mandates corrective action requirements for non-regulated solid waste management units subject to RCRA 3004(u).

Physical Characteristics

SRS occupies approximately 802.9 km^2 (310 mi^2) of land adjacent to the Savannah River, principally in Aiken and Barnwell counties of South Carolina (Figure 1). SRS is located approximately 40 km (25 mi) southeast of Augusta, Georgia, and 32 km (20 mi) south of Aiken, South Carolina. Approximately 90 percent of SRS land consists of natural and managed forests. The locations at SRS where nuclear materials were produced, stored, and disposed are clustered into distinct industrial areas that are separated by large areas of forest. OUs are generally contained within or adjacent to these industrial areas.

SRS is located on the Atlantic Coastal Plain. Subsurface and groundwater contamination associated with OUs is located in unconsolidated sands and clays. The depth to the water table at SRS varies from just below the surface in wetlands and near streams to approximately 39 m (130 ft) below ground surface. Recharge to the aquifers underlying the SRS is primarily through rainfall. Groundwater flows toward and discharges into site streams and the floodplain of the Savannah River.

Land and Resource Use

For nearly 40 years, USDOE and its predecessor agencies produced nuclear materials for the nation’s defense programs at SRS. Today, the focus of the USDOE has shifted to environmental stewardship, clean energy initiatives, and national security.

The future land use for all OUs at SRS is anticipated to be industrial with the USDOE maintaining control of the land. According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of SRS land should be prohibited. LUCs selected as part of a remedial action will prohibit residential use of the area.

SRS obtains its own drinking and process water supply from groundwater located beneath the SRS. SRS domestic and process water systems are supplied from a network of approximately 40 wells in widely scattered locations across the site, of which eight wells supply the primary drinking water system. Wells serving site process and drinking water in the larger site areas are typically 180 to 270 m (600 to 900 ft) in depth and pump water from the deeper Crouch Branch and McQueen Branch aquifers. Wells serving the smaller site facilities, such as barricades, pumphouses, and field laboratories, are shallower in depth (30 to 90 m [100 to 300 ft]) and are similar to large household type wells. The SRS domestic water systems meet state and federal drinking water standards.

History of Contamination

During the early 1950s, SRS began to produce materials used in nuclear weapons, primarily tritium, plutonium-239, and other special nuclear materials for national defense and the space program. 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. Hazardous substances, as defined by the CERCLA, are currently present in the environment at SRS, with past disposal practices (e.g., seepage basins, pits and piles, landfills, etc.) resulting in soil and groundwater contamination.

Initial Response

After SRS was placed on the NPL in 1989, the SRS Site Evaluation program was initiated to identify potential release sites at SRS that would require investigation and potential remediation under CERCLA. Five hundred fifteen (515) potential release sites have been identified. The FFA includes a schedule for the investigation and remedial action (if needed) for each potential release site.

A core team process for sharing and interpreting information and working together to reach agreement on key remedial decisions among USDOE, USEPA, and SCDHEC was implemented at SRS in 2000. The core team process has made environmental cleanup at SRS more efficient and has allowed remediation at many OUs to be accomplished on an accelerated schedule.

The collaborative efforts of the USDOE, USEPA, and SCDHEC support a consistent approach to site characterization, human health and ecological risk analysis, remedy selection, establishment of remedial goals (RGs) and remedy implementation for individual OUs at SRS. Technical and administrative protocols have been established to promote the consistent implementation of USEPA guidance at OUs across SRS. An environmental database is used to track sampling, analysis, and results of environmental characterization and monitoring. An SRS Area Completion Strategy (WSRC 2006) was developed which allowed for the simultaneous characterization and cleanup of multiple OUs and potential sources of contamination collocated in congested industrial areas.

During the period from April 2009 to September 2012, funds for accelerated environmental cleanup became available as part of the national economic stimulus package authorized by the American Recovery and Reinvestment Act of 2009 (ARRA). To take advantage of this additional funding, environmental cleanup under CERCLA was expedited by performing removal actions at a number of OUs using the administrative vehicle of Removal Site

Evaluation Report/Engineering Evaluation/Cost Analysis reports. Early action remedial decisions were also implemented under ARRA.

Table 1 provides a summary of the remedial actions implemented to date for the OUs with operating equipment remedies evaluated in this report. These remedial actions include removal actions and remedial actions conducted prior to an interim or final Record of Decision (ROD).

Basis for Taking Action

The most prevalent soil contaminants at SRS are cesium-137 and organic chemicals (volatile or semi-volatile). Other radionuclides, metals, polychlorinated biphenyls, and pesticides are present, but less common, at levels that exceed human health risk-based standards at a variety of units.

Remedial actions which result in any hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure are reviewed every five years to ensure protection of human health and the environment. The specific contaminants and remedial actions for each OU in this five-year remedy review are described in greater detail in the OU-specific appendices (Appendix C through Appendix M).

IV. REMEDIAL ACTIONS

Remedial actions may target source areas, soil, vadose zone, and/or groundwater. RGs are defined for individual OUs, but in general, remedial action objectives (RAOs) at SRS are:

- Prevent exposure of trespassers, industrial workers, and/or hypothetical residents to soils, surface water, or groundwater containing unacceptable levels of contaminants.
- Prevent exposure of ecological receptors to soils, surface water, or groundwater containing unacceptable levels of contaminants.
- Prevent or minimize the migration of contaminants to groundwater at levels that exceed maximum contaminant levels (MCLs).

- Prevent or minimize the discharge of contaminated groundwater to surface water at levels that exceed MCLs.

As previously discussed, the Fifth Five-Year Remedy Review Report will be conducted in five phases based on the remedy type. A general description of the five remedy types is provided in Appendix A.

Systems Operation and Maintenance

A site-wide maintenance program is in place to care for cover systems, signs, monitoring wells, operating equipment, and other infrastructure associated with environmental remediation. Operation and maintenance (O&M) of cover systems consist of growing grass, mowing, managing surface stormwater drainage, inspections, and repair of erosion or subsidence as necessary. Depending on OU-specific requirements, groundwater monitoring and fence maintenance may be performed. Groundwater monitoring networks require maintenance. Identifying signs on wells must remain legible, and locks and well covers must be operational. Access to groundwater wells must be maintained. Pumps and fittings periodically require repair or replacement, and wells are refurbished or redeveloped as necessary, or abandoned when no longer useable or needed.

Operating facilities (i.e., air strippers, recovery well systems, soil vapor extraction units, water treatment facilities) and passive remedial systems have varying site-specific requirements for O&M. An SRS operations organization with trained and qualified personnel manages the day-to-day activities at operating facilities. Environmental sampling, equipment operation, maintenance, and monitoring are among their responsibilities.

Groundwater monitoring is an important component of O&M at SRS. Groundwater monitoring includes installing monitoring wells, collecting water samples, analysis of samples at laboratories, data management, data interpretation, and document production. Groundwater monitoring reports are produced and submitted to USEPA and SCDHEC for individual OUs where monitoring and reporting are required.

The costs of the O&M activities for the individual OUs have been compiled as part of this five-year remedy review. As part of the process of selecting the most appropriate action for each OU, the cost of implementing each of the remedies was estimated and reported in the respective remedy decision documents. Table 2 compares the actual costs incurred at SRS OUs with operating equipment over the period from fiscal year (FY) 2012 to FY2017 to the estimated costs from the remedy decision documents projected for the same period. The review for the actual costs incurred (i.e., FY2012 to FY2017) is based on the time-period since the last review for these OUs was conducted in the Fourth Five-Year Remedy Review Report (SRNS 2014). The remedy cost evaluation and review of OU-specific Inspection Checklists were documented from FY2012 through FY2017 due to the phased approach schedule for the Fifth Five-Year Remedy Review Report. Specific details concerning costs incurred are included for each OU in Appendix C through Appendix M.

V. PROGRESS SINCE LAST REVIEW

For the eleven remedy reviews evaluated in this review, the previous protectiveness statements from the Fourth Five-Year Remedy Review Report (SRNS 2014) concluded that the remedies for these OUs were found to be protective.

Recommendations from the Fourth Five-Year Remedy Review Report that impact the OUs with operating equipment evaluated in this report are as follows:

- Five-year remedy reviews will be conducted in phases with OUs grouped by remedy types. This report presents the fifth phased review for eleven OUs that selected remedies with operating equipment as the final remedy.
- SRS recommended optimization of groundwater monitoring and reporting at some OUs, consistent with the results of the SRS Groundwater Monitoring Optimization Report (SRNS 2012). For this report, this recommendation pertains to the A/M-Area Groundwater, F-Area Groundwater, and H-Area Groundwater.
- SRS recommended monitoring of 1,4-dioxane for six OUs and reporting the results in the OU-specific groundwater reports. For this report, this recommendation pertains to the P-Area Burning/Rubble Pit (131-P) OU and TNX Area OU.

- SRS recommended incorporating bioremediation (i.e., edible oil injection) into the remedy for the TNX Area OU.
- SRS recommended that groundwater remediation activities at the A/M-Area Groundwater OU be evaluated and a strategy for optimization of plume capture and/or treatment be developed.

VI. FIVE-YEAR REMEDY REVIEW PROCESS

USDOE has implemented the Fifth Five-Year Remedy Review for SRS OUs with operating equipment. The review specifically evaluated remedies by comparing them to the OU-specific decision documents. The following actions were taken to perform the Fifth Five-Year Remedy Review for this category:

- A scoping summary was submitted to the USDOE, USEPA and SCDHEC on August 2, 2017. The USDOE, USEPA and SCDHEC agreed with the scope and schedule of the report, which was discussed in the scoping summary;
- Published an announcement on September 14, 2017 that the USDOE is conducting the Fifth Five-Year Remedy Review in phases. The public was notified through mailings of the SRS Environmental Bulletin, a newsletter sent to citizens in South Carolina and Georgia on an extensive mailing list, including landowners adjacent to SRS, and through notices in the *Aiken Standard* (Aiken, SC), *The Augusta Chronicle* (Augusta, GA), *The People Sentinel* (Allendale and Barnwell, SC), and *The State* (Columbia, SC) newspapers. The Environmental Bulletin and newspaper affidavits of publication are available in the Administrative Record File;
- Reviewed appropriate data, documentation (i.e., including RODs, Early Action RODs [EARODs], Interim RODs [IRODs], Explanation of Significant Differences [ESD]), and Land Use Control Implementation Plan (LUCIP) required field inspection checklists, etc. The specific data and document references used to review each remedy decision are listed in the OU-specific reports located in Appendix C through Appendix M;

- Confirmed protectiveness of the remedial actions through inspections and interviews. Cognizant personnel were interviewed as to the status and success of the current remedial systems. The results of the inspections and interviews are documented in the Site Inspection Checklist included with the OU-specific reports located in Appendix C through Appendix M;
- Reviewed changes in standards and to-be-considered guidance including federal and state promulgated standards (i.e., chemical specific applicable or relevant and appropriate requirements [ARARs]) that would call into question whether the prescribed remedy was meeting the newer standards or guidance. Any problems or discrepancies are reported in the Section VII (Technical Assessment), Section VIII (Issues), and Section IX (Recommendations and Follow-up Actions) of the OU-specific appendices; and
- Submitted an initial Fact Sheet to USEPA and SCDHEC for review with Revision 0 of the Fifth Five-Year Remedy Review Report for SRS OUs with Operating Equipment.

USEPA and SCDHEC performed their site inspections of OUs with operating equipment with issued RODs or IRODs on March 26, 2018. The Revision 0 report was submitted on December 20, 2017. USDOE addressed the comments received from USEPA and SCDHEC and provided a Revision 1 report for USEPA and SCDHEC approval. After the USEPA and SCDHEC approve the report and USDOE, USEPA, and SCDHEC sign this report, a notice of its availability will be published in the *Aiken Standard* (Aiken, SC), *The Augusta Chronicle* (Augusta, GA), *The People Sentinel* (Allendale and Barnwell, SC), and *The State* (Columbia, SC) newspapers. Additionally, the availability of the report will be announced in *The Savannah River Site Environmental Bulletin*, which will be sent to the SRS mailing list. The report will be made available to the public at four information repositories. A briefing to the Citizens Advisory Board will be conducted prior to finalizing the report.

VII. TECHNICAL ASSESSMENT

The technical assessment of the environmental cleanup program at SRS in general and each of the OU-specific remedies evaluated in this report (Appendices C through M) is described by answers to the following three questions posed by the USEPA.

- Question A: Is the remedy functioning as intended by the decision documents?
- Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs still valid?
- Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Question A: Is the remedy functioning as intended by the decision documents?

SRS remedial systems with operating equipment are functioning as intended as demonstrated below.

- Air stripping and soil vapor extraction (SVE) units associated with the A/M-Area Groundwater plume continue to operate reliably and remove volatile organic compounds (VOCs) from the groundwater and vadose zone.
- Passive and Low Energy SVE systems, solar powered MicroBlowers™ and barometric pressure-operated BaroBalls™ continue to remove contaminants from subsurface soils contaminated by low concentrations of VOCs
- Thermal treatment of tritium-contaminated soil and debris has been successfully implemented in D-Area.
- Edible oil injection to induce bioremediation has successfully decreased the size and concentration of the VOC plume in T Area.
- Groundwater data at Monitored Natural Attenuation (MNA) remedy plumes indicates that groundwater concentrations are generally decreasing and plumes are not expanding.

- Contaminated material has been excavated and consolidated or left in place under protective cover systems, breaking the pathway for worker exposure and for the migration of contaminants to groundwater.
- The cover system maintenance program and LUCs have been effective in maintaining the integrity of the cover systems at SRS OUs. The inspection reports indicate no significant deficiencies.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs still valid?

The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection are still valid for all OUs included in this report. An evaluation of changes in chemical and radiological standards including federal and state promulgated standards (i.e., chemical specific ARARs) that were in place when the last five-year remedy review was initiated in 2012 to the standards applicable in 2017 was conducted to determine if there were any changes that would affect the protectiveness of the selected remedies. There were no changes in chemical and radiological specific standards that would affect the protectiveness of the remedies. There were no changes in action-specific or location-specific requirements that would impact any remedy. This evaluation is included in Appendix B and described in the OU-specific appendices.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No other information that could call into question the protectiveness of the selected remedies and no outstanding issues have been identified in this Fifth Five-Year Remedy Review. For all OUs, land use at SRS remains consistent with assumptions in the respective decision documents.

Technical Evaluation Summary

According to the data reviewed, the site inspections, and interviews, the remedies selected for the SRS OUs included in this report are functioning as intended by the decision documents. The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection are still valid for all OUs included in this report. No new information has come to light that calls into question the protectiveness of the remedies.

VIII. ISSUES

Remedial actions evaluated in this Five-Year Remedy Review for SRS remain protective of human health and the environment and are functioning as intended. The identified issues discussed below are associated with altering or shutting down the remedial activities.

- The passive system at A-Area Miscellaneous Rubble Pile (AMRP) OU has been successful in treating VOC contamination. Soil RGs have likely been achieved and operation of the passive SVE system may no longer be needed for future protectiveness.
- The D-Area Operable Unit (DAOU) Bubble Tower MicroBlower™ SVE has been successful in treating VOC contamination. Contaminant removal from the MicroBlower™ SVE system has greatly diminished or ceased since 2012 and operation of the SVE system may no longer be needed for future protectiveness if the soil RG has been achieved.

The SVE systems at the AMRP OU and DAOU Bubble Tower will continue to operate until additional characterization confirms that the RGs have been met.

IX. RECOMMENDATIONS AND FOLLOW-UP ACTIONS

SRS recommends shutdown of the AMRP passive SVE system if soil RGs for trichloroethylene and tetrachloroethylene have been achieved. Additional characterization of the ash layer and vadose zone soils will be conducted to verify that the RGs have been met.

SRS recommends shutdown of the DAOU Bubble Tower MicroBlower™ SVE system due to the minimal removal of contaminants for the last four years. Confirmation soil samples will be collected to determine whether the PCE soil RGs have been met.

X. PROTECTIVENESS STATEMENT(S)

The protectiveness statements for each remedy are based on the recommended language from the *Comprehensive Five-Year Review Guidance* (USEPA 2001) and the supplemental guidance, *Clarifying the Use of Protectiveness Determinations for Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Reviews* (USEPA 2012).

For the OUs evaluated in this Five-Year Remedy Review, the remedies with operating equipment have been determined to be protective of human health and the environment. However, the remedy for the A/M-Area Groundwater has been determined to be protective in the short-term. To establish long-term protectiveness, optimization of the M-1 recovery system and/or other remediation technologies must be implemented to treat the high concentration part of the plume located outside of the recovery well zone of capture. Optimization of the system is occurring under the RCRA permit renewal.

LUCs are part of all final remedial actions where hazardous substances, pollutants, or contaminants remain on-site above levels that allow for unlimited use and unrestricted exposure. The type of LUCs and implementation and reference to the OU-specific LUCIP is described in detail in Section VII of the OU-specific appendices. For the OUs evaluated in this report, pathways for contaminants to reach human and ecological receptors have been successfully broken by the selected remedies. For the A/M Area Groundwater OU, F-Area Groundwater OU, and H-Area Groundwater OU, the LUC requirements are discussed and approved as part of the closure/post-closure/permit application process and are governed by the RCRA Permit Renewal for the SRS (SCDHEC 2017). Therefore, a LUCIP is not required for these three groundwater OUs.

Soil contamination, contaminated rubble, and buried wastes associated with spills, pits, and piles have been controlled either by excavation and removal, cover systems, or treatment. Pathways for contaminants to reach human and ecological receptors and for migration to groundwater have been successfully broken.

Groundwater contamination is being remedied through a variety of technologies that are tailored to plume-specific characteristics. In some cases, multiple remedial technologies are employed either in conjunction or sequentially. Technologies successfully implemented include thermal treatment, air stripping, in-situ injection of nutrients to enhance bioremediation of VOCs, funnel and gate with in-situ injection of base solution to change the pH of groundwater and immobilize contaminants, and MNA. In each groundwater remedy evaluated, data indicates that progress is being made toward meeting RGs and that the remedies are protective.

A protectiveness statement for each of the OUs evaluated in this report is included in the OU-specific remedy review located in Appendix C through Appendix M. The protectiveness statements are also provided in the Five-Year Review Summary Form located in the Executive Summary.

XI. NEXT REVIEW

As established in Section 121 of CERCLA, as amended by the SARA and the NCP, periodic reviews are required at least every five years for sites where hazardous substances, pollutants, or contaminants remain above levels that allow for unlimited use and unrestricted exposure following the completion of the remedial action. Barring a change in the governing laws, another review should be completed within five years from the signature date of this document. The Fifth Five-Year Remedy Review will be conducted in five phases. The final signature date for the last grouping of the Fifth Five-Year Remedy Review Report is due no later than January 21, 2019.

XII. OU-SPECIFIC FIVE-YEAR REMEDY REVIEW REPORTS

The OU-specific Five-Year Remedy Reviews for the remedies evaluated in this document are included in Appendix C through Appendix M.

XIII. REFERENCES

FFA, 1993. *Federal Facility Agreement for the Savannah River Site*, Administrative Docket Number 89-05-FF (Effective Date: August 16, 1993)

SRNS, 2012. *EC&ACP Groundwater Monitoring Optimization Report: A Comprehensive, Technical Approach for the Evaluation and Optimization of Groundwater Monitoring and Reporting (U),* SRNS-RP-2012-0196, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2014. *Fourth Five-Year Remedy Review Report for the Savannah River Site (U) Aiken, South Carolina,* SRNS-RP-2012-00011, Revision 1.1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2015a. *Fifth Five-Year Remedy Review Report for the Savannah River Site Operable Units with Native Soil Covers and/or Land Use Controls (U) Aiken, South Carolina*, SRNS-RP-2014-00902, Revision 1, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

SRNS, 2017. *Fifth Five-Year Remedy Review Report for the Savannah River Site Operable Units with Groundwater Remedies (U) Aiken, South Carolina*, SRNS-RP-2015-00419, Revision 1, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

SRNS, 2018a. *Fifth Five-Year Remedy Review Report for the Savannah River Site Operable Units with Engineered Cover Systems (U) Aiken, South Carolina*, SRNS-RP-2016-00609, Revision 1.1, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

SRNS, 2018b. *Fifth Five-Year Remedy Review Report for the Savannah River Site Operable Units with Geosynthetic or Stabilization/Solidification Cover Systems (U) Aiken, South Carolina*, SRNS-RP-2016-00610, Revision 1.1, Savannah River Nuclear Solutions, LLC, LLC, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

USEPA, 2001. *Comprehensive Five-Year Review Guidance*, EPA 540-R-01-007, OSWER No. 9355.7-03B-P, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response

USEPA, 2011a. *Recommended Evaluation of Institutional Controls: Supplement to the "Comprehensive Five-Year Review Guidance"*, OSWER Directive 9355.7-18, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response

USEPA, 2011b. *Transmittal of the Updated Five-Year Review Summary Form*, OSWER Directive 9200.2-105, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response

USEPA, 2012. *Clarifying the Use of Protectiveness Determinations for Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Reviews*, OSWER Directive 9200.2-111, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response

WSRC, 1997. *Five-Year Review of Records of Decision Report (U),* WSRC-RP-97-403, Revision 0, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2003. *Second Five-Year Review Report for the Savannah River Site (U),* WSRC-RP-2001-4163, Revision 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2006. *Area Completion Strategy for the Savannah River Site (U)*, ERD-EN-2005-0084, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2008. *Third Five-Year Remedy Review Report for the Savannah River Site (U)*, WSRC-RP-2007-4063, Revision 1.1, Washington Savannah River Company, Savannah River Site, Aiken, SC

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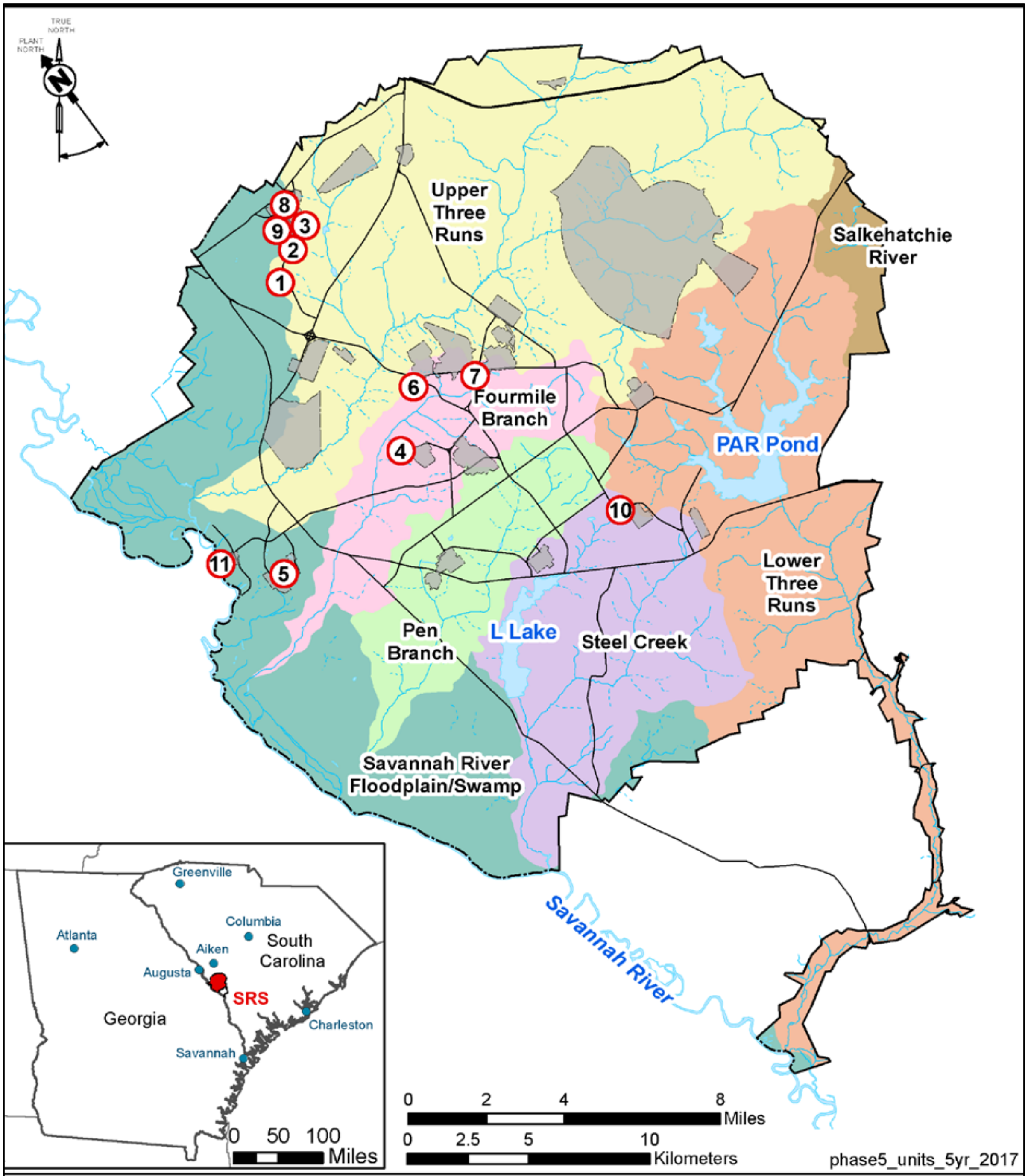

1. A-Area Burning/Rubble Pits (731-A and 731-1A) and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A)
2. A/M-Area Groundwater
3. A-Area Miscellaneous Rubble Pile (731-6A)
4. C-Area Burning/Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN)
5. D-Area Operable Unit
6. F-Area Groundwater Operable Unit
7. H-Area Groundwater Operable Unit
8. M-Area Settling Basin Inactive Process Sewer Lines to Manhole 1 (081-M)
9. M-Area Operable Unit
10. P-Area Burning/Rubble Pit (131-P)
11. TNX Area Operable Unit

Figure 1. Location Map for SRS OUs with Operating Equipment

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Table 1. SRS OUs with Operating Equipment

#	Appendix	Operable Unit	CERCLIS No.	Remedy Decision Document	Decision Document Issuance Year	Remedial Action[a]	Area Covered (acres)	LUCs (acres)
1	C	A-Area Burning/Rubble Pits (731-A and 731-1A) and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A) OU	28	IRODs ESD ROD	2001 2003 2007	SVE (Active and Passive), Air Sparging, Soil Cover, LUCs	10.1	10.1
2	D	A/M-Area Groundwater OU	36	IROD	1992	SVE (Active and Passive), Pump-and-Treat with Air Stripping, Humate Amendment, Recirculation Wells (Dynamic Underground Stripping previously implemented) (RCRA Permit Renewal)	2,500	N/A
3	E	A-Area Miscellaneous Rubble Pile (731-6A) OU	30	ROD	2003	Excavation, SVE, Soil Cover, LUCs	5.8	3.1
4	F	C-Area Burning/Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) OU	31	IROD ROD	1999 2008	SVE, Air Sparging, Soil Cover, MNA	0.6	141.2
5	G	D-Area OU	63	EAROD	2011	Removal Action (Excavation, Thermal Treatment, SVE), LUCs	210	162.5
6	H	F-Area Groundwater OU	8	IROD	1995	Barrier Wall Funnel and Gate System with Base Injection (Pump-and-Treat Groundwater previously implemented), LUCs (RCRA Permit Renewal)	267.1	N/A
7	I	H-Area Groundwater OU	9	IROD	1995	Barrier Wall Funnel and Gate System with Base Injection (Pump-and-Treat Groundwater previously implemented), LUCs (RCRA Permit Renewal)	303.2	N/A
8	J	M-Area Settling Basin Inactive Process Sewer Lines to Manhole 1 (081-M) OU	19	ROD	2007	SVE, Soil Fracturing, LUCs	1.6	5.3

Table 1. SRS OUs with Operating Equipment *(continued/end)*

#	Appendix	Operable Unit	CERCLIS No.	Remedy Decision Document	Decision Document Issuance Year	Remedial Action[a]	Area Covered (acres)	LUCs (acres)
9	K	M-Area OU	92	ROD ESD	2009 2009	Removal Actions (Excavation, Backfill), Passive SVE, LUCs	72.6	72.6
10	L	P-Area Burning/Rubble Pit (131-P) OU	59	ROD	2003	Soil Cover, Passive SVE, Groundwater Monitoring	0.8	0.9
11	M	TNX Area OU	21, 29	IROD ESD ROD ESD ESD	1994 2003 2004 2005 2013	Excavation, In Situ Solidification/ Stabilization, SVE (Pump-and-Treat with Air Stripping, Recirculation Wells, Air Sparging previously implemented), Treatability Study (Enhanced Bioremediation with Edible Oil), Cover, Groundwater Monitoring, LUCs	1.84	2.24

[a] OUs may include subunits with contaminants in building material or groundwater that are also addressed by the remedy decision document.

NBN – No Building Number

Table 2. Operation and Maintenance Cost Comparison for SRS OUs with Operating Equipment

Operable Unit	Main Remedy	Remedy Decision Document Year[a]	FY2012-FY2017 O&M Estimated Cost	FY2012-FY2017 O&M Actual Cost	% of Estimate	Comments
A-Area Burning/Rubble Pits (731-A and 731-1A) and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A) OU	SVE	2007	$399,216	$1,246,438	312%	Actual costs are higher than expected because the operational life of the active SVE system exceeded the ROD estimated three-year life.
A/M-Area Groundwater OU	Air stripping, SVE	1992	0	$13,235,807	N/A	RCRA documentation does not require estimated costs to be prepared. Therefore, a cost comparison cannot be provided in this remedy review.
A-Area Miscellaneous Rubble Pile (731-6A) OU	SVE	2003	$299,200	$538,752	180%	Actual costs were higher than expected because the operational life of the active SVE system exceeded the ROD estimated five-year life (anticipated end was FY2009).
C-Area Burning/Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) OU	SVE, MicroBlowers™	2008	$228,000	$701,179	308%	Actual costs are higher than expected due to the increased costs associated with MNA monitoring and reporting. No unexpected costs have been incurred.
D-Area OU	Soil Cover, LUCs	2011	$63,000	$956,062	1,518%	Actual costs are higher than expected because D-Area Bubble Tower Subunit costs were not included in the EAROD cost estimate.
F-Area Groundwater OU	Base injection, LUCs	1995	0	$3,582,920	N/A	RCRA documentation does not require estimated costs to be prepared. Therefore, a cost comparison cannot be provided in this remedy review.
H-Area Groundwater OU	Base injection, LUCs	1995	0	$3,611,856	N/A	RCRA documentation does not require estimated costs to be prepared. Therefore, a cost comparison cannot be provided in this remedy review.
M-Area Settling Basin Inactive Process Sewer Lines to Manhole 1 (081-M) OU	SVE	2007	$975,240	$761,227	78%	Actual O&M costs are as expected compared to the estimated O&M costs, until FY2015. Active SVE operations were supposed to end in FY2014, but are continuing to operate. Additional operating equipment repairs were incurred in FY2016/FY2017.

Table 2. Operation and Maintenance Cost Comparison for SRS OUs with Operating Equipment *(continued/end)*

Operable Unit	Main Remedy	Remedy Decision Document Year[a]	FY2012-FY2017 O&M Estimated Cost	FY2012-FY2017 O&M Actual Cost	% of Estimate	Comments
M-Area OU	Cap	2009	$372,000	$673,572	181%	Actual costs are higher than expected because the estimated cost did not include maintenance for the entire MAOU (e.g., mowing).
P-Area Burning/Rubble Pit (131-P) OU	Groundwater Monitoring / Passive SVE	2003	$186,292	$107,996	58%	The actual O&M costs are as expected, with the exception that the ROD estimated every five-year major soil cover repairs have not been necessary (FY2012 and FY2017) and inspections are performed annually instead of monthly as originally estimated.
TNX Area OU	SVE	1994	$1,512,918	$1,350,984	89%	The actual O&M costs are as expected compared to the estimated O&M costs.

FIFTH FIVE-YEAR REMEDY REVIEW REPORT PHASED REVIEWS

I. FIVE-YEAR REMEDY REVIEW PHASES

The size of the Savannah River Site (SRS) five-year remedy review reports has grown considerably since the first report was issued in 1997 due to the number of operable unit (OU) remedies evaluated and the level of detail required. For the Fifth Five-Year Remedy Review Report, the U.S. Department of Energy, U.S. Environmental Protection Agency (USEPA), and South Carolina Department of Health and Environmental Control (SCDHEC) agreed to segregate the OUs into five groupings based on remedy similarity with a different group submitted annually on a five-year cycle. This phased approach not only reduces the volume of future remedy reports, but is also more effective in identifying and resolving issues for similar remedies.

The SRS OUs are grouped by the following remedy types:

(1) Native Soil Covers and/or Land Use Controls (LUCs);
(2) Groundwater Remedies;
(3) Engineered Cover Systems;
(4) Geosynthetic or Stabilization/Solidification (S/S) Cover Systems; and
(5) Operating Equipment.

The trigger date for submittal of the next five-year remedy review report to the regulatory agencies is based on the USEPA signature date of the previous report. The final signature for the last grouping of the Fifth Five-Year Remedy Review Report is due no later than January 21, 2019. Prior to implementing the five annual remedy review submittals, a transitional period is necessary to prevent exceeding the five-year limit required between decision document reviews to remain in compliance with Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan. Issuance dates for the Fifth Five-Year Remedy Review Report during the transitional period are scheduled to occur over a four-year period (2016 to 2019). Table A-1 provides an overview of the number of years between remedy reviews for the five OU remedy groupings beginning with the transitional period between the fourth, fifth, and sixth reports until the five-year cycle is fully established between the sixth and seventh year reports.

A list of the SRS OUs with remedy decision documents grouped into the five phased reviews is provided in Table A-2. Table A-2 will be updated in future remedy review reports as additional remedy decision documents are approved. A general description of the five remedy types is provided below.

Phase 1: Native Soil Covers and/or LUCs

For purposes of the fifth five-year phased remedy review, SRS OUs with native soil covers and/or LUCs as the selected remedy are grouped under the Native Soil Covers and/or LUCs category.

Native soil covers are often implemented at SRS to protect against human and/or ecosystem exposure to waste or contaminated material left in place. Native soil covers are appropriate when water infiltration and leaching of contaminants to groundwater is not a concern. A typical soil cover is 0.30 m to 0.61 m (12 to 24 in) thick and is usually vegetated to minimize erosion. Native soil covers are usually low in cost and construction and materials are readily available from SRS local sources. Native soil covers may be combined with other remedial actions, but require LUCs as a component of the remedy. For these units, native soil covers were in place prior to selection of the remedial action. For this reason, only LUCs were required as the final remedial action for the nine OUs with existing soil covers discussed in the Native Soil Covers and/or LUCs report.

LUCs are maintained for all OUs where hazardous substances, pollutants, or contaminants remain on-site or have been left in place above levels that are acceptable for unlimited use and unrestricted exposure. LUCs may be implemented as a stand-alone remedy or combined with other remedial actions. LUCs involve institutional controls (i.e., administrative controls) and engineering controls and can include monitoring, maintenance, reporting, access restrictions, signage, fencing, and land use restrictions. In older SRS remedy documents, the term “institutional controls” was often used in place of the broader LUC term.

Phase 2: Groundwater Remedies

For purposes of the fifth five-year phased remedy review, SRS OUs that have similar groundwater monitoring activities, primarily associated with Monitored Natural Attenuation (MNA) or a Mixing Zone (MZ) permit, are grouped in the Groundwater Remedies category.

SRS uses a graded approach to groundwater remediation. The selection of groundwater remediation technologies for a specific contamination area is based on the size, contaminant type, contaminant concentration, configuration, and hydrogeologic setting of the plume. These attributes are the result of the nature and mass of the source of contamination and the subsurface characteristics of the plume. Many large plumes consist of several zones that are most efficiently addressed with separate complementary corrective action/remedial technologies. The highest concentrations of contaminants are found in the source zone. The most robust, high-mass-removal technologies are best suited for remediation of the source zone. In the primary plume zone, active remedies such as pump-and-treat may be necessary to remove contaminants and exert hydraulic control of the plume. Operable units that are undergoing active groundwater remedies are evaluated in Phase 5: Operating Equipment. In the dilute fringe zone, contaminants are generally low in concentration and can often be treated with passive techniques.

MNA is a passive groundwater remedial action where the fringe and dilute areas of a plume degrade by natural biogeochemical or physical processes such as biodegradation, radioactive decay, dilution, and simple dispersion. MNA remedies must be accompanied by source control and a technical justification that conditions are favorable for natural attenuation. In addition, the groundwater plume should not be expanding significantly, and surface water standards cannot be exceeded at the groundwater discharge point. MNA remedy justifications are supported by groundwater modeling and a commitment to continued monitoring and reporting. When only the uppermost aquifer is impacted, SCDHEC may issue a MZ permit that is essentially a permit for an MNA remedy. SRS has a mixture of CERCLA Record of Decisions (RODs) that require MNA as the final action for groundwater under CERCLA, and RODs that require SCDHEC MZ permits to implement the MNA remedy.

Phase 3: Engineered Cover Systems

For purposes of the fifth five-year phased remedy review, SRS OUs that selected an engineered cover system or similar cover system as the remedy, are grouped in the Engineered Cover Systems category.

The function of an engineered cover system is similar to native soil covers to protect against human and/or ecosystem exposure to waste or contaminated material left in place. Although engineered covers do not prevent infiltration, they can achieve very low permeabilities if well compacted. Compaction is important to reduce damage from differential settlement and is often used at SRS to remediate OUs that contain diverse waste material such as rubble pits/piles. Another objective of using engineered cover systems is to promote more effective surface drainage and to minimize infiltration.

SRS OUs were placed in this grouping if the selected cover features exceeded those of a basic native soil cover. For example, an OU with a remedy that selected cover and/or fill material with a higher clay content to minimize infiltration or for drainage and slope contouring was included in this category even if the clay material did not have engineering compaction requirements.

Phase 4: Geosynthetic or Stabilization/Solidification Cover Systems

For purposes of the fifth five-year phased remedy review, SRS OUs that installed a geosynthetic or stabilization/solidification cover system are grouped in the Geosynthetic or S/S Cover Systems category.

Many cover systems are designed to protect groundwater by minimizing the infiltration of rainwater through the contaminated material left in place. Geosynthetic cover systems are constructed at SRS OUs when there is a concern that contamination left in place may leach to groundwater above acceptable levels. A typical cross section of a geosynthetic cover system consists of a vegetative/soil protective layer, a geosynthetic drainage layer, an impermeable geosynthetic liner, and compacted common fill placed over the contaminated material. A specific hydraulic conductivity to reduce stormwater infiltration, usually 1E-07 cm/s or less, is specified in the design. Low permeability covers are often paired with soil vapor extraction (SVE) units that remove volatile organic compounds (VOCs) from the subsurface soil beneath the OU to prevent migration of contaminants to groundwater.

In some cases, radioactively contaminated soils have been stabilized with in-situ grouting followed by installation of a low permeability cover (i.e., compacted clay, concrete, etc.) to deter migration of contaminants to the groundwater. Not only does a S/S technology stabilize waste left in place, the in-situ containment also provides another layer of protection to prevent intrusion and exposure to contaminated material.

Phase 5: Operating Equipment

For purposes of the fifth five-year phased remedy review, SRS OUs that have ongoing active remediation systems are grouped under the Operating Equipment category.

A range of active remediation systems are used at SRS. SVE systems are used to remove VOCs from vadose zone source areas before the contaminants can migrate to the water table. Air strippers are employed to remove VOC contaminants from groundwater in the source zone. Pump and treat systems are used to remove contaminant mass and exert hydraulic control over contaminated groundwater plumes. Thermal technologies have been employed in several areas to mobilize dense non-aqueous phase liquid (DNAPL) VOCs in the vadose zone and groundwater. Dynamic Underground Stripping is a technology employed at SRS that utilizes steam injection to enhance removal from large DNAPL source zones. Electrical Resistance Heating has been used in smaller DNAPL source zones.

Enhanced-passive remedial systems are used extensively at SRS for groundwater remediation. These systems are low-energy-consumption, low-carbon-emission systems that are not completely passive. These “green” technologies leverage natural systems to protect and remediate groundwater. Many existing SVE systems have been converted from active vacuum extraction powered by fossil fuel to enhanced-passive systems powered by natural non-fossil-fuel energy sources. BaroBall™ and MicroBlower™ systems are two types of enhanced-passive SVE systems currently in operation at SRS. BaroBalls™ rely on natural fluctuations in barometric pressure to pump VOCs from the subsurface at individual SVE wells. SVE wells with MicroBlowers™ are designed to use solar power to generate a vacuum that exhausts VOC vapors from individual wells. Both MicroBlowers™ and BaroBalls™ are low-energy-consumption, low-carbon-emission devices that remove VOC contaminants from the subsurface.

After active systems have removed a significant amount of contaminant mass, the remedial technology is reevaluated through effectiveness monitoring reports, performance evaluation reports, and/or five-year remedy reviews to determine if the active system should transition to passive and enhanced natural technologies. For the remedial actions evaluated in this report, a discussion of the transition from active to passive remediation are discussed as appropriate in Appendices C through M.

II. SRS OUS WITH REMEDIAL DECISIONS

The following tables are included for information only and provide a tracking for all SRS OUs with approved remedial decisions, including No Action sites (i.e., RODs, Early Action RODs [EARODs], Interim RODs [IRODs], ROD Amendments, and Explanation of Significant Differences [ESDs]).

- Table A-3 chronologically lists all SRS issued decision documents. Document numbers are provided for reference;
- Table A-4 provides a summary of the “no remedial actions” selected in the decision documents; and

- Table A-5 provides the OU subunits with issued remedial decision documents and their associated Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) number.

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Table A-1. Phased Five-Year Remedy Review Report Schedule

Fourth Five-Year Review		Fifth Five-Year Review		Sixth Five-Year Review		Seventh Five-Year Review	
Issuance Year	Years Between Reviews	Issuance Year	Years Between Reviews	Issuance Year	Years Between Reviews	Issuance Year	Remedy Type
2014	2	2016 [a]	4	2020	5	2025	Phase 1: Native Soil Covers and/or LUCs
2014	3	2017	4	2021	5	2026	Phase 2: Groundwater Remedies
2014	4	2018	4	2022	5	2027	Phase 3: Engineered Cover Systems
2014	4	2018	5	2023	5	2028	Phase 4: Geosynthetic or S/S Cover Systems
2014	5	2019 [b]	5	2024	5	2029	Phase 5: Operating Equipment

a The Fifth Five-Year Remedy Review Report for SRS OUs with Native Soil Covers and LUCs was issued ahead of schedule in November 2015.

b Indicates the issue year for this report: Fifth Five-Year Remedy Review Report for SRS OUs with Operating Equipment.

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Table A-2. Fifth Five-Year Remedy Review Report Phases for SRS OUs

Native Soil Covers and/or LUCs		**Groundwater**		**Engineered Cover Systems**		**Geosynthetic or Stabilization/Solidification Cover Systems**		**Operating Equipment**	
Submittal Date[a]	***Issuance Year***	***Submittal Date***[a]	***Issuance Year***	***Submittal Date***[a]	***Issuance Year***	***Submittal Date***[a]	***Issuance Year***	***Submittal Date***[a]	***Issuance Year***
2014	**2015**	**2015**	**2017**	**2016**	**2018**	**2016**	**2018**	**2017**	**2019**
C-Area Operable Unit[b]		C-Area Groundwater		Central Shops Burning/Rubble Pits (631-1G and 631-3G)		B-Area Operable Unit		A-Area Burning/Rubble Pits (731-A/731-1A) and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A)	
C-, K-, and L-Reactor Complexes		Chemicals, Metals, and Pesticides Pit (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G)		D-Area Burning/Rubble Pits (431-D and 431-1D)		C-Area Reactor Seepage Basins (904-66G and 904-68G)		A/M-Area Groundwater	
Early Construction and Operational Disposal Site (ECODs) L-1, N-2, P-2, and R-1A, -1B, -1C		D-Area Oil Seepage Basin (631-G)		F-Area Hazardous Waste Management Facility (904-41G, 904-42G, and 904-43G)		D-Area Expanded Operable Unit (Consisting of D-Area Ash Basin [488-D] and D-Area Rubble Pit [431-2D])		A-Area Miscellaneous Rubble Pile (731-6A)	
F-Area Burning/Rubble Pits (231-F, 231-1F, and 231-2F)		L-Area Burning/Rubble Pit (131-L)		Ford Building Seepage Basin (904-91G)		E-Area Low-Level Waste Facility (643-26E)		C-Area Burning/Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN)	
Gunsite 012		L-Area Southern Groundwater		H-Area Hazardous Waste Management Facility (904-44G, 904-45G, 904-46G, and 904-56G)		F-Area Tank Farm		D-Area Operable Unit	
Heavy Equipment Wash Basin (No Building Number [NBN])		R-Area Operable Unit		K-Area Burning/Rubble Pit and K-Area Rubble Pile (131-K and 631-20G)		F-Area Retention Basin (281-3F)		F-Area Groundwater Operable Unit	
K-Area Bingham Pump Outage Pit (643-1G)		R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, and 904-104G) and 108-4R Overflow Basin		M-Area Hazardous Waste Management Facility (904-51G and 904-112G)		General Separations Area Consolidation Unit		H-Area Groundwater Operable Unit	
L-Area and P-Area Bingham Pump Outage Pits (643-2G, 643-3G, and 643-4G)				Metallurgical Laboratory Hazardous Waste Management Facility (904-110G)		H-Area Tank Farm[d]		M-Area Settling Basin Inactive Process Sewer Lines to Manhole 1 (081-M)	

Table A-2. Fifth Five-Year Remedy Review Phases for SRS OUs (*continued/end*)

Native Soil Covers and/or LUCs		**Groundwater**		**Engineered Cover Systems**		**Geosynthetic or Stabilization/Solidification Cover Systems**		**Operating Equipment**	
Submittal Date[a]	***Issuance Year***	***Submittal Date***[a]	***Issuance Year***	***Submittal Date***[a]	***Issuance Year***	***Submittal Date***[a]	***Issuance Year***	***Submittal Date***[a]	***Issuance Year***
2014	**2015**	**2015**	**2017**	**2016**	**2018**	**2016**	**2018**	**2017**	**2019**
PAR Pond (685-G) (Including the Pre-Cooler Ponds and Canals) and Lower Three Runs Integrator Operable Unit (IOU) Tail Portion (Middle and Lower Subunits)				Mixed Waste Management Facility (643-28E)		K-Area Reactor Seepage Basin (904-65G)		M-Area Operable Unit	
R-Area Bingham Pump Outage Pits (643-8G, 643-9G and 643-10G) and R-Area Unknown Pits #1, #2, and #3				SRL Seepage Basins (904-53G1, 904-53G2, 904-54G, and 904-55G)		L-Area Oil and Chemical Basin (904-83G)		P-Area Burning/Rubble Pit (131-P)	
Silverton Road Waste Unit (731-3A)						L-Area Reactor Seepage Basin (904-64G) and C-Area Reactor Seepage Basin (904-67G)		TNX Area Operable Unit	
Wetland Area at Dunbarton Bay in Support of Steel Creek IOU[c]						Old F-Area Seepage Basin (904-49G)			
						P-Area Operable Unit			
						P-Area Reactor Seepage Basin (904-61G, 904-62G, and 904-63G)			
						R-Area Burning/Rubble Pits (131-R and 131-1R) and R-Area Rubble Pile (631-25G)			
						T-Area Operable Unit			

a Represents December submittal date of the Revision 0 document for each five-year remedy review report.

b C-Area Operable Unit EAROD was issued in September 2015. This OU is not included in the first phase of the fifth five-year remedy review (i.e. native soil covers and/or LUCs) because the decision document was issued during development of the report and a remedy evaluation was premature.

c The Wetland Area at Dunbarton Bay ROD was issued in 2018. This OU was not included in the first phase of the fifth five-year review (i.e., native soil covers and/or LUCs) because the remedy has not been implemented.

d H-Area Tank Farm (Waste Tank 16) IROD was issued in August 2016. H-Area Tank Farm (Waste Tank 12) ESD to the IROD was issued in April 2017. A remedy evaluation in the fourth phase of the fifth five-year remedy review (i.e., geosynthetic or S/S cover systems) was premature.

Table A-3. Chronological Listing of SRS Issued Decision Documents

Document Title[a]	Document Number	Rev	Issuance Date[b]
Consent Decree Signed			***May 26, 1988***
NPL Listing Effective Date			***December 21, 1989***
A/M Area Groundwater IROD (RCRA)	**WSRC-RP-92-744**	**0**	**September 16, 1992**
M-Area Hazardous Waste Management Facility (904-51G, 904-112G) IROD (RCRA)	WSRC-RP-92-743	0	September 16, 1992
Metallurgical Laboratory Hazardous Waste Management Facility (904-110G) IROD (RCRA)	WSRC-RP-92-745	0	September 16, 1992
Federal Facility Agreement Declared Effective			***August 16, 1993***
F-Area Hazardous Waste Management Facility (904-41G, 904-42G, and 904-43G) ROD (RCRA)	WSRC-RP-93-1042	1	October 1, 1993
H-Area Hazardous Waste Management Facility (904-44G, 904-45G, 904-46G, and 904-56G) ROD (RCRA)	WSRC-RP-93-1043	1	October 1, 1993
Mixed Waste Management Facility (643-28E) ROD (RCRA)[c]	WSRC-RP-93-1511	1	September 23, 1994
Tank 105-C Hazardous Waste Management Facility ROD (RCRA)[c]	WSRC-RP-94-106	1	September 23, 1994
TNX Groundwater Operable Unit IROD[c]	**WSRC-TR-94-0375**	**1**	**November 16, 1994**
PAR Pond (685-G) IROD[c]	WSRC-RP-93-1549	0	February 16, 1995
F-Area Groundwater Operable Unit IROD (RCRA)[c]	**WSRC-RP-94-1162**	**1**	**April 13, 1995**
H-Area Groundwater Operable Unit IROD (RCRA)[c]	**WSRC-RP-94-1163**	**1**	**April 13, 1995**
M-Area West Unit (631-21G) ROD[c]	WSRC-RP-95-626	0	September 29, 1995
Old Radioactive Waste Burial Ground (643-E) IROD	WRSC-RP-96-102	0	July 25, 1996
Burma Road Rubble Pit (231-4F) ROD	WSRC-RP-96-101	1	July 25, 1996
D-Area Burning/Rubble Pits (431-D and 431-1D) ROD	WSRC-RP-96-867	1	July 3, 1997
F-Area Burning/Rubble Pits (231-F, 231-1F, and 231-2F) ROD	WSRC-RP-96-868	1	July 3, 1997
Grace Road Site (631-22G) ROD	WSRC-RP-96-160	1	July 3, 1997
Gunsite 113 Access Road Unit (631-24G) ROD	WSRC-RP-96-833	1	July 3, 1997
Gunsite 720 Rubble Pit Unit (631-16G) ROD	WSRC-RP-96-832	1	July 3, 1997
Silverton Road Waste Unit (713-3A) ROD	WSRC-RP-96-171	1	July 3, 1997
Central Shops Burning/Rubble Pit (631-6G) ROD	WSRC-RP-96-873	1	July 3, 1997
Old F-Area Seepage Basin (904-49G) ROD	WRSC-RP-96-872	1.1	July 3, 1997

Table A-3. Chronological Listing of SRS Issued Decision Documents *(continued)*

Document Title[a]	Document Number	Rev	Issuance Date[b]
First Five-Year Remedy Review	***WSRC-RP-97-403***	***0***	***August 27, 1997***
TNX Groundwater Operable Unit ESD	**WSRC-RP-97-169**	**1**	**October 10, 1997**
K-Area Bingham Pump Outage Pit (643-1G) ROD	WSRC-RP-97-178	1	June 11, 1998
C-, F-, K-, and P-Area Coal Pile Runoff Basins (189-C, 289-F, 189-K, and 189-P) ROD[c]	WSRC-RP-97-850	1	November 10, 1998
L-Area Oil and Chemical Basin and L-Area Acid/Caustic Basin (904-83G and 904-79G) ROD	WSRC-RP-97-143	1	November 10, 1998
716-A Motor Shops Seepage Basin (904-101G) ROD	WSRC-RP-97-840	0	November 16, 1998
Fire Department Hose Training Facility (904-113G) ROD	WSRC-RP-97-171	1	November 16, 1998
Old F-Area Seepage Basin (904-49G) ESD	WSRC-RP-98-4123	1	December 16, 1998
D-Area Oil Seepage Basin (631-G) ROD	WSRC-RP-97-402	1	May 7, 1999
C-Area Burning/Rubble Pit (131-C) IROD	**WSRC-RP-98-4039**	**0**	**May 7, 1999**
F-Area Retention Basin (281-3F) ROD	WSRC-RP-97-145	1.1	May 19, 1999
Ford Building Waste Site (643-11G) ROD	WSRC-RP-98-4066	1	October 13, 1999
Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G) IROD	WSRC-RP-98-4192	1.1	January 19, 2000
SRL Seepage Basins (904-51G1, 904-52G2, 904-52G, and 904-55G) ROD	WSRC-RP-97-848	1.1	April 26, 2000
C-Area Reactor Seepage Basins (904-66G, 904-67G, and 904-68G) Plug-In ROD ESD	WSRC-RP-2000-4032	0	October 18, 2000
L & P Bingham Pump Outage Pits (643-2G, 643-3G, and 643-4G) ROD	WSRC-RP-98-4015	1	October 18, 2000
Burma Road Rubble Pit (231-4F) ESD[c]	WSRC-RP-98-4170	1	February 6, 2001
A-Area Burning/Rubble Pits (731-A/731-1A) and Rubble Pit (731-2A) IROD	**WSRC-RP-2000-4001**	**1**	**February 9, 2001**
Miscellaneous Chemical Basin/Metals Burning Pit (731-4A/731-5A) IROD	**WSRC-RP-98-4031**	**1.1**	**February 9, 2001**
West of SRL “Georgia Fields” Site (631-19G) ROD	WSRC-RP-99-4164	0	February 22, 2001
F-Area Retention Basin (281-3F) ESD[c]	WSRC-RP-2000-4079	1	June 7, 2001
K-Area Burning/Rubble Pit (131-K & 631-20G) ROD[c]	WSRC-RP-97-862	1	August 20, 2001
ORWBG Old Solvent Tanks (650-01E - 22E) IROD	WSRC-RP-2000-4193	1	September 27, 2001
Ford Building Seepage Basin ROD	WSRC-RP-2000-4156	1	April 5, 2002

Table A-3. Chronological Listing of SRS Issued Decision Documents *(continued)*

Document Title[a]	**Document Number**	**Rev**	**Issuance Date**[b]
Chemical, Metals, and Pesticides Pits (080-170G, 080-171G, 080-181G, 080-182G, 080-183G, and 080-190G) IROD Amendment	WSRC-RP-2000-4158	1.2	April 8, 2002
K-Area Reactor Seepage Basin ESD[c]	WSRC-RP-99-4200	1.1	September 16, 2002
General Separations Area Consolidation Unit ROD	WSRC-RP-2002-4002	0	October 25, 2002
Central Shops Sludge Lagoon (080-24G) ROD	WSRC-RP-2000-4189	1	November 15, 2002
C-Area Reactor Seepage Basin (904-67G) & L-Area Reactor Seepage Basin (904-64G) ROD Amendment	WSRC-RP-2002-4063	1	December 5, 2002
R-Area Acid/Caustic Basin (904-77G) ROD	WSRC-RP-2002-4015	1	February 10, 2003
L-Area Burning/Rubble Pit (131-L) & L-Area Rubble Pile (131-3L) & Gas Cylinder Disposal Facility (131-2L) ROD	WSRC-RP-98-4195	1.1	February 17, 2003
A-Area Burning/Rubble Pits (731-A/731-1A) and Rubble Pit (731-2A) ESD	**WSRC-RP-2001-4281**	**1**	**March 10, 2003**
R-Area Bingham Pump Outage Pits (643-8G, 643-9G and 643-10G) and R-Area Unknown Pits #1, #2, and #3 ROD	WSRC-RP-2001-4129	1.1	April 28, 2003
TNX Area Groundwater Operable Unit ESD[c]	**WSRC-RP-2001-00764**	**0**	**May 19, 2003**
Central Shops Burning/Rubble Pits (631-1G and 631-3G) ROD	WSRC-RP-2001-4265	1.1	June 30, 2003
P-Area Burning/Rubble Pit (131-P) ROD	**WSRC-RP-2000-4197**	**1**	**August 8, 2003**
A-Area Miscellaneous Rubble Pile (731-6A) ROD	**WSRC-RP-2001-4197**	**1.3**	**August 11, 2003**
P-Area Reactor Seepage Basin (904-61G, 904-62G, and 904-63G) Plug-In ROD ESD	WSRC-RP-2002-4105	1.1	October 2, 2003
Chemical, Metals, and Pesticides Pits (080-170G, 080-171G, 080-181G, 080-182G, 080-183G, and 080-190G) Second IROD Amendment	WSRC-RP-2001-4232	1.1	October 21, 2003
L-Area Hot Shop (717-G) ROD	WSRC-RP-2002-4025	1.1	November 3, 2003
Road A Chemical Basin (904-111G) ROD	WSRC-RP-2002-4153	0	November 3, 2003
Second Five-Year Remedy Review[c]	***WSRC-RP-2001-4163***	***1.1***	***February 12, 2004***
R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, and 904-104G) and 108-4R Overflow Basin ROD	WSRC-RP-2003-4093	1	March 18, 2004
TNX Burying Ground (643-G), New TNX Seepage Basin, Old TNX Seepage Basin and TNX Groundwater (082-G) ROD	**WSRC-RP-2003-4017**	**1**	**April 7, 2004**
SRL Oil Test Site (808-16G) ROD	WSRC-RP-2003-4164	1	September 20, 2004

Table A-3. Chronological Listing of SRS Issued Decision Documents *(continued)*

Document Title[a]	**Document Number**	**Rev**	**Issuance Date[b]**
R-Area Burning/Rubble Pits (131-R, 131-1R) and R-Area Rubble Pile (631-25G) ROD	WSRC-RP-2004-4004	1	September 28, 2004
C-Area Reactor Groundwater IROD	WSRC-RP-2004-4022	1	October 15, 2004
D-Area Expanded Operable Unit (Consisting of D-Area Ash Basin [488-D] and D-Area Rubble Pit [431-2D]) ROD	WSRC-RP-2004-4007	1	December 17, 2004
Old F-Area Seepage Basin (904-49G) ROD Amendment	WSRC-RP-2003-4136	1	December 17, 2004
Heavy Equipment Wash Basin and Central Shops Burning/Rubble Pit (631-5G) ROD	WSRC-RP-2003-4185	1.1	January 28, 2005
Chemical, Metals, and Pesticides Pits (080-170G, 080-171G, 080-181G, 080-182G, 080-183G, and 080-190G) ROD	WSRC-RP-2004-4090	1	May 10, 2005
Silverton Road Waste Unit (731-3A) ESD	WSRC-RP-2004-4092	1.1	June 16, 2005
TNX Area Operable Unit ESD	**WSRC-RP-2005-4030**	**1**	**November 7, 2005**
Hydrofluoric Acid Spill (631-4G) ROD	WSRC-RP-2005-4000	0	December 28, 2005
T-Area Operable Unit ROD	WSRC-RP-2004-4070	1	January 4, 2006
K-Area Sludge Land Application Site (761-4G) and PAR Pond Sludge Land Application Site (761-5G) ROD	WSRC-RP-2005-4064	1	June 30, 2006
211-FB Pu-239 Release (081-F) ROD	WSRC-RP-2005-4090	1	September 18, 2006
M-Area Inactive Process Sewer Lines (081-M) ROD	**WSRC-RP-2006-4001**	**1**	**April 26, 2007**
L-Area Southern Groundwater ROD	WSRC-RP-2006-4052	1.1	May 9, 2007
A-Area Burning/Rubble Pits and Rubble Pit (731-A, 731-1A, 731-2A) and the Miscellaneous Chemical Basin/Metals Burning Pit (731-4A/731-5A) ROD	**WSRC-RP-2005-4095**	**1.1**	**August 2, 2007**
C-Area Burning/Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) ROD	**WSRC-RP-2007-4082**	**1**	**July 9, 2008**
Third Five-Year Remedy Review	***WSRC-RP-2007-4063***	***1.1***	***January 29, 2009***
P-Area Operable Unit EAROD	WSRC-RP-2008-4037	1.1	January 29, 2009
M-Area Operable Unit ROD	**WSRC-RP-2008-4030**	**1**	**February 5, 2009**
M-Area Operable Unit ESD	**SRNS-RP-2009-00406**	**1**	**July 9, 2009**
P-Area Operable Unit EAROD ESD	SRNS-RP-2009-00704	1	October 27, 2009
C-, K-, L- and R-Reactor Complexes EAROD	SRNS-RP-2009-00707	1	December 8, 2009
E-Area Low Level Waster Facility (Slit Trench Disposal Units 1 and 2) IROD	SRNS-RP-2009-00538	1	January 22, 2010
Early Construction and Operational Disposal Site L-1, N-2, P-2, R-1A, R-1B, R-1C ROD	SRNS-RP-2009-00072	1	March 30, 2010

Table A-3. Chronological Listing of SRS Issued Decision Documents *(continued/end)*

Document Title[a]	Document Number	Rev	Issuance Date[b]
E-Area Low Level Waste Facility (Slit Trench Disposal Units 3 through 5) ESD to the IROD	SRNS-RP-2009-01128	1	April 22, 2010
P-Area Operable Unit ROD	SRNS-RP-2009-01368	1	July 22, 2010
Gunsite 218 Rubble Pile ROD	SRNS-RP-2010-00051	1	October 22, 2010
R-Area Operable Unit ROD	SRNS-RP-2010-01062	1	April 20, 2011
L-Area Northern Groundwater ROD	SRNS-RP-2011-00134	1	June 20, 2011
Gunsite 012 (including ECODS G-3) ROD	SRNS-RP-2010-01232	1	June 27, 2011
D-Area Operable Unit EAROD	**SRNS-RP-2010-00162**	**1.2**	**September 26, 2011**
PAR Pond Unit: Lower Three Runs IOU Tail Portion (Middle and Lower Subunits) ESD	SRNS-RP-2012-00121	1	September 13, 2012
B-Area Operable Unit ROD	SRNS-RP-2012-00354	1	April 16, 2013
F-Area Tank Farm (Waste Tanks 17 and 20) IROD	SRR-CWDA-2013-00111	1	April 30, 2013
TNX Area Operable Unit (Second ESD to the ROD)	**SRNS-RP-2012-00205**	**1**	**June 12, 2013**
F-Area Tank Farm (Tanks 18 and 19) ESD to the IROD)	SRR-CWDA-2013-00007	1.1	September 23, 2013
Fourth Five-Year Remedy Review	***SRNS-RP-2012-00011***	***1.1***	***February 4, 2014***
L-Area Southern Groundwater Operable Unit ESD to the ROD	SRNS-RP-2012-00736	1	September 10, 2014
F-Area Tank Farm (Tanks 5 and 6) ESD to the IROD	SRR-CWDA-2014-00008	1	September 11, 2014
C-Area Operable Unit EAROD	SRNS-RP-2014-00836	1	September 2, 2015
Fifth Five-Year Remedy Review for SRS OUs with Native Soil Covers and/or LUCs	***SRNS-RP-2014-00902***	***1***	***November 30, 2015***
H-Area Tank Farm (Waste Tank 16) IROD	SRR-CWDA-2015-00157	1	August 16, 2016
Fifth Five-Year Remedy Review for SRS OUs with Groundwater Remedies	***SRNS-RP-2015-00419***	***1***	***February 2, 2017***
H-Area Tank Farm (Waste Tank 12) ESD to the IROD	SRR-CWDA-2016-00107	0	April 20, 2017
Fifth Five-Year Remedy Review for SRS OUs with Engineered Covers	***SRNS-RP-2016-00609***	***1***	***February 21, 2018***
Fifth Five-Year Remedy Review for SRS OUs with Geosynthetic or S/S Cover Systems	***SRNS-RP-2016-00610***	***1***	***March 27, 2018***
Wetland Area at Dunbarton Bay in Support of Steel Creek IOU ROD	SRNS-RP-2013-00730	1	June 20, 2018

[a] Shaded text identifies the SRS OUs evaluated in this report for the fifth phase of the fifth five-year review (i.e., operating equipment).

[b] Unless otherwise noted, the Issuance Date represents the date that the public was notified that the Three-Party signed document was available.

[c] This is the last signature date instead of the Issuance Date.

Table A-4. Summary of No Remedial Actions at SRS OUs

Operable Unit	Remedial Action
No Action/No Further Action	
211-FB Pu-239 Release (081-F)	No Action
716-A Motor Shops Seepage Basin (904-101G)	No Action
Burma Road Rubble Pit (231-4F)	No Action
Central Shops Burning/Rubble Pit (631-6G)	No Action
Central Shops Sludge Lagoon (080-24G)	No Action
C-, F-, K-, and P-Area Coal Pile Runoff Basins (189-C, 289-F, 189-K, and 189-P)	No Further Action
Fire Department Hose Training Facility (904-113G)	No Action
Ford Building Waste Site (643-11G)	No Further Action (Removal)
Gas Cylinder Disposal Facility (131-2L)	No Action
Grace Road Site (631-22G)	No Action
Gunsite 113 Access Road Unit (631-24G)	No Action
Gunsite 218 Rubble Pile (621-23G)	No Action
Gunsite 720 Rubble Pit Unit (631-16G)	No Action
Hydrofluoric Acid Spill (631-4G)	No Action
K-Area and PAR Pond Sludge Land Application Site (761-4G and 761-5G)	No Action
L-Area Burning/Rubble Pit (131-L)	No Action
L-Area Hot Shop (717-G)	No Further Action
L-Area Northern Groundwater (NBN)	No Action
M-Area West Unit (631-21G)	No Action
L-Area Rubble Pile (131-3L)	No Action
R-Area Acid/Caustic Basin (904-77G)	No Action
Road A Chemical Basin (904-111G)	No Action
SRL Oil Test Site (080-16G)	No Action
West of SRL "Georgia Fields" Site (631-19G)	No Action
No Action/No Further Action OUs Associated with OUs Requiring Remedial Action	
108-4R Overflow Basin (108-4R)[1]	No Further Action
Central Shops Burning/Rubble Pit (631-5G)[2]	No Action
ECODS B-3 and B-5 (NBN)[3]	No Further Action
ECODS G-3 (Adjacent to Gunsite 012) (NBN)[4]	No Action
L-Area Acid/Caustic Basin (904-79G)[5]	No Action
Rubble Pile Across from Gunsite 012 (NBN)[4]	No Action
RCRA Units that are No Further Action under CERCLA	
H-Area Hazardous Waste Management Facility (904-44G, 904-45G, 904-46G, and 904-56G)	No Further Action (Low Permeability Cap)
Tank 105-C Hazardous Waste Management Facility (NBN)	No Further Action
F-Area Hazardous Waste Management Facility (904-41G, 904-42G, and 904-43G)	No Further Action (Low Permeability Cap, In Situ S/S)
Mixed Waste Management Facility (643-28E)	No Further Action (Low Permeability Cap)

1 – Included with R-Reactor Seepage Basins (904-103G, 904-104G, 904-57G, 904-58G, 904-59G, 904-60G)
2 – Included with Heavy Equipment Wash Basin (NBN)
3 – Included with B-Area Operable Unit
4 – Included with Gunsite 012
5 – Included with L-Area Oil and Chemical Basin (904-83G)

Table A-5. List of OU Subunits with Remedial Actions

#	OU Subunits[a,b]	CERCLIS #
1	A-Area Burning/Rubble Pit, 731-1A	28
	A-Area Burning/Rubble Pit, 731-A	
	A-Area Rubble Pit, 731-2A	
	Miscellaneous Chemical Basin, 731-4A	
	Metals Burning Pit, 731-5A	
2	A-Area Miscellaneous Rubble Pile, 731-6A	30
3	A/M-Area Groundwater	36
4	B-Area Operable Unit	53
5	C-Area Burning/Rubble Pit, 131-C	31
	Old C-Area Burning/Rubble Pit, NBN	
6	C-Area Groundwater	82
7	C-Area Process Sewer Line as Abandoned, NBN	79
	C-Area Reactor Area Cask Car Railroad Tracks as Abandoned, NBN	
	C-Reactor Discharge Canal, NBN	
	ECODS C-1 (Near C-Area Reactor Discharge Canal), NBN	
	Potential Release from C-Area Disassembly Basin, NBN	
	Potential Release from C-Area Reactor Cooling Water System, 186/190-C	
8	C-Area Reactor Seepage Basin, 904-66G	60
	C-Area Reactor Seepage Basin, 904-67G	
	C-Area Reactor Seepage Basin, 904-68G	
9	Central Shops Burning/Rubble Pit, 631-1G	50
	Central Shops Burning/Rubble Pit, 631-3G	
10	CMP Pit, 080-170G	24
	CMP Pit, 080-171G	
	CMP Pit, 080-180G	
	CMP Pit, 080-181G	
	CMP Pit, 080-182G	
	CMP Pit, 080-183G	
	CMP Pit, 080-190G	
11	C-, K-, L-Reactor Complexes	79, 90, 91
12	D-Area Burning/Rubble Pit, 431-D	15
	D-Area Burning/Rubble Pit, 431-1D	
13	D-Area Ash Basin, 488-D	67
	D-Area Rubble Pit, 431-2D	
14	D-Area Oil Seepage Basin, 631-G	27
15	D-Area Coal Pile Runoff Basin, 489-D	63
	D-Area Waste Oil Facility, 484-10D	
	D-Area Asbestos Pit, 080-20G	
	Combined Spills from 483-D and Associated Areas, NBN	
	D-Area Process Sewer Lines as Abandoned, NBN	
16	E-Area Low Level Waste Facility, 643-26E	86
17	ECODS L-1, NBN	22
	ECODS P-2, NBN	
	ECODS R-1A, -1B, -1C, NBN	
	ECODS N-2, NBN	

Table A-5. List of OU Subunits with Remedial Actions *(continued)*

#	OU Subunits[a,b]	CERCLIS #
18	F-Area Burning/Rubble Pit, 231-1F	14
	F-Area Burning/Rubble Pit, 231-2F	
	F-Area Burning/Rubble Pit, 231-F	
19	F-Area Groundwater Operable Unit	8
20	F-Area Hazardous Waste Management Facility (F-Area Seepage Basin, 904-41G)	6
	F-Area Hazardous Waste Management Facility (F-Area Seepage Basin, 904-42G)	
	F-Area Hazardous Waste Management Facility (F-Area Seepage Basin, 904-43G)	
21	F-Area Retention Basin, 281-3F	23
22	F-Area Tank Farm, Waste Tanks 17 and 20	23
	F-Area Tank Farm, Waste Tanks 18 and 19	
	F-Area Tank Farm, Waste Tanks 5 and 6	
23	Ford Building Seepage Basin, 904-91G	58
24	General Separations Area Consolidation Unit including Old Radioactive Waste Burial Ground(643-E) and Old Solvent Tanks (650-01E through 650-22E)	32
	Warner's Pond, 685-23G and Spill of 3/08/1978 of Unknown Seepage Basin Pipe Leak in H-Area Seepage Basin, NBN and Spill on 02/08/1978 of Unknown H-Area Process Sewer Line Cave-In, NBN	
	H-Area Retention Basin, 281-3H and Spill of 5/01/1956 of Unknown Retention Basin Pipe Leak, NBN	21
	HP-52 Ponds, NBN	
25	H-Area Tank Farm, Waste Tank 12[c]	89
	H-Area Tank Farm, Waste Tank 16[c]	
26	Gunsite 012 Rubble Pile, NBN	78
	Rubble Pile across from Gunsite 012, NBN	
27	H-Area Groundwater OU	9
28	H-Area Hazardous Waste Management Facility (F-Area Seepage Basin, 904-44G)	7
	H-Area Hazardous Waste Management Facility (F-Area Seepage Basin, 904-46G)	
	H-Area Hazardous Waste Management Facility (F-Area Seepage Basin, 904-45G)	
	H-Area Hazardous Waste Management Facility (F-Area Seepage Basin, 904-56G)	
29	Heavy Equipment Wash Basin, NBN	25
30	K-Area Bingham Pump Outage Pit, 643-1G	20
31	K-Area Burning/Rubble Pit, 131-K	40
	K-Area Rubble Pile, 631-20G	
32	K-Area Reactor Seepage Basin, 904-65G	55
33	L-Area Bingham Pump Outage Pit, 643-2G	26
	L-Area Bingham Pump Outage Pit, 643-3G	
	P-Area Bingham Pump Outage Pit, 643-4G	39
34	L-Area Oil Chemical Basin, 904-83G	17
35	L-Area Reactor Seepage Basin, 904-64G	65
36	L-Area Southern Groundwater, NBN	77
37	M-Area Hazardous Waste Management Facility: Lost Lake, 904-112G	1
	M-Area Hazardous Waste Management Facility: M-Area Settling Basin, 904-51G	
38	M-Area Settling Basin Inactive Process Sewers to Manhole 1, 081-M	19

Table A-5. List of OU Subunits with Remedial Actions *(continued)*

#	OU Subunits[a,b]	CERCLIS #
39	Inactive Clay Process Sewer Lines (Including Potential Release of TCT, TET, TCE, HNO_3, U, Heavy Metals from 321-M Abandoned Sewer Line), NBN	92
	Salvage Yard, 741-A	
	M-Area Underground Sump 321-M #001	
	M-Area Underground Sump 321-M #002	
	M-Area Test Pile Facility, 305-A	
40	Metallurgical Laboratory Hazardous Waste Management Facility (904-110G)	2
41	Mixed Waste Management Facility, 643-28E	33
42	Old F-Area Seepage Basin, 904-49G	16
43	PAR Pond (including the Pre-Cooler Ponds and Canals), 685-G	35
	PAR Pond: Lower Three Runs Integrator Operable Unit Tail Portion (Middle and Lower Subunits)	
44	P-Area Burning/Rubble Pit, 131-P	59
45	P-Area Ash Basin (including Outfall P-007), 188-P	94
	Potential Release from P-Area Disassembly Basin, NBN	
	Potential Release from P-Area Reactor Cooling Water System, 186/190-P	
	P-Area Reactor Area Cask Car Railroad Tracks as Abandoned, NBN	
	P-Area Process Sewer Lines as Abandoned, NBN and Spill on 3/15/79 of 5500 Gallons of Contaminated Water, NBN	
46	P-Area Reactor Seepage Basin, 904-61G	66
	P-Area Reactor Seepage Basin, 904-62G	
	P-Area Reactor Seepage Basin, 904-63G	
47	R-Area Bingham Pump Outage Pit, 643-10G	38
	R-Area Bingham Pump Outage Pit, 643-8G	
	R-Area Bingham Pump Outage Pit, 643-9G	
	R-Area Unknown Pit #1 (Runk-1), NBN	
	R-Area Unknown Pit #2 (Runk-2), NBN	
	R-Area Unknown Pit #3 (Runk-3), NBN	
48	R-Area Burning/Rubble Pit, 131-1R	43
	R-Area Burning/Rubble Pit, 131-R	
	R-Area Rubble Pit, 631-25G	
49	Area on the North Side of Building 105-R	95
	Laydown Area North of 105-R	
	R-Area Cooling Water Effluent Sump, 107-R	
	Potential Release of $NaOH/H_2SO_4$ from 183-2R, NBN	
	R-Area Ash Basin, 188-R	
	Potential Release from R-Area Disassembly Basin, NBN	
	R-Area Reactor Area Cask Car Railroad Tracks as Abandoned, NBN	
	Release from the Decontamination of R-Reactor Disassembly Basin, NBN	
	Combined Spills North of Building 105-R, NBN	
	R-Area Process Sewer Lines as Abandoned, NBN	
	R-Area Reactor Building, 105-R	

Table A-5. List of OU Subunits with Remedial Actions *(continued/end)*

#	OU Subunits[a,b]	CERCLIS #
50	R-Area Reactor Seepage Basin, 904-103G	25
	R-Area Reactor Seepage Basin, 904-104G	
	R-Area Reactor Seepage Basin, 904-57G	
	R-Area Reactor Seepage Basin, 904-58G	
	R-Area Reactor Seepage Basin, 904-59G	
	R-Area Reactor Seepage Basin, 904-60G	
51	Silverton Road Waste Unit, 731-3A	13
52	SRL Seepage Basin, 904-53G1	47
	SRL Seepage Basin, 904-53G2	
	SRL Seepage Basin, 904-54G	
	SRL Seepage Basin, 904-55G	
53	Neutralization Sump, 678-T	96
	X-001 Outfall Drainage Ditch, NBN	
	TNX Outfall Delta, Lower Discharge Gully and Swamp, NBN	
	TNX-Area Process Sewer Lines and Tile Fields as Abandoned, NBN	
54	TNX Groundwater, 082G	21
	New TNX Seepage Basin, 901-102G	29
	Old TNX Seepage Basin, 904-76G	
	TNX Burying Ground, 643-5G (Including Spill on 1/12/53 of ½ Ton of Uranyl Nitrate, NBN)	
55	Wetland Area at Dunbarton Bay[d]	71

[a] OU subunits include RCRA/CERCLA units and RCRA regulated units. Deactivation & Decommissioning facilities are not represented.

[b] Shaded text identifies the SRS OUs evaluated in this report for the fifth phase of the fifth five-year review (i.e., operating equipment).

[c] H-Area Tank Farm (Waste Tank 16) IROD was issued in August 2016. H-Area Tank Farm (Waste Tank 12) ESD to the IROD was issued in April 2017. A remedy evaluation in the fourth phase of the fifth five-year remedy review (i.e., geosynthetic or S/S cover systems) was premature.

[d] The Wetland Area at Dunbarton Bay ROD was issued in June 2018. This OU was not included in the first phase of the fifth five-year review (i.e., native soil covers and/or LUCs) because the remedy has not been implemented.

EVALUATION OF CHANGES IN STANDARDS AND TOXICITY

This appendix provides an evaluation of changes in standards and toxicity for chemical and radiological constituents since the last five-year remedy review was initiated in 2012 for the Savannah River Site (SRS) operable units (OUs) evaluated in this report. The purpose of the evaluation is to determine if there are any changes in standards or toxicity values that would call into question the protectiveness of the remedy. No protectiveness issues with respect to changes in standards and toxicity were identified in the previous five-year remedy review report (SRNS 2014).

An evaluation was performed for analytes that were identified as constituents of concern (COCs) for the OUs discussed in Appendix C through Appendix M. These OUs were grouped in the Operating Equipment category if the remedial action involved active remediation systems (i.e., soil vapor extraction systems, air strippers, pump and treat systems, thermal technologies, etc.) used to address contaminants in soil and groundwater.

The U.S. Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) for Non-Radiological Constituents (June 2017), USEPA Preliminary Remediation Goals (PRGs) for Radionuclides (July 2017), and USEPA Maximum Contaminant Levels (MCLs) for radiological and chemical constituents were evaluated in this review. These values are identified as 2017 RSLs, 2017 PRGs, and MCLs in Tables B-1 through B-5 and were compared to the values available in 2012 when the last five-year remedy review for these OUs was initiated. Standards and toxicity values for both the industrial worker and hypothetical residential receptor are provided for comparative purposes for most media.

The comparison tables do not make any distinction between COCs that were the primary drivers for the selected remedial action and other analytes that were simply addressed through the same remedy. Most importantly, the values presented in Tables B-1 through B-5 are not cleanup levels and should not be considered remedial goals unless otherwise noted in the OU-specific remedy reviews. For these reasons, the information in Appendix B is not stand-alone, but must be considered in context with the information and selected remedy presented in the OU-specific reviews located in Appendix C through Appendix M.

Changes to a standard or toxicity factor is unique to each analyte and is often related to revisions in exposure assumptions, reference doses, cancer potency factors, and exposure pathways used to calculate the value. For the reasons explained in the previous paragraph, the impact that more stringent RSLs or PRGs have on protectiveness must be considered with respect to the OU-specific remedy. In most cases, a change in a standard or toxicity value is irrelevant because the analyte(s) may no longer be present or is (are) significantly reduced if the selected remedy also included excavation and offsite disposal. In addition, exposure to contaminants may be controlled by a cover system.

Noteworthy changes in the RSLs and PRGs are a result of implementing revised exposure parameters from the 2011 Exposure Factors Handbook in 2014. In 2016, a major revision to the approach for calculating PRGs was announced by USEPA. The primary change was that the plus daughters (+D) isotopes designation was removed from the radionuclide selection list and the secular equilibrium PRG calculation was identified as the preferred (i.e., default) value.

Before this revision, the +D designation indicated that the slope factor used in the PRG calculation included the contribution from ingrowth of daughter isotopes. Prior to 2014, the +D designation included daughter products with half-lives of six months or less; in 2014, the +D designation was expanded to include daughter products with half-lives out to 100 years. The intention of the +D designation was to ensure realistic PRGs by including contributions from their short-lived decay products, assuming equal activity concentration (i.e., secular equilibrium) with the principal or parent nuclide in the environment.

The current PRG calculation considers all the daughters in the decay chain (regardless of half-life). The PRGs for each daughter are combined with the parent on a fractional basis to produce a single PRG for the parent. The resulting PRG is based on secular equilibrium of the full chain.

Table B-2 is a Comparison of Radiological Standards in Soil Media. In 2012, the PRGs for cesium-137, radium-226, radium-228, thorium-228, uranium-235, and uranium-238 had the +D designation and included daughter products with half-lives less than six months (see footnote d). Daughter products were not considered in the PRG calculation for the other analytes in the table.

There are two entries for the 2017 PRGs in Table B-2. For each constituent, the top entry is the PRG for the individual radionuclide (i.e., no daughter products). The bottom entry (in parentheses) is the default PRG that includes the subsequent daughter products from the entire decay chain.

The evaluation for each remedy to determine if exposure assumptions, toxicity data, cleanup levels, and remedial action objectives are still valid is discussed in each OU-specific review located in Appendix C through Appendix M. The evaluations shown in Tables B-1 through B-5 confirm that there have been no significant changes in standards or toxicity factors that would affect the protectiveness of the remedies evaluated in this report.

DOCUMENTS REVIEWED

SRNS, 2014. *Fourth Five-Year Remedy Review Report for the Savannah River Site (U) Aiken, South Carolina*, SRNS-RP-2012-00011, Revision 1.1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

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Table B-1. Comparison of Nonradiological Standards in Soil Media

Analyte	2012 RSLs[a]		2017 RSLs[b]		CERCLIS Number(s)[c]
	Residential Soil (mg/kg)	Industrial Worker Soil (mg/kg)	Residential Soil (mg/kg)	Industrial Worker Soil (mg/kg)	
Antimony	3.1E+01	4.1E+02	3.1E+01	4.7E+02	59
Arsenic	3.9E-01	1.6E+00	6.8E-01	3.0E+00	21,28,30,63
Chromium (III)	1.2E+05	1.5E+06	1.2E+05	1.8E+06	21,59
Copper	3.1E+03	4.1E+04	3.1E+03	4.7E+04	21,59
Dibenzofuran	7.8E+01	1.0E+03	7.3E+01	1.0E+03	59
Hexachlorodibenzo-p-dioxin, Mixture	9.4E-05	3.9E-04	1.0E-04	4.7E-04	31
Lead and Compounds	4.0E+02	8.0E+02	4.0E+02	8.0E+02	21,30
Mercury	1.0E+01	4.3E+01	1.1E+01	4.6E+01	21
Nickel	1.5E+03	2.0E+04	1.5E+03	2.2E+04	59
Polychlorinated biphenyls (PCBs)					
~ Aroclor 1242	2.2E-01	7.4E-01	2.3E-01	9.5E-01	59
~ Aroclor 1254	2.2E-01	7.4E-01	2.4E-01	9.7E-01	30
Polynuclear Aromatic Hydrocarbons (PAHs)					
~ Benzo[a]anthracene	1.5E-01	2.1E+00	1.1E+00	2.1E+01	30,59
~ Benzo[b]fluoranthene	1.5E-01	2.1E+00	1.1E+00	2.1E+01	30,59
~ Benzo[k]fluoranthene	1.5E+00	2.1E+01	1.1E+01	2.1E+02	59
~ Benzo[a]pyrene	1.5E-02	2.1E-01	1.1E-01	2.1E+00	59
~ Chrysene	1.5E+01	2.1E+02	1.1E+02	2.1E+03	30,59
~Dibenzo[a,h,]anthracene	1.5E-02	2.1E-01	1.1E-01	2.1E+00	30,59
~Fluoranthene	2.3E+03	2.2E+04	2.4E+03	3.0E+04	59
~Indeno[1,2,3-cd]pyrene	1.5E-01	2.1E+00	1.1E+00	2.1E+01	59
~Methylnapthalene, 2-	2.3E+02	2.2E+03	2.4E+02	3.0E+03	63
~Pyrene	1.7E+03	1.7E+04	1.8E+03	2.3E+04	59
Selenium	3.9E+02	5.1E+03	3.9E+02	5.8E+03	28
Silver	3.9E+02	5.1E+03	3.9E+02	5.8E+03	21
Tetrachloroethylene (PCE)	2.2E+01	1.1E+02	2.4E+01	1.0E+02	19,28,30, 59,63,92
Trichloroethylene (TCE)	9.1E-01	6.4E+00	9.4E-01	6.0E+00	19,28,30, 31,59,63,92
Zinc	2.3E+04	3.1E+05	2.3E+04	3.5E+05	59

a USEPA Nonradiological RSLs for soil media, May 2012.

b USEPA Nonradiological RSLs for soil media, June 2017.

c OUs and corresponding CERCLIS number(s) are identified in Appendix A, Table A-5.

mg/kg = milligram per kilogram

Table B-2. Comparison of Radiological Standards in Soil Media

Analyte	2012 PRGs[a]		2017 PRGs[b]		CERCLIS Number(s)[c]
	Residential Soil (pCi/g)	Industrial Worker Soil (pCi/g)	Residential Soil (pCi/g)	Industrial Worker Soil (pCi/g)	
Actinium-228	6.79E+02	9.88E+02	7.35E+02 (1.01E-02)	1.07E+03 (1.54E-02)	21
Cesium-137	6.23E-02[d]	1.03E-01[d]	2.53E+01 (4.55E-02)	5.71E+01 (6.90E-02)	21
Tritium (H-3)	9.34E-01	1.27E+00	2.37E-01 (1.25E-01)	2.99E-01 (1.61E-01)	63
Potassium-40	1.50E-01	2.65E-01	1.44E-01 (1.44E-01)	2.19E-01 (2.19E-01)	28
Lead-212	3.60E+03	5.33E+03	3.40E+03 (1.59E-02)	5.02E+03 (2.40E-02)	21
Radium-226	1.27E-02[d]	2.23E-02[d]	1.03E+00 (1.27E-02)	3.05E+00 (2.03E-02)	21,28
Radium-228	3.19E-02[d]	4.84E-02[d]	1.47E+00 (9.87E-03)	7.50E+00 (1.53E-02)	21,28
Thorium-228	1.54E-01[d]	2.30E-01[d]	2.80E+01 (1.56E-02)	1.07E+02 (2.38E-02)	21,28
Thorium-234	1.31E+03	2.75E+03	1.22E+03 (1.25E-02)	2.45E+03 (2.00E-02)	21
Uranium-233	4.70E+00	2.55E+01	5.63E+00 (8.87E-02)	2.55E+01 (1.48E-01)	21
Uranium-234	4.92E+00	2.91E+01	5.83E+00 (1.26E-02)	2.78E+01 (2.03E-02)	21
Uranium-235	1.94E-01[d]	3.48E-01[d]	2.03E-01 (4.58E-02)	3.15E-01 (7.31E-02)	21
Uranium-238	7.25E-01[d]	1.49E+00[d]	6.48E+00 (1.24E-02)	3.12E+01 (2.00E-02)	21,28

[a] USEPA Radiological PRGs for soil media, August 2010.

[b] USEPA Radiological PRGs for soil media, July 2017. Top entry for each constituent is the PRG for the individual radionuclide. Bottom entry (in parenthesis) is the default secular equilibrium PRG that includes daughter products from the entire decay chain.

[c] OUs and corresponding CERCLIS number(s) are identified in Appendix A, Table A-5.

[d] 2012 PRGs included daughter products with half-lives less than 6 months; these constituents had a plus daughters (+D) designation.

pCi/g = picoCuries per gram

Table B-3. Nonradiological Standards in Groundwater Media (MCLs)[a]

Analyte	**MCL (µg/L)**	**CERCLIS Number(s)[b]**
Antimony	6	8,9
Arsenic	10	8,9
Barium	2,000	8,9
Benzene	5	8,9
Beryllium	4	8,9
Bis(2-ethylhexl)phthalate	6	8,9
Cadmium	5	6,7,8,9
Carbon tetrachloride	5	29,36
Chromium	100	8,9
Copper	1,300	8,9
Cyanide	200	9
1-1-Dichloroethene (DCE)	7	59
cis-1,2-Dichloroethene (DCE)	70	31
Dichloromethane (methylene chloride)	5	8,9,31,36
Lead	15	8,9,36
Lindane	0.2	
Mercury	2	8,9,29
Nitrate	10,000	8,9
Selenium	50	8,9
Tetrachloroethylene (PCE)	5	8,9,29,31,36
Thallium	2	8,9
Trichloroethylene (TCE)	5	8,9, 29,31,36,59
Uranium	30	29
Vinyl chloride	2	31

[a] Current MCL table provided for reference only. Comparative analysis is not shown because MCLs have not changed since previous five-year remedy review.

[b] OUs and corresponding CERCLIS number(s) are identified in Appendix A, Table A-5.

Table B-4. Comparison of Non-Radiological Standards in Groundwater Media (2012 RSLs and 2017 RSLs)

Analyte	2012 RSL[a] (µg/L)	2017 RSL[b] (µg/L)	CERCLIS Number(s)[c]
Cobalt	4.7E+00	6.0E+00	8,9
Nickel	3.0E+02	3.9E+02	8,9
Phenol	4.5E+03	5.8E+03	8
Silver	7.1E+01	9.4E+01	8,9
Tin	9.3E+03	1.2E+04	9
Trichlorofluoromethane	1.1E+03	5.2E+03	8,9
Vanadium	7.8E+01	8.6E+01	8,9
Zinc	4.7E+03	6.0E+03	8,9

a USEPA Nonradiological RSLs for tapwater media, May 2012.
b USEPA Nonradiological RSLs for tapwater media, June 2017.
c OUs and corresponding CERCLIS number(s) are identified in Appendix A, Table A-5.

Table B-5. Radiological Standards in Groundwater Media (MCLs)

Analyte	**MCL[a] (µg/L)**	**CERCLIS Number[b]**
Amercium-241	15[c]	9
Carbon-14	2,000	9
Cesium-137	200[d]	8
Cobalt-60	100[d]	9
Curium-242	15[c]	8,9
Curium-243/244	15[c]	8,9
Curium-246	15[c]	8
Iodine-129	1[c]	8,9
Nickel-63	50[d]	9
Plutonium-238	15[c]	8,9
Plutonium-239/240	15[c]	8,9
Radium-226	5[e]	8,9,29
Radium-228	5[e]	8,29
Radium total	5 [e]	8,9
Strontium-90	8[d]	8,9
Technetium-99	900	8,9
Thorium-228	15[c]	8,9
Thorium-232	15[c]	8,9
Thorium-230	15 [c]	8,9
Tritium	20,000[d]	8,9
Uranium-233/234	10[f]	8,9
Uranium-234	10[f]	9
Uranium-235	0.5[f]	8,9
Uranium-238	10[f]	8,9

a USEPA Implementation Guidance for Radionuclides, March 2002. Comparative analysis is not shown for MCLs because standards have not changed since the previous five-year remedy review.
b OUs and corresponding CERCLIS number(s) are identified in Appendix A, Table A-5.
c Gross alpha particle activity = 15 pCi/L.
d Man-made beta/gamma emitters = 4 mrem/year dose
e Combined radium-226 and radium-228 = 5 pCi/L.
f Uranium values based on MCL of 30 µg/L; derived using naturally occurring isotopes of uranium in secular equilibrium.

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A-AREA BURNING/RUBBLE PITS (731-A, -1A) AND RUBBLE PIT (731-2A) MISCELLANEOUS CHEMICAL BASIN/METALS BURNING PIT (731-4A/731-5A) OPERABLE UNIT

I. Introduction

This report is the fourth five-year review for the A-Area Burning/Rubble Pits (731-A, 731-1A) and Rubble Pit (731-2A) (ABRP) and Miscellaneous Chemical Basin/Metals Burning Pit (731-4A/731-5A) (MCB/MBP) Operable Unit (OU). The review was conducted from August 2017 through November 2017. Contaminants have been left in place at the OU at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the OU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table C-1 lists the chronology of events for the ABRP/MCB/MBP OU.

III. Background

ABRP and MCB/MBP are listed as separate Resource Conservation and Recovery Act (RCRA) / Comprehensive Environmental Response, Compensation, and Liability Act units in Appendix C of the Federal Facility Agreement (FFA) for Savannah River Site (SRS) (FFA 1993). To achieve final closure, the individual units have been consolidated to form the ABRP/MCB/MBP OU. The media of concern is surface and vadose zone soils. The final action for the groundwater in the area is being addressed under the A/M Groundwater OU corrective action.

Physical Characteristics

The ABRP/MCB/MBP OU is located approximately 4.8 km (3 mi) east of the SRS boundary and 2.4 km (1.5 mi) south of M Area (Figure C-1). The OU is situated on the eastern edge of a north-south trending topographic ridge within the Upper Three Runs watershed. This ridge drains east to Tim's Branch and west to the Savannah River floodplain. Its relief is characterized by flat areas and a few low rolling hills. Pine/hardwood forests are dominant, with some grassy areas.

The ABRP/MCB/MBP OU is comprised of the following subunits (Figure C-2):

ABRP Area Subunits

- A-Area Burning/Rubble Pit (731-A) - constructed in 1951 and is approximately 6.6 m (22 ft) wide, 2.7 to 3 m (9 to 10 ft) deep, and 75 m (250 ft) long;
- A-Area Burning/Rubble Pit (731-1A) - constructed in 1951 and is approximately 6.6 m (22 ft) wide, 2.7 to 3 m (9 to 10 ft) deep, and 75 m (250 ft) long;
- A-Area Rubble Pit (731-2A) - used from about 1951 until 1983 and is approximately 12 m (40 ft) wide, 195 m (650 ft) long, with a depth that could extend to 6 m (20 ft);
- Potential Pit - estimated dimensions of 60 x 78 m (200 x 260 ft);
- Depressional Area - estimated dimensions of 48 x 111 m (160 x 370 ft);
- Ash Scatter Area/Ditch - area is approximately 0.4 hectares (1.0 acre) and the ditch measures approximately 90 x 6 m (300 x 20 ft);
- A-Area Ash Pile (788-2A) - covered approximately 1.02 hectares (2.5 acres) and rose approximately 4.2 to 7.2 m (14 to 24 ft) above the surrounding topography. Based on an average ash thickness of 6 m (20 ft), the total volume of ash was approximated to be 60,435 m^3 (79,000 yd^3);
- Trench subunit - approximately 4.6 m (15 ft) wide by 91.4 m (300 ft) long, most of which is overlain by about 6.1 m (20 ft) of compacted ash, and is between 2.4 and 4.6 m (8 and 15 ft) deep, with approximately 5% to 10% of the Trench exposed south of the Ash Pile; and
- Vadose zone in the vicinity of the ABRP is about 40 m (130 ft) thick with the upper 24 m (80 ft) comprised of sands and silt. This is underlain by a predominantly clay layer, 1.8 to 2.4 m (6 to 8 ft) thick that sits atop another sand/silt layer approximately

12.2 m (40 ft) thick. A perched water zone is present at times just above the clay-rich zone at a depth of 22.9 to 25.9 m (75 to 85 ft) below the surface.

MCB/MBP Subunits

- MCB Surface Soil Subunit - approximately 6 by 6 m (20 by 20 ft) and approximately 0.3 m (1 ft) deep;
- MCB vadose zone - approximately 36.6 m (120 ft) thick and contains a fine-grained sediment zone up to 4.6 m (15 ft) below ground surface, underlain by 18.3 to 21.3 m (60 to 70 ft) of sands/silts, a 3.0 m (10 ft) thick clay lens at a depth of 22.9 to 25.9 m (75 to 85 ft), and sands and silts to the water table; and
- MBP Surface Soil Subunit - irregular in shape, approximately 120 by 120 m (400 by 400 ft). Waste materials were piled 0.9 to 1.8 m (3 to 6 ft) high within the MBP boundaries.

Land and Resource Use

According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of SRS land should be prohibited. The *Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999b) designates the ABRP/MCB/MBP OU as being within an industrial area. The future land use is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

Starting in 1951, the three pits, 731-A, -1A and -2A, were used monthly to burn paper, plastics, wood, rubber, rags, cardboard, oil degreasers, and solvents. After burning was discontinued in October 1973, the burn area was covered with a layer of soil. The pits were subsequently filled with rubble consisting of paper, wood, concrete, empty galvanized steel barrels, and cans. The pits reached capacity in 1978 and were retired from service in 1983. Pits 731-A and 731-1A were covered with native soils to grade-level and vegetation could re-establish. Rubble Pit 731-2A was backfilled and seeded.

The Potential Pit and Depressional Area were areas of depression/subsidence that were investigated, but produced no evidence of waste disposal. The Ash Scatter Area/Ditch was located between the A-Area Ash Pile (788-2A) and the Depressional Area.

The A-Area Ash Pile (788-2A) subunit was used to dispose of ash from the A-Area Powerhouse prior to 1994, as permitted under Industrial Wastewater Permit No. 7289, issued on June 29, 1981.

The Trench subunit was filled with debris and covered with soil prior to construction of the A-Area Ash Pile (788-2A), and was mostly buried beneath the compacted ash along the eastern portion of the ash pile. No disposal records for the trench have been found.

The MCB was an old borrow pit, later used to receive liquid chemical wastes. No disposal records were kept, though the assumed use was disposal of waste solvents and used oil. It is likely that waste drums were emptied at this site, and the empty drums were discarded at the MBP. Existing records indicate that the basin was in use from about 1956 to 1974.

The MBP was a cleared area used for burning lithium-aluminum alloys, scrap, and cuttings from A/M-Area machining operations. Wastes were primarily contained in two discrete areas: one large pile and a series of small piles oriented in a semi-circular arc. The pit was reportedly placed in service in 1960 and taken out of service in 1974.

Initial Response

Following assessment of the ABRP/MCB/MBP OU, no remedial action was required for the Burning/Rubble Pits 731-A and 731-1A, Depressional Area, Potential Pit, and Ash Scatter Area/Ditch.

An Interim Record of Decision (IROD) was approved in November 2000 for ABRP OU (WSRC 2000) to address benzo(a)pyrene contamination in soil at Rubble Pit 731-2A and reduce concentrations of volatile organic compounds (VOCs) in the M-Area aquifer and vadose zone. The approved final remedial action for soil was installation of a 1-ft thick earthen cap, coupled with implementation of land use controls (LUCs) (i.e., institutional controls). The approved interim action for groundwater involved the implementation of air sparging with active/passive soil vapor extraction (SVE) system (installed at Rubble Pit

731-2A) to reduce VOCs in the M-Area aquifer contaminated plume. A passive SVE system was installed to reduce VOCs in the vadose zone beneath the trench underlying the Ash Pile. An ABRP monitoring well system was installed to determine the effectiveness of the SVE systems and began operation in September 2001. Based on the results of the first year of operation and subsequent testing of the air sparging system, it was determined that the system had not and likely would not meet the remedial action objectives (RAOs) for the subunit. An Explanation of Significant Differences (ESD) for the ABRP (WSRC 2002) was issued in 2003 to remove the air sparging system and expand the SVE portion of the remedy presented in the ABRP IROD to operate four MicroBlower^{TM}-equipped SVE wells at the Trench subunit to remediate VOCs in the vadose zone.

An IROD was approved in December 1999 for MCB/MBP OU (WSRC 1999a) to address elevated levels of aluminum in MBP surface and subsurface soil, elevated levels of polychlorinated biphenyls (PCBs) (i.e., Aroclor 1254 and Aroclor 1260) in MCB surface and subsurface soil, elevated levels of VOCs in MCB vadose zone soils, and elevated levels of VOCs in groundwater. Interim actions at the MCB/MBP OU were taken beginning in 2000 to remove contaminated surface soils exceeding 1,000 µg/kg Aroclor 1254 and 215 µg/kg Aroclor 1260 at MCB, and exceeding 11,000 mg/kg aluminum at MBP (considered final actions), and to treat VOC-contaminated vadose zone soils with active and passive SVE. Contaminated surface soils at MCB/MBP were excavated and shipped to a sanitary landfill. Clean fill was backfilled into the excavated areas. At MCB, the area was cleared and remediation equipment (i.e., active SVE followed by passive SVE using BaroBall^{TM} technology) was installed to treat the contaminated vadose zone soils by lowering VOC concentrations to below 50 ppmv. Three banks of airlift recirculation wells (i.e., in situ air stripping) were used to treat contaminated groundwater.

Basis for Taking Action

No human health, ecological, or contaminant migration (CM) constituents of concern (COCs) have been identified at the Burning/Rubble Pits (731-A, 731-1A), Potential Pit, Depressional Area, and Ash Scatter Area/Ditch subunits. Thus, there is no problem warranting action for these subunits.

Benzo(a)pyrene in surface soil at Rubble Pit 731-2A was identified as a COC for the future industrial worker at concentrations exceeding the remedial goal (RG) of 0.2 mg/kg.

Arsenic and coal-related radionuclides are present at the A-Area Ash Pile subunit (788-2A) at concentrations that exceed the 1E-06 risk for the future industrial worker. Arsenic and selenium are present in concentrations that may be predictive of a potential ecological hazard (hazard quotients > 1). These RGs are listed in Table C-2.

In 2001, before the start of the interim action, the maximum detection of trichloroethylene (TCE) at the Trench subunit was 487,000 μg/kg. TCE concentrations in the vadose zone were present at levels expected to migrate to groundwater above the maximum contaminant level (MCL) of 5 µg/L in less than 10 years (Figure C-3).

At the MCB subunit, PCBs exceeding both the human health RG (1 mg/kg) and the ecological RG (0.215 mg/kg) were present in surface soils. Octachlorodibenzo-p-dioxin (OCDD) was also present as a human health COC.

In the MCB vadose zone, tetrachloroethylene (PCE) and TCE contamination was found at levels that would migrate to groundwater at a concentration above the MCL (5 µg/L) in less than 10 years.

Aluminum concentrations at the MBP subunit exceeded the ecological RG of 11,000 mg/kg at two areas totaling approximately 0.177 hectares (0.436 acres).

IV. Remedial Actions

Remedy Selection

As stated in the ABRP/MCB/MBP OU ROD (WSRC 2007b), the final RAOs are as follows:

A-Area Ash Pile (788-2A) Subunit

- Prevent human exposure to COCs that present a risk to future industrial workers.
- Prevent ecological exposure to COCs that present a hazard to ecological receptors.

A-Area Trench Subunit

- Prevent migration of TCE contamination in soil to groundwater resulting in concentrations above the MCL (5 μg/L).

As stated in the ABRP OU IROD (WSRC 2000), the final RAO that was addressed by the interim action is as follows:

A-Area Rubble Pit (731-2A) Surface Soils

- Prevent direct contact with and ingestion of benzo[a]pyrene contaminated surface soil which may present a significant risk (> 1E-06 or hazard index = 1) to current and future workers.

As stated in the MCB/MBP OU IROD (WSRC 1999a), the final RAO that was addressed by the interim action is as follows:

MCB/MBP Surface and Vadose Zone Soils

- Prevent direct contact with aluminum, OCDD, Aroclor 1254, and Aroclor 1260 contaminated surface/subsurface soils, such that the COCs are not a continued significant risk to human health or ecological receptors.

As stated in the ABRP/MCB/MBP OU ROD (WSRC 2007c), the selected final remedial actions to meet the RAOs are listed below. Figures C-4 through C-9 show the ABRP/MCB/MBP OU subunits during operations, prior to and after the final action.

A-Area Ash Pile (788-2A) Subunit

- Installation of a soil cover; and
- Institutional controls (i.e., LUCs).

A-Area Trench Subunit

- Expand the existing interim remedial action SVE system; and
- Institutional controls (i.e., LUCs)

A-Area Rubble Pit (731-2A) Surface Soils

- Installation of a soil cover; and
- Institutional controls (i.e., LUCs).

MCB Surface Soil

- Excavation of contaminated soil with Aroclor 1260 concentrations above the ecological RG (215 µg/kg) to consist of soil removal areas 3 and 4 to a maximum depth of 0.3 m (1 ft), and soil removal area 5 to maximum depth of 1.2 m (4 ft). Excavation of the 0.3-m (1-ft) interval will also remove all soil contaminated with Aroclor 1260 above the Applicable or Relevant and Appropriate Requirement (ARAR)-based limit of 1,000 µg/kg;
- Excavation of contaminated soil with Aroclor 1254 concentrations above the ARAR limit of 1000 µg/kg to a maximum depth of 0.3 m (1 ft) from soil removal areas 3 and 4 and 1.2 m (4 ft) from soil removal area 5;
- Disposal of excavated soil to a Subtitle D landfill, backfilled with clean fill, vegetation of surface soil; and
- Institutional controls (i.e., LUCs).

MCB Vadose Zone

- Continued passive operation of SVE BaroBall^{TM} wells; and
- Institutional controls (i.e., LUCs)

MBP Surface and Subsurface Soil

- Excavation of soil containing aluminum in excess of the site-specific maximum background of 11,000 mg/kg to a maximum depth of 1.2 m (4 ft) to consist of soil removal areas 1 and 2;
- Disposal of excavated soil at a Subtitle D landfill, backfilled with clean fill, vegetation of surface soil; and

- Institutional controls (i.e., LUCs).

Remedy Implementation

The selected final action remedies were implemented to meet the RAOs and included the following activities. Remedial actions completed during the interim action phase are noted below.

A-Area Ash Pile (788-2A) Surface Soils

- In 2008, as the final remedial action, installed a 1-hectare (2.5-acre) soil cover with a minimum of 45 cm (18 in) of compacted common fill and 15 cm (6 in) of topsoil and sod.

A-Area Rubble Pit (731-2A) Surface Soils (completed during the interim action phase)

- In 2001, installed a 2.4-hectare (6-acre) soil cover with a minimum of 30 cm (12 in) of compacted common fill and 7.5 cm (3 in) of topsoil and sod. The soil cover also covered the A-Area Burning/Rubble Pits (731-A and 731-1A) for adequate drainage purposes. This was accepted as part of the final remedial action for the OU.

ABRP Vadose Zone

- In 2001, installed an air sparging system for removal of VOC from the vadose zone contaminated soils. However, air-sparging operations were found to be ineffective due to the presence of impermeable soils just above the water table and, with concurrence of the U.S. Environmental Protection Agency (USEPA), South Carolina Department of Health and Environmental Control (SCDHEC) and USDOE, were discontinued in March of 2003. The wells of the sparging system were converted to passive SVE using BaroBalls^{TM}.
- In 2003, under the Interim Action, installed four passive SVE wells (operating with either MicroBlowers^{TM} or BaroBalls^{TM}) at the Trench Subunit to remove VOCs from the ABRP vadose zone contaminated soils. The four passive SVE wells installed were ABV-01, ASH-06, AHT-05, and AHT-06.

- In 2008, in support of the final remedial action, installed an active SVE system, consisting of a vacuum blower, condensate removal system, piping to the well bank, 17 extraction wells, and control instrumentation, to treat 42,000 m^3 (55,000 yd^3) of vadose zone soil. Additionally, when the soil vapor extraction unit (SVEU) is down for maintenance, ASH-06, AHT-05, ABV-01 ARV-2D1, ARV-2D2, and ARV-2D3 were operated as MicroBlower™ SVE wells.

MCB/MBP Surface Soil (completed during the interim action phase)

- In 2002, removed a total of 7,800 m^3 (10,200 yd^3) of soil (3,060 m^3 [4,000 yd^3] at MCB (Figure C-10); 4,740 m^3 [6,200 yd^3] at MBP) contaminated with Aroclor 1260 and Aroclor 1254 by excavating to a depth of 0.3 m (1 ft) in soil removal areas 3 and 4 and 1.2 m (4 ft) in soil removal areas 1, 2, and 5, packaging, and shipping to a Subtitle D landfill;
- Backfilled 0.59 hectares (1.45 acres) of excavated areas to grade with clean native soil and vegetated surface soil after confirmatory sampling verified that RGs were met; and
- Established a maintenance program for 0.59 hectares (1.45-acre) native soil cover.

MCB Vadose Zone (completed during the interim action phase)

- Installed an active SVE system, consisting of a vacuum blower, condensate removal system, underground piping to the well bank, five extraction wells, and control instrumentation, to treat 4,590 m^3 (6,000 yd^3) of vadose zone soils. Active SVE was discontinued in 2004 and the SVE wells were transitioned to passive SVE operation; and
- Installed additional passive SVE wells to supplement the active SVE system. The current SVE system consists of two MicroBlower^{TM} SVE wells and 25 BaroBall^{TM} SVE wells. SVE operation will continue at the MCB vadose zone subunit until RAOs are met (Figure C-10).

ABRP/MCB/MBP OU

- In 2008, established LUCs for 4.1 hectares (10.1 acres) including posting eleven warning signs.

System Operations/Operation and Maintenance

The ABRP/MCB SVE systems are operational and will continue operations until RGs are achieved for the ABRP/MCB/MBP OU. The SVE systems, with implementation of the interim and final remedies, started operation in 2001 with full implementation at ABRP in 2008.

In 2012, a rebound test was conducted at the ABRP SVEU, which indicated VOC removal at the ABRP Trench Subunit is mostly diffusion limited. In 2013, due to rising concentrations occurring at extraction well ASH-06, the Core Team agreed to add ASH-06 to the ABRP SVEU extraction well network. Due to decreasing concentrations to non-detect levels for several years, the Core Team concurred in 2015 with the decision to begin transitioning 15 wells from active SVE to passive SVE in the ABRP SVEU. The three remaining active SVE wells will be transitioned to passive SVE wells in fiscal year (FY) 2018 (Figure C-3).

The active SVE system at ABRP has removed approximately 64.9 kg (143.1 lbs) of TCE since operations began in 2008. The active system at MCB removed approximately 77.1 kg (170 lbs) of TCE while in operation. A quantitative removal estimate is not available for passive SVE but the system is monitored for qualitative results to ensure off-gas concentrations continue to decrease over time.

A Performance Evaluation Report (PER) is submitted annually to USEPA and SCDHEC and provides the results and analyses of the baseline sampling prior to active SVE and passive SVE operation and all process and performance monitoring during operation.

The following maintenance activities are ongoing:

- Visual inspections for evidence of damage to the cover systems due to erosion or intrusion by burrowing animals are being performed annually as a minimum. The inspections also address upkeep of the vegetative cover and access control barriers (e.g., the warning signs).
- Necessary repairs (e.g., replacing eroded or disturbed soil, sign repair, active SVE system maintenance, etc.) and vegetation management (e.g., mowing, removal of larger vegetation, etc.) are being performed when required.
- Institutional controls (i.e., LUCs) are being enforced to preclude access through the SRS Site Use/ Site Clearance program and SRS site security.

Table C-3 compares the actual operation and maintenance (O&M) costs for the five-year remedy review period to the estimated direct O&M costs from the ROD (WSRC 2007b). The estimated cost for FY 2012 to FY2017 is $399,216 for the SVE systems, soil covers, institutional controls (LUCs), and five-year remedy reviews. The actual O&M cost for FY2012 to FY2017 is $1,246,438. The O&M costs from FY2012 to FY2017 are higher than estimated because the operational life of the active SVE system is longer than expected.

V. Progress Since Last Review

The previous protectiveness statement concluded that the remedial actions at ABRP/MCB/MBP OU are expected to be protective and, in the interim, exposure pathways that could result in unacceptable risks are being controlled by the operation of active SVE/ passive SVE and cover systems along with institutional controls (i.e., LUCs). All systems have been functioning properly.

Since the previous review in support of final remediation activities as set forth in the Corrective Measures Implementation/Remedial Action Implementation Plan (WSRC 2007a), the following actions have been completed:

- Transition of fifteen active SVE wells at the ABRP Trench subunit to the passive SVE system, due to decreasing TCE contamination in the vadose zone soils.

There were no further recommendations or follow-up actions from the last five-year review.

VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII, Documents Reviewed;
- Confirmed the implementation of the remedial actions;
- Reviewed all process and performance monitoring data provided by the annual PERs and provided a technical assessment of whether the active SVE / passive SVE are functioning as intended by the ROD and whether the shutdown criteria have been achieved;
- Inspected the OU, reviewed the annual site inspection reports, interviewed maintenance personnel, and documented the results on the Inspection Checklist provided in Attachment C-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance

Data Review

Annual PERs continue to be submitted and were reviewed (SRNS 2013, SRNS 2014, SRNS 2015, SRNS 2016, and SRNS 2017).

Summary of Inspections and Interviews

Interviews were conducted with Richard Feagin, O&M Staff member, on October 11, 2017 and George Joyner, O&M Site Manager, on October 12, 2017 at the O&M organization offices. No issues were identified for the ABRP/MCB/MBP OU during these interviews.

The ABRP/MCB/MBP OU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) and USDOE personnel on December 15, 2017. No issues were identified for the ABRP/MCB/MBP OU during this inspection.

A site inspection will be conducted by USEPA and SCDHEC personnel, accompanied by USDOE and SRNS personnel, prior to submittal of the Revision 1 of this document. It is anticipated that no significant problems regarding this OU will be identified during the inspection.

Scheduled annual site inspections conducted from FY2012 through FY2017 identified the presence of ant mounds, instances of bare spots in the grass of soil covers and some hog damage to soil covers. These findings were documented on the field inspection checklist and resolved soon after discovery.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The removal of contaminated soils at MCB/MBP (731-4A / 731-5A surface soil subunits) and the cover systems installed at ABRP (A-Area Rubble Pit [731-2A] and Ash Pile [788-2A] subunits) are effective in preventing human receptor and ecological exposure to COCs. The MCB/MBP removal action has achieved industrial RGs. The ABRP cover system maintenance program is effective in maintaining the integrity of the cover systems. The annual inspection reports indicate no significant deficiencies.

The active SVE / passive SVE systems at the ABRP Trench and MCB subunits are effective in preventing the migration of VOC contamination in the vadose zone soils to the groundwater at concentrations above MCLs. Sampling and analysis of groundwater samples indicate that the underlying groundwater VOC concentrations have also been steadily decreasing with time.

As reported in the annual PERs, VOC concentrations in soil gas samples have been decreasing over time which is expected to correlate to decreasing concentrations of VOC contamination in the vadose zone soils. Active SVE performance monitoring has determined that TCE extraction has been successful at the ABRP Trench. Figures C-11 and C-12 depict a large decrease in TCE production and well exhaust gas concentrations since the implementation of seventeen active SVE wells in 2008. In 2015, fifteen active SVE wells were transitioned to passive SVE operation, leaving only three active SVE wells (i.e., AHT-08B, AHT-11A, and ASH-06). Figures C-13 and C-14 show the TCE production rates and well exhaust gas concentrations of the three currently operational active SVE wells since 2008.

In May 2017, the SRS submitted the annual PER for the period of January through December 2016 (SRNS 2017). The report recommended that active SVE wells AHT-08B, AHT-11A, and ASH-06 be transitioned to passive SVE with MicroBlowers™ since the active SVE system has reached a point of diminishing returns as documented in the PER. In their respective letters dated September 27, 2017 and November 27, 2017, the SCDHEC and USEPA approved converting wells AHT-08B, AHT-11A, and ASH-06 from active SVE to MicroBlower™ operation. The SRS plans to complete the conversion in 2018.

MCB and ABRP (Trench subunit) vadose zones are approaching their respective RGs, but the rate of approach is very slow. Completion of the remedial action is not expected to be achieved for many years.

The Land Use Control Implementation Plan for the ABRP/MCB/MBP OU governs LUC implementation, maintenance, monitoring, reporting, and enforcement of LUCs (WSRC 2008). The LUCs that are in place include physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), use restrictions to prevent unauthorized contact, removal or excavation of contaminated soils, restrictions to prevent unauthorized access to or use of groundwater until cleanup levels are met, and restrictions to prevent disturbance of the ABRP soil cover system. Warning signs are in good condition, and no activities were observed that would have violated the LUCs. All LUC objectives are being met.

Are Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs still valid?

Exposure assumptions, toxicity data, and cleanup levels used at the time of remedy selection are still valid. MCLs for TCE and PCE have not changed since implementation of the remedy. There have been no changes in standards or to-be-considered guidance identified in the ROD that call into question the protectiveness of the remedy.

The USEPA standards and toxicity values have been updated since the last five-year remedy review as shown in Appendix B. The changes to the values for COCs at the ABRP/MCB/MBP OU were not significant, and the RAOs continue to be met by the remedial actions. More stringent standards and toxicity values do not impact the protectiveness of the remedy because soil covers installed at the ABRP prevent exposure of human and ecological receptors to remaining soil contaminants left in place. Similarly, excavation and off-site disposal of soil contaminants at the MCB/MBP subunit followed by a soil cover eliminates the human health and ecological exposure pathway. There have been no changes in the MCLs for TCE and PCE that would impact SVE operations in the MCB and ABRP vadose zones. Finally, more stringent standards and toxicity values would not impact the LUCs already in place at the ABRP/MCB/MBP OU.

Fact sheets provided on the USEPA webpage regarding emerging contaminants were reviewed for applicability to this site. None of the listed emerging contaminants were identified as applicable to this OU.

Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that could call into question the protectiveness of the remedy.

VIII. Issues

There are no issues related to current site conditions or activities that currently prevent the remedy from being protective.

IX. Recommendations and Follow-up Actions

There are no recommendations or follow-up actions for this OU.

X. Protectiveness Statement(s)

The remedy at the ABRP/MCB/MBP OU is protective of human health and the environment.

Exposure pathways that could result in unacceptable risks are being controlled by the soil covers and LUCs, continued operation of the active SVE/passive SVE systems, environmental monitoring, site inspections and maintenance activities. All threats at the ABRP/MCB/MBP OU have been addressed through implementation of physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the ABRP/MCB/MBP OU for industrial use only, and warning signs and land use restrictions via the SRS Site Use/Site Clearance Program.

XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Operating Equipment is scheduled for January 2024.

XII. Documents Reviewed

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

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 1998. *RCRA Facility Investigation / Remedial Investigation Report with Baseline Risk Assessment for the Miscellaneous Chemical Basin/Metals Burning Pit*, WSRC-RP-96-853, Revision 1.2, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1999a. *Interim Record of Decision Remedial Selection for the Miscellaneous Chemical Basin/Metals Burning Pit (731-4A/5A) Operable Unit (U),* WSRC-RP-98-4031, Revision 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1999b. *Land Use Control Assurance Plan for the Savannah River Site,* WSRC-RP-98-4125, Revision 1.1, latest update, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC, 2000. *Interim Record of Decision Remedial Alternative Selection for the A-Burning/Rubble Pits (731-A/1A) and Rubble Pit (731-2A) (U)*, WSRC-RP-2000-4001, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2002. *Explanation of Significant Difference (ESD) for the A-Area Burning/Rubble Pits (731-A/1A) and Rubble Pits (731-2A) (ABRP)*, WSRC-RP-2001-4281, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2007a. *Corrective Measures Implementation/Remedial Action Implementation Plan (CMI/RAIP) for the A-Area Burning/Rubble Pits (731-A, -1A) and Rubble Pit (731-2A) and the Miscellaneous Chemical Basin/Metals Burning Pit (731-4A, -5A) Operable Unit (U)*, WSRC-RP-2006-4071, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2007b. *Record of Decision Remedial Alternative Selection for the A-Area Burning/Rubble Pits (731-A, -1A) and Rubble Pit (731-2A) and the Miscellaneous Chemical Basin / Metals Burning Pit (731-4A, -5A) Operable Unit (U)*, WSRC-RP-2005-4095, Revision 1.1, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2008. *Land Use Control Implementation Plan (LUCIP) for the A-Area Burning/Rubble Pits (731-A, -1A) and Rubble Pit (731-2A) and the Miscellaneous Chemical Basin/Metals Burning Pit (731-4A, -5A) Operable Unit (U)*, WSRC-RP-2006-4073, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

SRNS, 2013. *Performance Evaluation Report for the Combined A-Area Burning/Rubble Pits, Miscellaneous Chemical Basin, and Metals Burning Pit Operable Unit, January through December 2012 (U)*, SRNS-RP-2013-00170, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2014. *Performance Evaluation Report for the Combined A-Area Burning/Rubble Pits, Miscellaneous Chemical Basin/Metals Burning Pit Operable Unit, January through December 2013 (U)*, SRNS-RP-2014-00438, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2015. *Performance Evaluation Report for the Combined A-Area Burning/Rubble Pits, Miscellaneous Chemical Basin/Metals Burning Pit Operable Unit, January through December 2014 (U)*, SRNS-RP-2015-00225, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2016. *Performance Evaluation Report for the A-Area Burning/Rubble Pits, Miscellaneous Chemical Basin/Metals Burning Pit Operable Unit, January through December 2015 (U)*, SRNS-RP-2016-00243, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2017. *Performance Evaluation Report for the A-Area Burning/Rubble Pits, Miscellaneous Chemical Basin/Metals Burning Pit Operable Unit, January through December 2016 (U)*, SRNS-RP-2017-00125, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

Various - Inspection Data Sheets – *Field Inspection Checklist A-Area Burning/Rubble Pits (731-A/731-1A) and Rubble Pit (731-2A) and A-Area Ash Pile (788-2A) (U)*, ER-IDS-019-010, Inspection period 2012 through 2017 (annually)

Various - Inspection Data Sheets – *Field Inspection Checklist Miscellaneous Chemical Basin/Metals Burning Pit (731-4A/731-5A) (U)*, ER-IDS-019-014, Inspection period 2012 through 2017 (annually)

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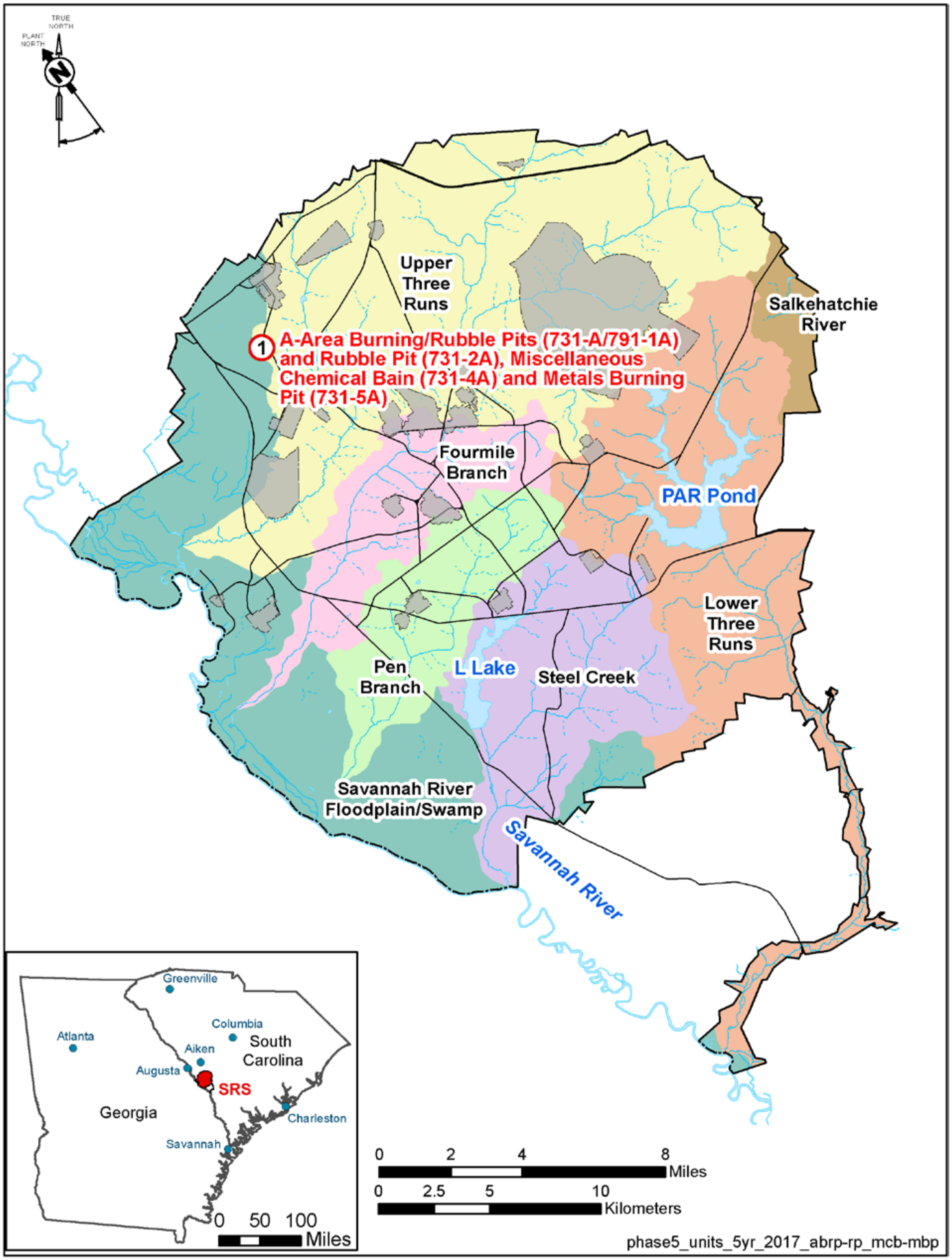

Figure C-1. Location of ABRP/MCB/MBP OU at SRS

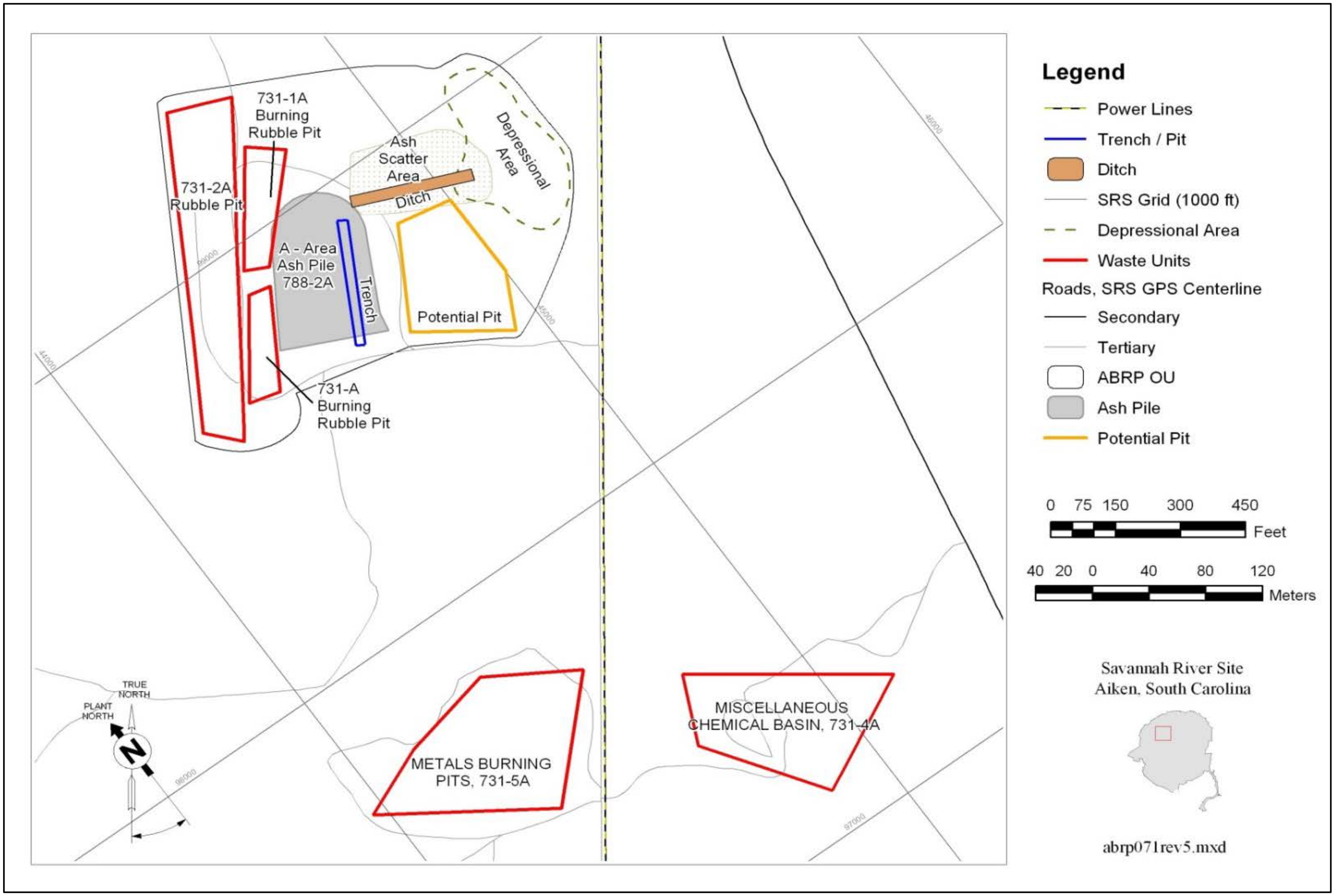

Figure C-2. **ABRP/MCB/MBP OU Subunits Layout**

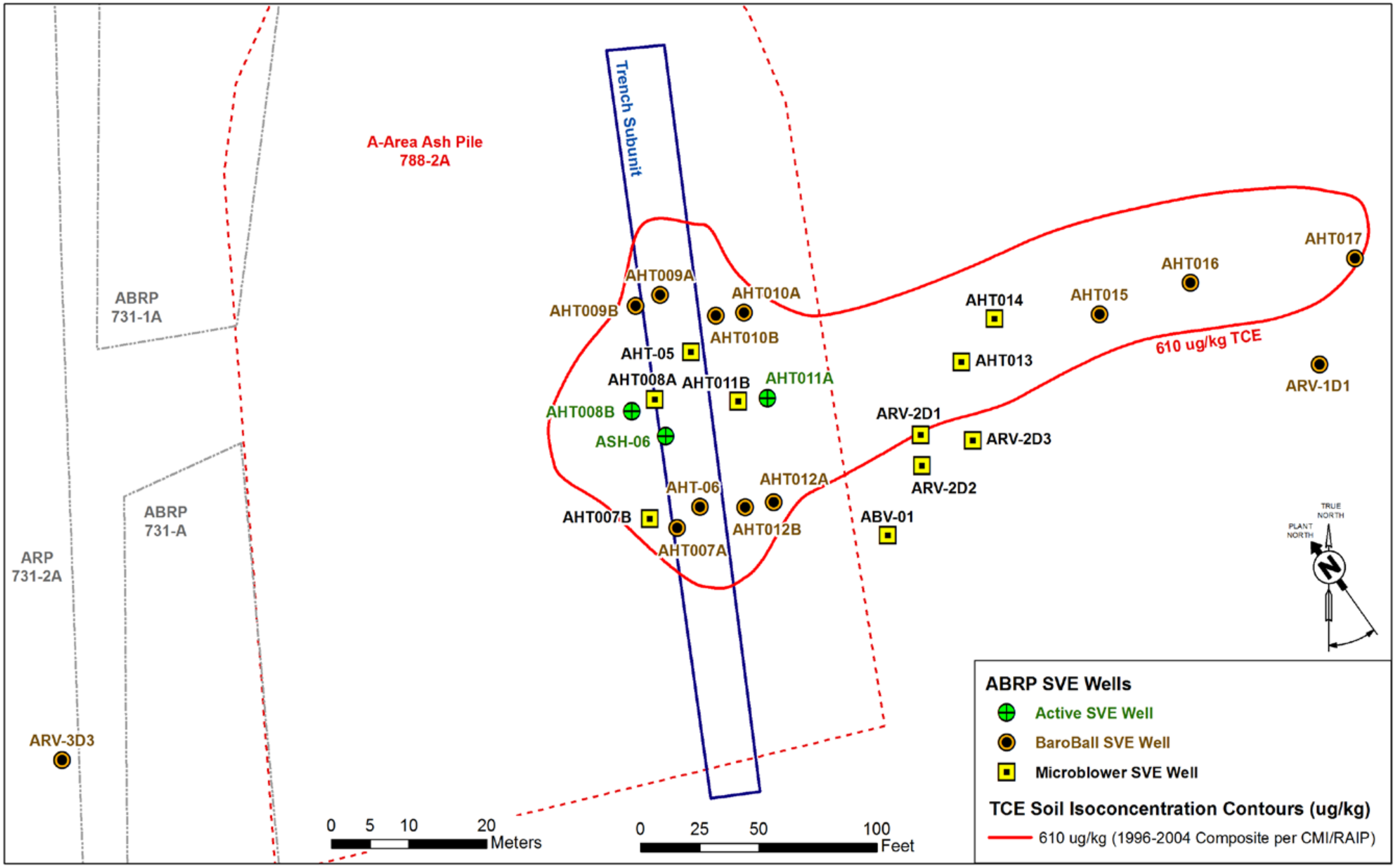

Figure C-3. ABRP Trench Subunit (current) SVE System

Figure C-4. A-Area Ash Pile and Underlying Trench Subunit during Operations (1981-1994)

Figure C-5. **A-Area Ash Pile and Underlying Trench Subunit after Halting Operations, prior to Final Action (2000)**

Figure C-6. **A-Area Ash Pile and Underlying Trench Subunit after Final Action, with Installation of Trench Subunit SVE System (2008)**

Figure C-7. **Miscellaneous Chemical Basin During Operation (1970)**

Figure C-8. Miscellaneous Chemical Basin after Halting Operations, Prior to Final Action (1974 - 2000)

Figure C-9. Miscellaneous Chemical Basin after Final Action (2008)

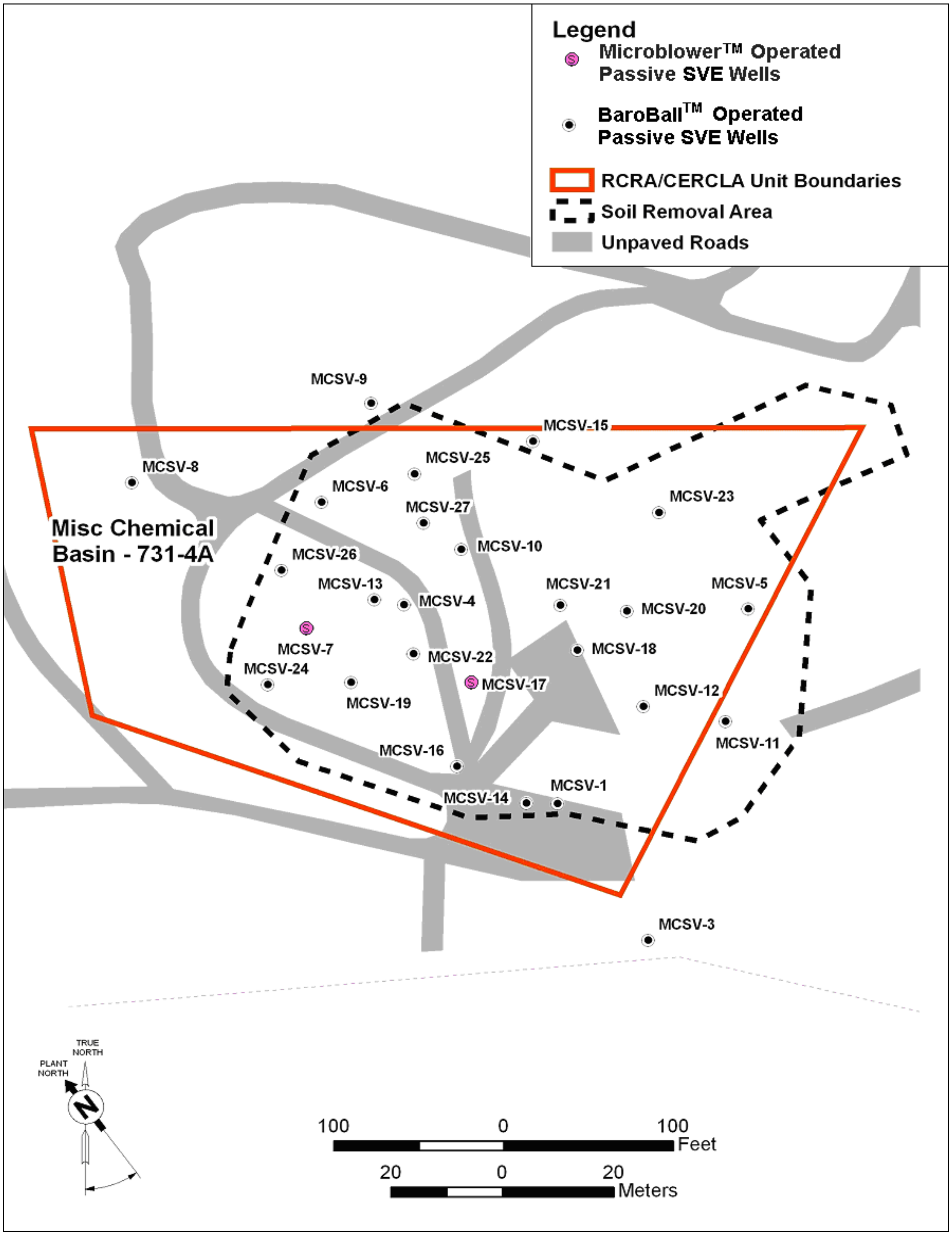

Figure C-10. MCB Subunit SVE System

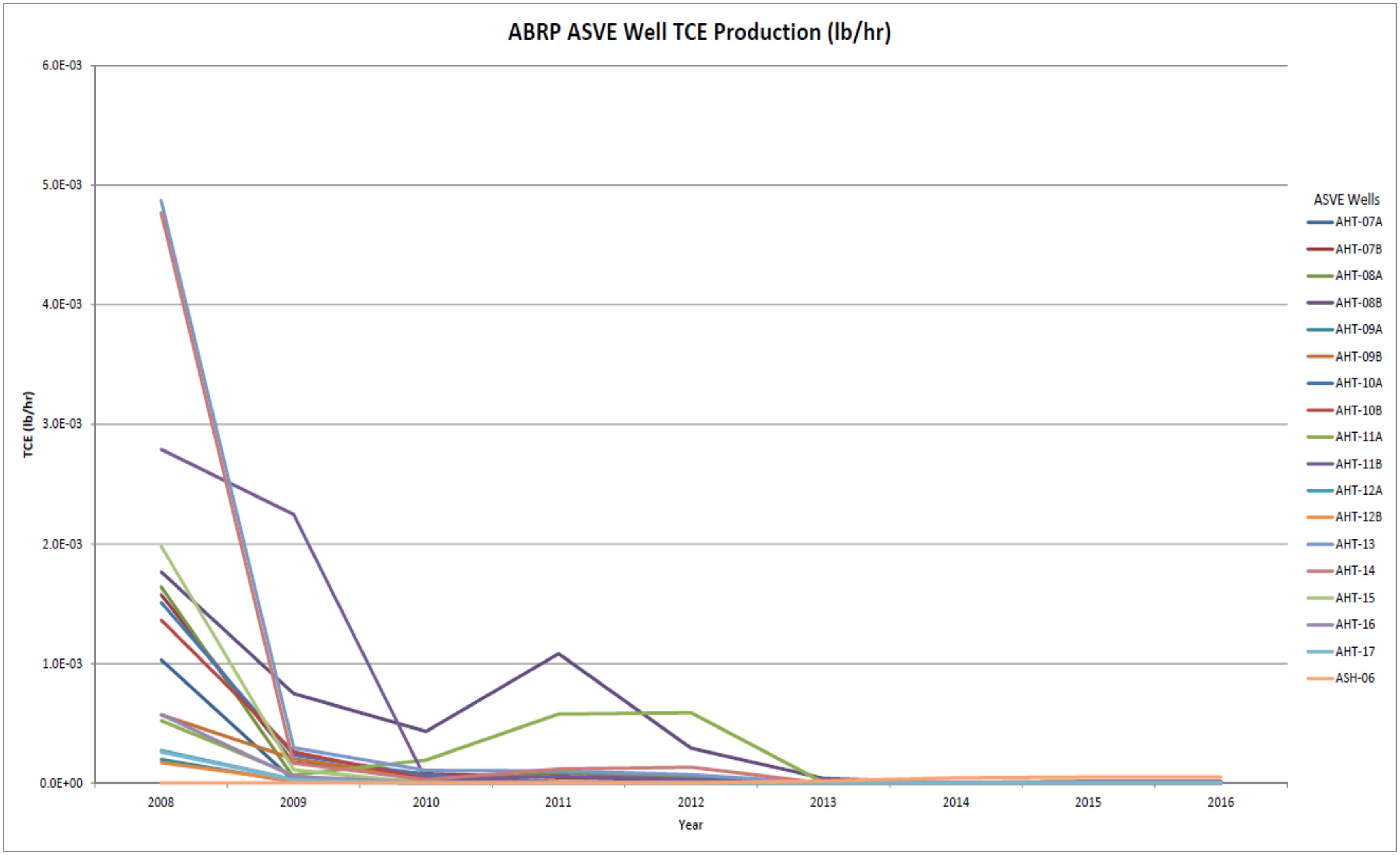

Figure C-11. ABRP Phased Active SVE Well TCE Production (2008-2016)

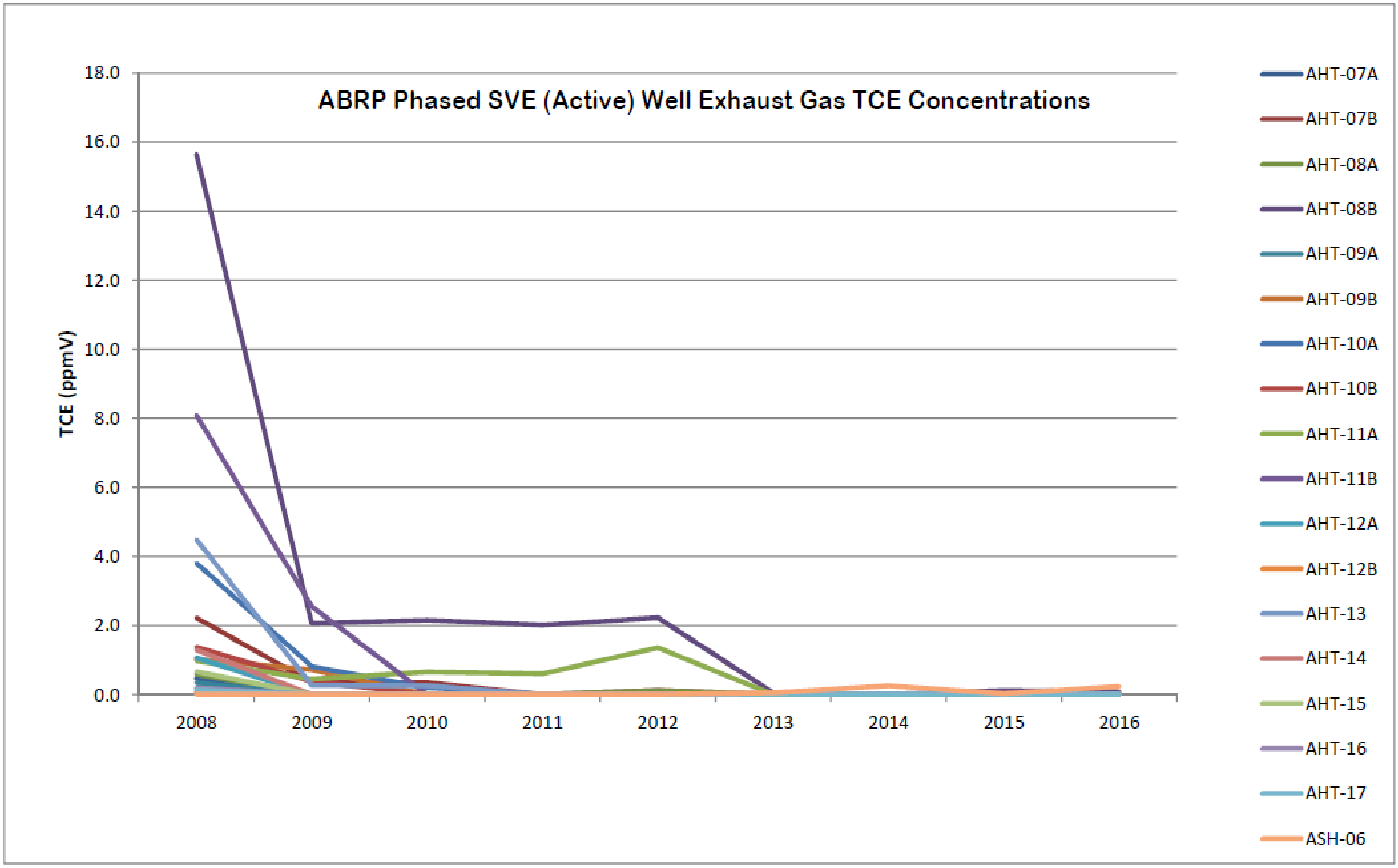

Figure C-12. **ABRP Phased SVE Well Exhaust Gas TCE Concentrations (2008-2016)**

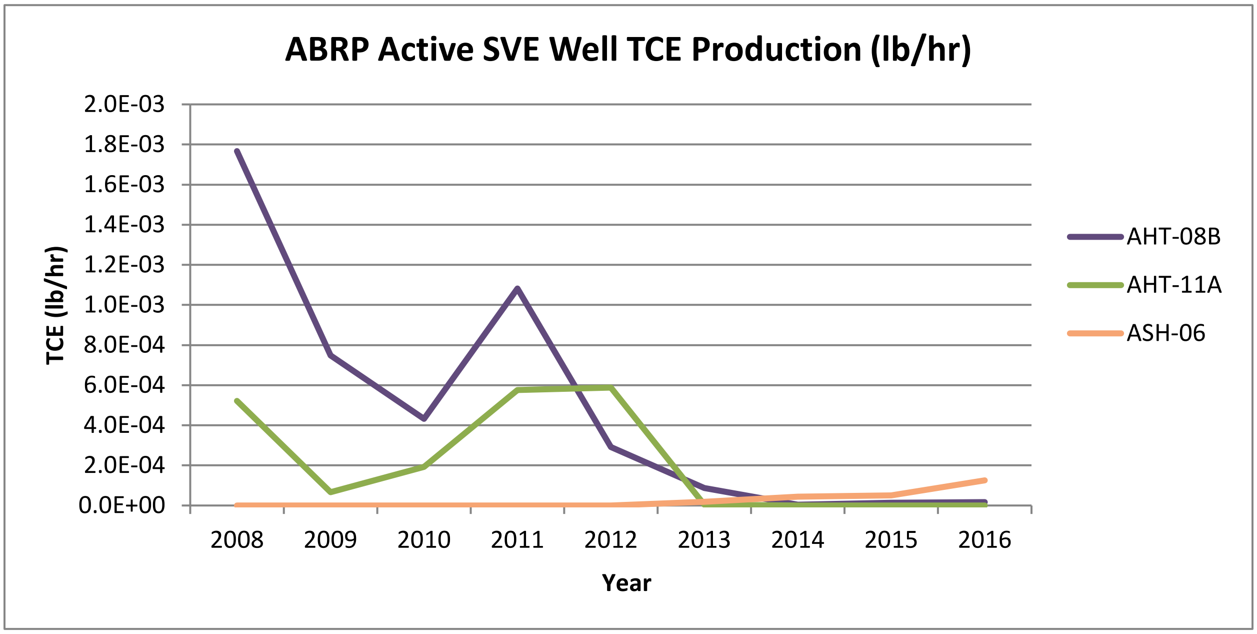

Figure C-13. **ABRP Phased Active SVE Well TCE Production (Current System)**

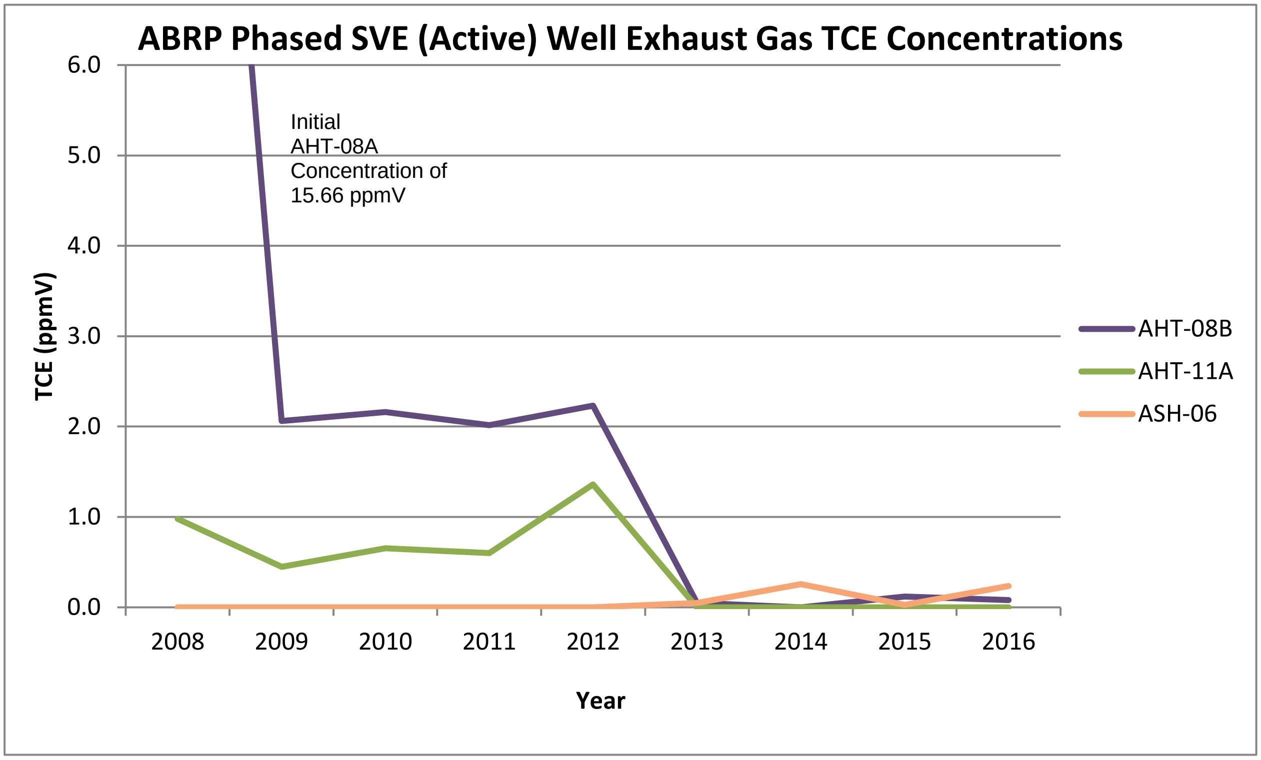

Figure C-14. **ABRP Phased SVE Well Exhaust Gas TCE Concentrations (Current System)**

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Table C-1. Chronology of OU Events

Event	Date
MCB/MBP IROD Issuance	February 9, 2001
Interim Remedial Action Construction Start / Completion – MCB/MBP	February 17, 2000 / February 6, 2002
Interim Remedial Action Operations Start / Completion – MCB/MBP	October 29, 2001 / Ongoing
ABRP IROD Issuance	February 9, 2001
Interim Remedial Action Construction Start / Completion – ABRP	September 28, 2000 / December 12, 2001
Interim Remedial Action Operations Start / Completion – ABRP	September 26, 2001 / Ongoing
RFI/RI Field Start / Completion	March 22, 2001 / March 8, 2005
ABRP ESD Issuance	March 10, 2003
ABRP/MCB/MBP ROD Issuance	August 2, 2007
Remedial Action Construction Start / Complete	August 21, 2007 / February 23, 2009
Remedial Action Operations Start / Complete	June 25, 2008 / Ongoing
Previous Five-Year Reviews Issuance	February 12, 2004 / January 29, 2009 / February 4, 2014

RFI/RI – RCRA Facility Investigation/Remedial Investigation

Table C-2. Summary of Remedial Action Objectives and Remedial Goals for Soil

Area/Media of Concern	Refined COCs	Type of COC				Final Remedial Goal Option	Final Remedial Goal Option Basis
		ARAR	CM	HH	ECO		
MCB Vadose Zone **Remedial Action Objectives** ▪ Prevent migration of TCE and PCE contamination in soil to groundwater at a concentration above its MCL	TCE		X			344 µg/kg	Contaminant Migration Final RG – WSRC 1999
	PCE		X			344 µg/kg	Contaminant Migration Final RG – WSRC 1999
ABRP Trench Subunit **Remedial Action Objectives** ▪ Prevent migration of TCE contamination in soil to groundwater at a concentration above its MCL.	TCE		X			610 µg/kg	Contaminant Migration
A-Area Ash Pile Subunit **Remedial Action Objectives** ▪ Prevent human exposure to COCs that present a risk to future industrial workers ▪ Prevent ecological exposure to COCs that present a hazard to ecological receptors	Arsenic			X	X	9,753 µg/kg	Background[1]
	Selenium				X	15,280 µg/kg	Background[1]
	Potassium-40			X		1.60 pCi/g	Background[1]
	Radium-226			X		0.0255 pCi/g	HH-industrial
	Radium-228			X		1.83 pCi/g	Background[1]
	Thorium-228			X		1.69 pCi/g	Background[1]
	Uranium-238			X		1.79 pCi/g	HH – Industrial

1. Background value is two times average site-specific background concentration from Table 4-3 of the RFI/RI with Baseline Risk Assessment (WSRC 1997). The activities of the daughter products of some of the radiological COCs identified in the table were used to establish the activity of the parent since these constituents are in secular equilibrium. Specifically, the two times background mean of Actinium-228 was used to establish the Radium-228 concentration and the two times background mean of Lead-212 was used to establish the Thorium-228 background concentration.
2. Actual soil sampling in the vadose zone at the points of greatest contamination will be conducted to determine when the RGs have been achieved, and no change in the operation of the SVE process will be allowed without the concurrence of the Core Team.

HH - human health; ECO - ecological

Table C-3. Actual versus Estimated O&M Costs

	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	5-Year Total
Total Actual O&M Costs ($)	108,581	236,528	230,955	71,665	376,110	222,599	1,246,438
Total ROD Estimated Direct O&M Costs ($)	85,408	57,100	57,100	57,100	57,100	85,408	399,216

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Attachment C-1. Five-Year Review Site Inspection Checklist – A-Area Burning/Rubble Pits (731-A/731-1A), and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A)

I. SITE INFORMATION

Site Name:	**A-Area Burning/Rubble Pits (731-A/731-1A), and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A)**	**Date of Inspection:**	**08/23/2017**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**CERCLIS #28**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**91°F and Clear**

Remedy Includes: *(Click all that apply)*

☒ Landfill Cover/Containment
☒ Access Controls
☒ Institutional Controls
☐ Groundwater Pump and Treatment
☐ Surface Water Pump and Treatment
☐ Monitored Natural Attenuation
☐ Groundwater Containment
☐ Vertical Barriers

☒ Other Soil Vapor Extraction (active and passive), air sparging,

Attachments: ☐ Inspection team roster attached ☐ Inspection team roster attached

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 10/12/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

Problems/Suggestions: ☐ Report Attached

2. **O&M Staff:** Richard Feagin (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 10/11/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4416

Problems/Suggestions: ☐ Report Attached

Attachment C-1. Five-Year Review Site Inspection Checklist – A-Area Burning/Rubble Pits (731-A/731-1A), and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A) *(continued)*

II. INTERVIEWS *(Click all that apply) (Continued)*

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

Agency: ____________________

Contact: __________ (Name) __________ (Title) __________ (Date) __________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

Agency: ____________________

Contact: __________ (Name) __________ (Title) __________ (Date) __________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

Agency: ____________________

Contact: __________ (Name) __________ (Title) __________ (Date) __________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

4. **Other Interviews** *(Optional):* ☐ Report Attached ____________________

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Click all that apply)*

1. **O&M Documents:**

☐ O&M Manual	☐ Readily Available	☐ Up to Date	☒ N/A
☒ As-Built Drawings	☒ Readily Available	☒ Up to Date	☐ N/A
☐ Maintenance Logs	☐ Readily Available	☐ Up to Date	☒ N/A

Remarks:See Waste Unit Inspection and Maintenance, ER-SOP-019 and *Field Inspection Checklist for A-Area Burning Rubble/Pits and Rubble Pit and A-Area Ash Pile*, ER-IDS-019-010, and *Field Inspection Checklist for Miscellaneous Chemical Basin/Metals Burning Pit*, ER-IDS-019-014

Attachment C-1. Five-Year Review Site Inspection Checklist – A-Area Burning/Rubble Pits (731-A/731-1A), and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A) *(continued)*

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)*

2. Health and Safety Plans (HASPs):

☐ Site-Specific Health and Safety Plans ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Contingency Plan/Emergency Response Plan ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks: Routine O&M activities do not require an SSHASP under 29 CFR 1910.120, HAZWOPER. An SSHASP is prepared if needed.

3. O&M and OSHA Training Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix

4. Permits and Service Agreements:

☒ Air Discharge Permit ☒ Readily Available ☒ Up to Date ☐ N/A
☐ Effluent Discharge ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Waste Disposal; POTW ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Other Permits ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

5. Gas Generation Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

6. Settlement Monument Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

7. Groundwater Monitoring Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks:

8. Leachate Extraction Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

9. Discharge Compliance Records:

☒ Air ☒ Readily Available ☒ Up to Date ☐ N/A
☐ Water (Effluent) ☐ Readily Available ☐ Up to Date ☐ N/A

Remarks:

10. Daily Access/Security Logs: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

Attachment C-1. Five-Year Review Site Inspection Checklist – A-Area Burning/Rubble Pits (731-A/731-1A), and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A) *(continued)*

IV. O&M COSTS

1. O&M Organization:

☐ State In-House ☐ Contractor for State
☐ PRP In-House ☐ Contractor for PRP
☒ Other: SRS

2. O&M Cost Records:

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review

Total annual cost by year for review period, if available

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

3. Unanticipated or Unusually High O&M Costs During Review Period

Describe costs and reasons: ______

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing Damage: ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks: OU-specific perimeter fencing is not required by the remedial action.

B. Signs

1. Signs and Other Security Measures: ☐ Location shown on site map ☐ N/A
Remarks: Signs are in good condition.

Attachment C-1. Five-Year Review Site Inspection Checklist – A-Area Burning/Rubble Pits (731-A/731-1A), and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A) *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A

Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown

Frequency: Once in 5 years

Responsible Party/Agent: USDOE Savannah River Field Office

Contact:	Karen Adams	Federal Project Director	12/15/17	803-952-7871
	(Name)	(Title)	(Date)	(Phone No.)

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A

Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A

Violations have been reported: ☐ Yes ☐ No ☒ N/A

Problems/Suggestions: ☐ Report Attached

2. Adequacy: ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A

Remarks:

D. General

1. Vandalism/Trespassing: ☐ Location shown on site map ☒ No vandalism is evident

Remarks:

2. Land use changes onsite: ☒ N/A

Remarks:

3. Land use changes offsite: ☒ N/A

Remarks:

Attachment C-1. Five-Year Review Site Inspection Checklist – A-Area Burning/Rubble Pits (731-A/731-1A), and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A) *(continued)*

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. Roads damaged: ☐ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks: Roads are in good condition

B. Other Site Conditions

Remarks: Annual site inspections identified the presence of ant mounds, instances of bare spots in the grass of the soil cover, and evidence of hog damage to the soil cover. These findings were resolved soon after discovery.

VII. LANDFILL COVER/CONTAINMENT ☒ Applicable ☐ N/A

A. Landfill Surface

1. Settlement (Low spots)**:** ☐ Location shown on site map ☒ Settlement not evident

Areal extent________ Depth________

Remarks: Soil covers at A-Area Rubble Pit (731-2A) and A-Area Ash Pile (788-2A) are complete and in good condition.

2. Cracks: ☐ Location shown on site map ☒ Cracking not evident

Lengths________ Widths________ Depths________

Remarks:________

3. Erosion: ☐ Location shown on site map ☒ Erosion not evident

Areal extent________ Depth________

Remarks:________

4. Holes: ☐ Location shown on site map ☒ Holes not evident

Areal extent________ Depth________

Remarks:________

5. Vegetative Cover: ☒ Grass ☒ Cover properly established ☐ No signs of stress

Areal extent________ Depth________

Remarks: Vegetation is mowed routinely.

Attachment C-1. Five-Year Review Site Inspection Checklist – A-Area Burning/Rubble Pits (731-A/731-1A), and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A) ***(continued)***

VII. LANDFILL COVER/CONTAINMENT ***(Continued)***

6. Alternative Cover (armored rock, concrete, etc.): ☒ N/A
Remarks:______________________________

7. Bulges: ☐ Location shown on site map ☒ Bulges not evident
Areal extent__________ Depth__________
Remarks:______________________________

8. Wet Areas / Water Damage: ☒ Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent__________
☐ Ponding ☐ Location shown on site map Areal extent__________
☐ Seeps ☐ Location shown on site map Areal extent__________
☐ Soft subgrade ☐ Location shown on site map Areal extent__________
Remarks:______________________________

9. Slope Instability: ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability
Areal extent__________
Remarks:______________________________

B. Benches ☐ Applicable ☒ N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel)

C. Letdown Channels ☐ Applicable ☒N/A
(Channel lined with erosion control mates, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies)

Attachment C-1. Five-Year Review Site Inspection Checklist – A-Area Burning/Rubble Pits (731-A/731-1A), and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A) *(continued)*

VII. LANDFILL COVER / CONTAINMENT *(Continued)*

D. Cover Penetrations ☒ Applicable ☐ N/A

1. Gas Vents: ☐ Active ☐ Passive
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A
Remarks:____
____

2. Gas Monitoring Probes:
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A
Remarks:____
____

3. Monitoring Wells:
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good Condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A
Remarks:____
____

4. Leachate Extraction Wells:
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A
Remarks:____
____

5. Settlement Monuments: ☐ Located ☐ Routinely Surveyed ☒ N/A
Remarks:____
____

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

F. Cover Drainage Layer ☐ Applicable ☒ N/A

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

H. Retaining Walls ☐ Applicable ☒ N/A

I. Perimeter Ditches/Offsite Discharge ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A

Attachment C-1. Five-Year Review Site Inspection Checklist – A-Area Burning/Rubble Pits (731-A/731-1A), and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A) *(continued)*

X. OTHER REMEDIES

If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

A. Soil Vapor Extraction System ☒ Applicable ☐ N/A

1. Blowers, Wellhead Plumbing, and Electrical:

☒ Good Condition ☒ All required wells located ☐ Needs maintenance ☐ N/A

Remarks: Active and passive SVE systems are in service.

2. Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances:

☒ Good Condition ☐ Needs maintenance

Remarks:

3. Spare Parts and Equipment:

☒ Readily Available ☒ Good Condition ☐ Requires Upgrade ☐ Needs to be provided

Remarks:

Attachment C-1. Five-Year Review Site Inspection Checklist – A-Area Burning/Rubble Pits (731-A/731-1A), and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A) *(continued/end)*

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

The remedial action for this OU are removal of contaminated soil, soil covers, active SVE/passive SVE and institutional controls (i.e., LUCs) to prevent exposure to hazardous materials and to reduce contaminant mass. The remedy is fully established and functioning as designed.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The O&M procedures are adequately maintaining the soils covers and active SVE/passive SVE systems. The O&M procedures consisting of annual site inspections and site maintenance (cover system and warning signs) and site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the OU) have been implemented. There are no issues requiring corrective actions.

C. Early Indicators of Potential Remedy Failure

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

N/A

A/M-AREA GROUNDWATER OPERABLE UNIT

I. Introduction

This is the fifth five-year review for the A/M-Area Groundwater Operable Unit (OU). This review was conducted from August 2017 through November 2017. This report documents the results of the review. The review for this unit is conducted under the Savannah River Site (SRS) Resource Conservation and Recovery Act (RCRA) program. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) review requirements are met by the RCRA program; therefore, a separate review of the RCRA Corrective Action is not duplicated in this document. Contaminants remaining at the A/M-Area Groundwater OU are at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the A/M-Area Groundwater OU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table D-1 lists the chronology of site events for the A/M-Area Groundwater OU.

III. Background

A/M-Area Groundwater OU is listed as a RCRA unit in Appendix C of the Federal Facility Agreement (FFA) for SRS (FFA 1993). The media associated with the A/M-Area Groundwater OU is the groundwater associated with the M-Area Hazardous Waste Management Facility (HWMF) OU, the Metallurgical Laboratory (Met Lab) HWMF OU, and the A-Area Burning/Rubble Pits (731-A and 731-1A) and Rubble Pit (731-2A) (ABRP) and the Miscellaneous Chemical Basin (731-4A) (MCB) and Metals Burning Pit (731-5A) (MBP) OU.

Physical Characteristics

The 142-hectare (350-acre) A/M Area is located near the northwest edge of SRS, approximately 1.6 km (1 mi) from the nearest SRS boundary (Figure D-1). The A/M-Area

Groundwater OU encompasses impacted groundwater from M-Area HWMF OU, Met Lab HWMF OU, and ABRP/MCB/MBP OU. This integration was a result of the comingling of the plumes associated with these sources. Figure D-2 shows the plume extent, which covers about 1,000 hectares (2,500 acres). The A/M-Area Groundwater OU is located within the Upper Three Runs Watershed, bounded to the south by Tims Branch, to the southwest by Upper Three Runs Creek, and to the west by wetlands and ultimately the Savannah River. Groundwater flow is generally to the southwest. Depth to groundwater over much of the plume is greater than 30-m (100 ft).

Land and Resource Use

According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The Land Use Control Assurance Plan for the SRS (WSRC 1999a) designates the M-Area and Met Lab HWMF OUs as being within an industrial area. The future land use for the M-Area and Met Lab HWMF OUs is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land. Although the groundwater plumes associated with these sources extend beyond the industrial area boundaries, it is also reasonably expected that the USDOE will maintain industrial uses and control of the land.

History of Contamination

The A/M Area contained manufacturing facilities for nuclear fuel components, offices and research facilities. From 1952 to 1981, chlorinated solvents were used in the M-Area process facilities. These facilities manufactured aluminum fuel and target assemblies that were used in the SRS reactors. The manufacturing process utilized conventional metal fabrication technologies and included cleaning and degreasing of components and final assemblies. Purchasing records indicate that approximately 6-million kg (13-million lbs) of solvents were used within the process facilities with an estimated 50 to 90% of the solvents lost to the atmosphere by evaporation. Used solvents were discharged as waste to process sewer systems that led to the A-014 Outfall from the M-Area Settling Basin. Additional contamination originated at a solvent transfer station in Building 313-M, the solvent storage tank area, laboratory facilities, and Met Lab Basin, which received process wastewaters from the Met Lab HWMF (723-A). Disposal estimates compiled in 1982 and 1984 indicate that approximately 1 million kg (2.1 million lbs) of solvent were released to the M-Area Settling Basin and approximately 0.6 million kg (1.4 million lbs) of solvent were released to the A-014 Outfall. The principal contaminants are trichloroethene (TCE), tetrachloroethene (PCE), and lesser quantities of 1,1,1-trichloroethane.

Originally, ABRP and MCB/MBP were separate OUs under the FFA. These units were later combined in the FFA as the ABRP/MCB/MBP OU. Prior to combining the OUs, separate investigations associated with the ABRP OU and MCB/MBP OU found surface soil, vadose zone, and groundwater contamination. The soil and vadose zone contamination are addressed by remedial activities for the ABRP/MCB/MBP OU as discussed in Appendix C.

Residual contaminants migrating downward from the vadose zone of the ABRP and MCB/MBP subunits have resulted in the contamination of the underlying groundwater with TCE and PCE. The groundwater plume from these subunits has comingled with the M-Area HWMF groundwater plume from the upgradient source areas. In 2006, the South Carolina Department of Health and Environmental Control (SCDHEC) and the U.S. Environmental Protection Agency (USEPA) agreed that the groundwater impacts associated with the ABRP and the MCB/MBP subunits would be transferred to the RCRA program through the submittal of a modification to the 2000 RCRA Part B Permit Renewal Application.

Initial Response

The remedial investigation of the A/M-Area Groundwater OU began in June 1981 when solvent contamination was discovered in the groundwater beneath the M-Area Settling Basin. In 1983, SRS voluntarily instituted a groundwater cleanup program within the A/M Area. The initial response involved the installation of a pilot groundwater pumping well and experimental air stripping technology. This pilot-program was one of several across the United States that demonstrated groundwater extraction and air stripping as a viable groundwater remediation technology for volatile organic compounds (VOCs). In 1985, a full-scale pump-and-treat system (i.e., M-1 Air Stripper), which comprised eleven groundwater recovery wells and a 2,309-L/min (610-gpm) air stripper column, was constructed to treat contaminated groundwater from the shallow aquifer.

Currently, groundwater corrective action is performed under the 2014 RCRA Permit Renewal which became effective February 11, 2014 (SCDHEC 2014). The SCDHEC modified the 2014 RCRA Permit Renewal on August 17, 2017, which became effective on September 2, 2017 (SCDHEC 2017). The modified permit has schedules detailing the individual corrective action plans for each sector of the M-Area HWMF, the Met Lab HWMF, and the ABRP/MCB/MBP OU as an intermediate step leading toward a complete RCRA corrective action program.

Basis for Taking Action

The groundwater beneath A/M Area has been contaminated with the organic solvents in both the dissolved state and, in limited occurrences, as concentrated dense non-aqueous phase liquids (DNAPLs). The two primary constituents of concern (COCs) that significantly exceed drinking water standards or maximum contaminant limits (MCLs) are TCE and PCE. Other constituents that have recently (SRNS 2017) exceeded primary MCLs include cis-1,2-dichloroethene, 1,1-dichloroethene, 1,4-dioxane, lead, and mercury. Two main aquifers, the Steed Pond Aquifer Unit and the Crouch Branch Aquifer Unit, are impacted. The Steed Pond Aquifer Unit contains the water table (i.e., M-Area Aquifer Zone) and the Lost Lake Aquifer Zone. These two aquifer units are separated by the Crouch Branch Confining Unit, which contains the Middle Sand Aquifer Zone. All four aquifer zones contain TCE and PCE above MCLs. A hydrostratigraphic column for the A/M-Area Groundwater OU is shown in Figure D-3. The extent of TCE contamination in the Lost Lake Aquifer Zone is shown in Figure D-2.

COCs identified in the Interim Record of Decision (IROD) at the ABRP subunit included TCE, PCE, and dichloromethane (Table D-2). Currently, TCE, PCE, and 1,4-dioxane exceed drinking water standards or MCLs in the M-Area Aquifer Zone, the Lost Lake

Aquifer Zone, and the Middle Sand Aquifer Zone. TCE is the only ABRP COC observed in the Crouch Branch Aquifer Unit.

COCs identified in the IROD for MCB/MBP subunit included TCE, PCE, carbon tetrachloride and lead (Table D-2). The USDOE, USEPA, and SCDHEC agreed not to treat lead because elevated levels are sporadic and are judged to be caused by natural geologic conditions. Currently, TCE, PCE, and 1,4-dioxane exceed drinking water standards or MCLs at the MCB/MBP subunit. The two aquifer zones impacted above MCLs at the MCB/MBP subunit are the Middle Sand Aquifer Zone and the Lost Lake Aquifer Zone.

IV. Remedial Actions

Three interim remedial actions for the A/M-Area Groundwater OU have been issued. The first was the IROD for the A/M-Area Groundwater OU, dated June 1992 (WSRC 1992). The second IROD, dated December 1999, addressed the groundwater contamination associated with the MCB/MBP subunit (WSRC 1999b). The third IROD, dated April 2000, addressed the groundwater contamination associated with the ABRP subunit (WSRC 2000). Each IROD is discussed below. The location and spatial relationship of these areas are illustrated in Figure D-2.

The final actions for the A/M-Area Groundwater OU will be documented by modifications to the RCRA permit renewal.

Remedy Selection

As stated in the IROD for the A/M-Area Groundwater OU (WSRC 1992), the purpose of the interim action was to:

- Prevent further groundwater plume migration and initiate groundwater restoration while risk assessment activities are being planned and conducted; and
- Obtain further information about the response of the aquifer to remediation.
- The preferred interim remedy for groundwater within the A/M-Area Groundwater OU was groundwater recovery with treatment by air stripping.

The components of the remedy included the following:

- Installing strategically located groundwater recovery wells;
- Extracting groundwater and processing it through an air stripper to release VOCs;
- Discharging the treated water to a National Pollutant Discharge Elimination System (NPDES) permitted outfall; and
- Conducting a treatability study to evaluate technologies to control air stripping tower gaseous emissions.

As stated in the IROD for the MCB/MBP (WSRC 1999b), the purpose of the interim action was to:

- Treat contaminated groundwater to prevent further VOC plume growth;
- Demonstrate the effectiveness of in situ air stripping wells in achieving significant contaminant mass removal; and
- Obtain necessary site-specific run data to determine a final remedial goal.

The preferred interim remedy for the MCB/MBP subunit groundwater was in situ air stripping and monitoring. The components of the remedy included the following:

- Installing three series (banks) of in situ air stripping wells located to address groundwater concentrations exceeding 500 μg/L, 200 μg/L, and 50 μg/L, respectively;
- Groundwater monitoring to evaluate and report the effectiveness of the in-situ air stripping wells; and
- Conducting a treatability study to evaluate technologies to control air stripping tower gaseous emissions.

As stated in the IROD for ABRP (WSRC 2000), the interim remedial action objectives were to:

    - Mitigate any further plume growth;

- Reduce concentration of the contaminant plume within the 100 µg/L VOC contaminant plume isopleth;
- Evaluate the effectiveness of the remedial system and its impact on the aquifer system; and
- Reduce the uncertainty of commingling of plumes between the two aquifer systems.

The preferred interim remedy for the ABRP subunit groundwater was air sparging with soil vapor extraction (SVE). The components of the remedy include the following:

- A two-staged approach with stage one including the installation of ten active air sparging wells, each with three BaroBall^{TM} passive SVE wells to be operated for about 12 months;
- Evaluation of enhanced bioremediation; and
- Stage two will incorporate the operating and effectiveness data obtained from stage one to design a more extensive system to address the > 100 µg/L VOC plume.

Interim and final remedial goals for ABRP and MCB/MBP subunits are shown in Table D-2.

Final remedial action objectives for all A/M-Area groundwater are to prevent exposure to contaminated groundwater above MCLs and restore groundwater to its beneficial use.

Remedy Implementation

A/M Area Groundwater OU

The remedial action for the A/M Area Groundwater OU was initiated with the installation and operation of the M-1 Air Stripper and eleven recovery wells in September 1985. Two additional recovery wells were installed near the Met Lab and began supplying groundwater to the M-1 Air Stripper in July 2000. This system was designed to hydraulically contain and capture the high concentration VOC plume predominantly in the Lost Lake Aquifer Zone, with a few of the wells also having screens in the M-Area Aquifer Zone and the Middle Sand Aquifer Zone of the Crouch Branch Confining Unit. Monitoring of air stripper influent and effluent water, recovery well flow rates and concentrations, and groundwater concentrations in nearby monitoring wells is conducted to evaluate the effectiveness of the system. The treated effluent from the air stripper is sampled at NPDES permitted outfalls to comply with the Clean Water Act. The exhaust from the M-1 Air Stripper currently complies with the air emissions permit without additional treatment.

The A-2 Air Stripper and recovery well system was installed to capture the northern portion of the VOC groundwater plume, which is associated with historical solvent use and disposal in laboratory facilities. The A-2 Air Stripper and six recovery wells were installed to restrict migration of VOC contamination within the Lost Lake Aquifer Zone, thereby preventing future downward migration into the deeper aquifer system. The A-2 Air Stripper began operations in 1996. The six recovery wells are screened in the Lost Lake Aquifer Zone and the Middle Sand Aquifer Zone of the Crouch Branch Confining Unit. Due to diminished mass removal rates at the six recovery wells, the A-2 Air Stripper was shut down in October 2012 after SCDHEC approved a temporary authorization (TA) (SCDHEC 2012). The A-2 Air Stripper remains shutdown as a series of monitoring wells are used to observe the potential effects on VOC contaminant migration from the Lost Lake Aquifer to the underlying Crouch Branch Aquifer Unit. The A-2 Air Stripper is temporarily operated quarterly to perform preventative maintenance and to sample the recovery wells that are a part of the shutdown monitoring well network. Monitoring of air stripper influent and effluent water and groundwater concentrations in nearby monitoring wells is conducted to evaluate the effectiveness of the system. The treated effluent from the air stripper is sampled at NPDES permitted outfalls to comply with the Clean Water Act. The exhaust from the A-2 Air Stripper currently complies with the air emissions permit without additional treatment.

The groundwater recovery well systems have been complemented with the use of SVE technology to address known source areas in the vadose zone. Four sites with elevated concentrations of PCE and TCE in the vadose zone were initially chosen for vadose zone remediation using vacuum extraction: the abandoned process sewer line leading to the M-Area Basin, the M-Area Settling Basin, the A-014 Outfall, and the former 321-M

Solvent Storage Tank Area. The SVE units are connected to vertical and/or horizontal SVE wells, effectively reducing the VOC mass in the vadose zone preventing future impacts to the groundwater. In the A-014 Outfall area, residual VOCs in lower permeability soils were addressed by soil hydraulic fracturing at seven locations, which allowed for improved rates of mass removal using a high vacuum SVE unit (Figure D-5) for those wells.

As contaminant levels have decreased in the vadose zone, several of the larger active systems have reached shutdown criteria as established in the M-Area and Met Lab HWMFs RCRA permit renewal application. To continue to provide mass removal the SVE wells associated with these units are often transitioned to passive SVE wells. Recent strategies have employed renewable energy (solar) powered blowers (MicroBlowers™) or passive barometric pumping using BaroBalls™. These passive technologies are proving beneficial in aiding cleanup when contaminant removal becomes limited by the rate of diffusion from fine-grained sediments.

Recognizing that a significant amount of solvents remains trapped in the subsurface in the form of DNAPLs, SRS has evaluated and implemented DNAPL specific remedies where appropriate. The most effective DNAPL specific remedy used within the A/M-Area Groundwater OU has been the use of thermal heating using the Dynamic Underground Stripping (DUS) process. Under this process steam is injected into the subsurface using multiple injection wells with the objective to provide a total steam flood throughout the DNAPL source zone. The steam flood promotes the enhanced removal of volatile compounds using vapor and groundwater extraction wells.

DUS was first deployed at the 321-M Solvent Storage Tank Area beginning in March 2000 and ending in September 2001. Approximately 31,750 kg (70,000 lbs) of VOCs were removed from the 30 m x 30 m x 48 m (100 ft x 100 ft x 160 ft) deep target area during the 12 months of operation. The second deployment of DUS targeted DNAPL beneath the closed M-Area Settling Basin to address the main source of the groundwater contamination in this area. The second DUS project commenced operation in August 2005 and operated through September 2009. More than 204,116 kg (450,000 lbs) of VOCs have been removed. Since DUS has been terminated, all further SVE and groundwater remediation near the M-Area Settling Basin are now associated with the Western Sector Treatment System (SRNS 2012). Ten of the Western Sector Treatment System SVE wells are still connected to the 782-6M soil vapor extraction unit (SVEU), while eleven of the SVE wells were converted to low energy solar powered MicroBlowers™.

The southeastern portion of the plume is associated with discharges from the A-014 Outfall and along its un-named tributary. The plume, which covers an area of approximately 325 hectares (800 acres), was being treated by a series of twelve in situ air stripping wells (airlift recirculation wells [ARW]) that were brought online in 1996. Due to high contaminant concentrations in the plume on the north end of the ARW line, multi-stage in-well aerators were installed in four of the twelve wells (i.e., SSR009 through SSR012) to enhance removal efficiency from 70% to 90% in 2001. In 2011, eight of the ARWs (i.e., SSR001 through SSR007, and SSR010) were shut down due to low VOC removal rates after SCDHEC approved a TA (SCDHEC 2011a). Shut down criteria was established for the remaining wells in the 2000 RCRA Part B Permit Renewal Application Volume III for M-Area and Met Lab HWMFs Postclosure (Volume III). This shutdown criterion was approved by SCDHEC in the 2014 RCRA Permit Renewal that became effective September 2, 2017 (SCDHEC 2017). SSR011 and SS012 meet the shutdown criteria of 9.1 kg (20 lbs) of VOC mass removal per well per year and are in the process of being shut down, leaving only SSR008 and SSR009 operational.

An enhanced bioremediation project is utilizing SSR001 to distribute humate amended groundwater to stimulate aerobic biodegradation of the VOC plume. This project started in 2017 and is expected to continue for 3 to 5 years. Additionally, in situ chemical oxidation (ISCO) was applied to the high concentration portion of the plume near the A-014 Outfall. ISCO was demonstrated twice under separate TAs (SCDHEC 2009 and SCDHEC 2011b). Although some VOC destruction was observed, ISCO (using persulfate) was determined to not be the most effective corrective action option for this area.

The western plume is associated with contaminant migration from the M-Area Settling Basin and the 321-M Solvent Storage Tank Area. An additional M-1 Air Stripper recovery well, RWM018, was installed to capture the greater than 10,000 µg/L VOC plume. RWM018 was installed in 2017 and will be operational in 2018. ISCO will also be deployed in the western portion of the plume, utilizing the enhanced hydraulic gradient created by the operation of RWM018. RWM018 and the ISCO project were approved as a TA by SCDHEC in March 2016 (SCDHEC 2016a).

Two process water production wells (PW 20A and PW 53A), which are screened in the deeper Crouch Branch Aquifer Unit, are operated to provide water for the Savannah River National Laboratory (SRNL) key essential services such as chilled water, steam, cooling water, and for SRNL's Nuclear Safety Class fire water system. These wells are operated at a minimum of 50% capacity to capture a portion of the groundwater plume within the Crouch Branch Aquifer Unit downgradient of the SRNL complex. Groundwater from these production wells is not treated. On January 5, 2016, the SRS requested a "contained-in determination" for the groundwater contaminated with RCRA-listed wastes (F001/F002) that is used as process water throughout the A/M Area (SRNS 2016). On December 7, 2016, the SCDHEC approved a "contained-in determination" for production wells, PW 20A and PW 53A, establishing limits of 161 µg/L for TCE and 27 µg/L for PCE (SCDHEC 2016b). To determine compliance with these limits, samples are collected from the two production wells a minimum of once per quarter. In addition, TCE and PCE is also analyzed at NPDES permitted outfalls to verify no impacts to surface water.

MCB/MBP Subunit

The remedial action for the groundwater portion of the MCB/MBP subunit was implemented through the following activities:

- Treating the plume using an in-situ air stripping system consisting of eleven wells arranged in three banks, with five wells in the first bank and three wells in each of the next two banks. These ARWs became operational in February 2002. The vertical and horizontal flow fields modeled during the operation of these wells was predicted to result in a 90% contaminant concentration reduction in one pass through the well field at 40 gpm. Seventeen new and existing monitoring wells were identified to assist in determining the effectiveness of the system. Monitoring of ARW off-gas was conducted to assess the effectiveness of the ARW system.

- Between 2002 and 2011, the eleven ARWs only removed a total of 46 lbs of VOCs from the Lost Lake Aquifer. MIS-001 through MIS-005 were installed to target the >500 µg/L TCE plume, a concentration that has not been observed since after start-up in 2002. The removal rates in the Lost Lake Aquifer had declined over time, which was an indication that active remediation of the vadose zone had cut off the majority of contaminant migration to the groundwater at the MCB/MBP OU. In 2011, the eleven ARWs (i.e., MIS001 through MIS011) were shut down after SCDHEC approved a TA (SCDHEC 2011a). Since the shutdown, new monitoring wells have been installed to observe VOC contaminant plume migration and establish regional groundwater flow directions. A schedule for the final corrective action at MCB/MBP Subunit will be incorporated into the Corrective Action Plan for the ABRP/MCB/MBP OU as defined in the 2000 RCRA Part B Permit Renewal Application for M-Area and Met Lab HWMFs Postclosure (Volume III). The corrective action schedule was incorporated into the 2014 RCRA Permit Renewal that became effective September 2, 2017 (SCDHEC 2017).

ABRP Subunit

Stage one of the remedial actions for the groundwater portion of the ABRP subunit was implemented through the following activities:

- Installing and operating ten air sparging wells to address the areas of the VOC plume in the M-Area Aquifer in excess of 500 µg/L. Each well had a discrete 0.3-m (1-ft) upper and lower screen separated vertically by about 3 m (10 ft). All wells became operational by October 2001. Due to reduced water tables levels, only the lower screens were operated. Each air sparge well had three passive SVE wells located at distances of 1.5, 3, and 4.5 m (5, 10, and 15 ft) away, screened across the vadose zone above the water table (M-Area Aquifer) to capture off-gas from the air sparging system.

- Groundwater monitoring and vapor monitoring of off-gas was conducted to evaluate the effectiveness of the remediation system and provide data to design and implement stage two of the remedy. The monitoring data also provided information on the amount of VOCs removed.

Stage two of the remedial action was not implemented based on the limited effectiveness of the stage one system. The presence of a low permeability zone above the lower air sparging target zone did not allow for the effective recovery of sparge air with entrained VOCs, and led to the lateral expansion of the groundwater plume in the M-Area Aquifer. Operating in pulsed mode and venting the middle sand of the Green Clay Confining Unit were evaluated and determined to likely not result in significant improvement in system performance. Thus, USDOE, USEPA, and SCDHEC agreed to discontinue operation of the system (WSRC 2003).

1,4-Dioxane has been detected at the ABRP Subunit since 2008. In 2011, the groundwater protection standard changed from 150 µg/L to 6.1 µg/L. In 2012, SRS initiated a comprehensive sampling plan to analyze for 1,4-dioxane at all monitoring wells as defined in the 2000 RCRA Permit Renewal Application for M-Area and Met Lab HWMFs Postclosure (WSRC-IM-98-30, Volume III). Based on the comprehensive sampling, a contaminant plume was identified below the M-Area Settling Basin and the ABRP Subunit. The plume extends to the southeast toward the Crackerneck Swamp Recreation Area. The plume will be further characterized and the final corrective action at the ABRP Subunit will be incorporated into the Corrective Action Plan for the ABRP/MCB/MBP OU as defined in the 2000 RCRA Permit Renewal Application for M-Area and Met Lab HWMFs Postclosure (WSRC-IM-98-30, Volume III). The corrective action schedule was incorporated into the 2014 RCRA Permit Renewal that became effective September 2, 2017 (SCDHEC 2017).

System Operations/Operation and Maintenance

The IROD for the A/M-Area Groundwater OU remediation indicated that testing would continue in an effort to further increase recovery of groundwater. Periodic redevelopment of the recovery wells and pump replacements have been conducted to optimize recovery rates. Current average recovery rates are 1,904.8 L/min (419 gpm) (SRNS 2017). In addition, the two process water production wells, PW 20A and PW 53A, are required under the permit to operate to provide mass removal and plume control in the Crouch Branch Aquifer Unit.

The in-situ air stripping wells require notification to SCDHEC upon shutdown.

Routine and preventative maintenance is conducted on all operating systems, along with comprehensive monitoring of groundwater, effluent discharge, and off-gas associated with the treatment systems.

Institutional controls (i.e., LUCs) have been implemented through the SRS Site Use/Site Clearance program to preclude inadvertent access or use of contaminated groundwater.

Costs associated with the selected remedy for A/M Groundwater include operation and maintenance (O&M) costs of air strippers, SVE units, and institutional controls (i.e., LUCs). The actual O&M cost during Fiscal Year (FY) 2012 to FY2017 is $13,235807. RCRA documentation does not require estimated project costs to be prepared. Therefore, a cost comparison cannot be provided in this remedy review.

V. Progress since Last Review

The previous protectiveness statement concluded that the interim remedial actions at A/M-Area Groundwater OU are expected to be protective, and in the interim, exposure pathways that could result in unacceptable risks are being prevented by existing SRS Site Use/Site Clearance requirements. Containment and remediation by several treatment systems are monitored by the groundwater monitoring network which has been functioning properly.

Data from background, plume definition, airlift recirculation, and recovery wells, as applicable, are used to assess the effectiveness of the corrective action program. Background and plume definition wells monitor the horizontal and vertical extent of groundwater contamination and groundwater quality. Recovery wells pump contaminated groundwater to air strippers, which remove VOCs from the water before it is discharged to the appropriate outfall. ARWs perform in-situ air stripping to reduce VOC mass in the plume.

There were four recommendations in the Fourth Five-Year Remedy Review Report for the A/M Groundwater OU. The status of each recommendation is listed below:

- Optimize the M-1 recovery system and/or consider other remediation technologies to treat the Lost Lake Aquifer Zone high dissolved concentration area – The high concentration plume in Western Sector was characterized with 33 wells and soil borings between 2014 and 2016. Based on this characterization, a new recovery well, RWM018, was installed in 2017 and will become operational in 2018. In addition to RWM018, ISCO is planned to start in 2018 with monitoring continuing through 2020. Two additional TAs are planned near the M-Area Settling Basin, which is thought to be the source of the Western Sector contamination. The first TA will install another recovery well, RWM019, in the Lost Lake Aquifer Zone to the south of the M-Area Settling Basin. RWM019 is expected to be operational in 2020. The second TA will deploy an in situ remedial technology into the M-Area Aquifer Zone and the upper Lost Lake Aquifer Zone to the west of the M-Area Settling Basin. The second TA is expected to start in 2021.
- Reduce reporting frequency from semiannual to annual – SCDHEC approval to change the reporting frequency from semi-annual to annual became effective on July 12, 2013.
- Remove/add wells to monitoring network based on current plume configuration. Reduce sampling frequency for remedial systems. – SRS continues to modify the monitoring well network and sampling frequency for remedial systems for the M-Area and Met Lab HWMFs. The most recent changes are in the 2014 RCRA Permit Renewal that became effective on September 2, 2017 (SCDHEC 2017).
- Submit a schedule for corrective action, including additional characterization of the distal plume (ABRP/MCB/MBP OU) – A final corrective action for the ABRP/MCB/MBP OU plume is still pending. However, the updated corrective

action schedule, was approved by SCDHEC in the 2014 RCRA Permit Renewal that became effective on September 2, 2017 (SCDHEC 2017). The updated schedule extended the final corrective action decision until 2023 to allow time to characterize the 1,4-dioxane plume.

A summary of the operation and performance data over the last five years for the various remediation systems associated with the A/M-Area Groundwater OU and MCB/MBP subunit is presented in Table D-3.

VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII, Documents Reviewed;
- Confirmed the implementation of the remedial actions;
- Reviewed all process and performance monitoring data provided by the annual groundwater monitoring and corrective action reports and provided a technical assessment of whether the treatment systems are functioning as intended by the ABRP and MCB/MBP Subunit IRODs and whether the shutdown criteria have been achieved;
- Inspected the OU, interviewed maintenance personnel and documented the results on the Inspection Checklist provided in Attachment D-1; and
- Assured that all actions required under the RCRA Permit were implemented.

Data Review

M-1 Air Stripper and Recovery Wells

The M-1 Air Stripper and associated recovery wells have removed 12,751 kg (28,111 lbs) of VOCs over the last five years, with an increase in mass of about 44% between the last and first year of the period. During 2016, the average monthly influent VOC concentration was 5,382 µg/L. The average monthly effluent total VOC concentration was 0.00 µg/L or less than the detection limit for TCE and PCE. The M-1 Air Stripper has removed a cumulative total of approximately 230,735 kg (508,684 lbs) of VOCs since the beginning of operation in 1984.

A-2 Air Stripper and Recovery Wells

The A-2 Air Stripper and associated recovery wells and have removed 147 kg (325 lbs) of VOCs over the last five years. The A-2 Air Stripper was shut down in October 2012 and placed in suspended state which requires the stripper and recovery wells to operate minimally each month for preventative maintenance. A minimal amount of VOC mass was removed from 2013 to 2016 because of these maintenance activities.

Southern Sector ARWs

During the last five years the recirculation wells removed approximately 246 kg (542 lbs) of solvent, with a decrease of about 65% between the last and first year of the period. Only four of the twelve wells (SSM008, SSM009, SSM011, and SSM012), at the northern end of the remediation line, are operational. SSM011 and SSM012 will be removed from operation since their mass removal rates have decreased to less than the 20 lbs per year for two years criteria specified in the RCRA permit renewal (SCDHEC 2017).

DUS / Western Sector Treatment System at the M-Area Settling Basin

The second DUS project commenced operation on August 8, 2005 and targeted DNAPL source zones associated with the M-Area Settling Basin. Steaming operations were conducted through October 2008 and again from May 2009 until September 2009 when shutdown criteria (WSRC 2006) had been met. The DUS project removed a total of 207,485 kg (457,426 lbs) of VOCs from the target area. Although steaming has terminated, SVE wells continue to remove VOC mass from the subsurface. In the last five years, the 782-6M SVEU has removed a total of 943 kg (2,078 lbs). The MicroBlowers™ at the Western Sector Treatment System have only operated since 2015 and have removed 309 kg (682 lbs).

Other SVE Units

After completion of the first DUS at the 321-M Solvent Storage Tank Area in 2001, active SVE was continued, and eventually converted to a MicroBlower™ system using solar power in November 2010. This MicroBlower™ has removed 981 kg (2,162 lbs) of VOCs over the last five years, with a decrease in mass of about 20% between the last and first year of the period.

Two SVEUs have been in operation at the A-014 Outfall area over the last five years. The 782-3M unit targets the deep vadose zone, and has removed 1,486 kg (3,275 lbs) of VOCs over the last five years. A high vacuum SVE unit is used for the shallow vadose zone, which is lower permeability and was hydraulically fractured to improve air flow through the contaminated zone. It has removed 1,031 kg (2,272 lbs) of VOCs over the last five years. Considering both units, the mass removed in the last year decreased about 40% between the last and first year of the period.

BaroBall™-equipped wells near the Met Lab HWMF and along the abandoned process sewer line leading to the M-Area Basin continue to operate passively.

<u>MCB/MBP Subunit</u>

Operational and performance data for the eleven (11) MCB/MBP ARWs is presented in Table D-3. During the review period, the ARWs were shut down; therefore, no mass was removed.

Summary of Inspections and Interviews

Interviews were conducted with Richard Feagin, O&M Staff member, on October 11, 2017 and George Joyner, O&M Site Manager, October 12, 2017 at the O&M organization offices. No issues were identified for the A/M-Area Groundwater OU during these interviews.

The A/M-Area Groundwater OU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) and the U.S. Department of Energy (USDOE) personnel on December 15, 2017. No issues were identified for the A/M-Area Groundwater OU during this inspection.

A site inspection will be conducted by USEPA and SCDHEC personnel, accompanied by USDOE and SRNS personnel, prior to submittal of the Revision 1 of this document. It is anticipated that no significant problems regarding this OU will be identified during the inspection.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

Each of the three interim remedies effectiveness in meeting the interim remedial action objectives is described below:

A/M-Area Groundwater OU

The zone of influence of the M-1 Air Stripper and associated recovery well network was designed to capture the high concentration regions of the TCE/PCE plumes present, thus preventing significant plume migration. The system has been effective, removing 230,735 kg (508,684 lbs) of VOCs since 1984. Mass removal at the M-1 Air Stripper increased during 2015 and 2016 due to increasing VOC concentrations at RWM 8 and RWM 10. Recent groundwater monitoring well data from the Lost Lake Aquifer Zone indicate that a portion of the high concentration groundwater plume is located to the west of the recovery well zone of capture (SRNS 2017). A new recovery well, RWM018, has been installed to capture this portion of the plume. It will be connected to the M-1 Air Stripper and begin operations in 2018. The recovery wells are primarily screened in the Lost Lake Aquifer Zone; however residual contamination within the M-Area Aquifer Zone would ultimately also be captured by these wells. Any contamination in the Crouch Branch Aquifer is not affected by this system.

The active SVEU systems at the Western Sector Treatment System and the A-014 Outfall will remain operational until VOC removal is 18 kg/week (40 lbs/week) or less for each SVEU. At that time, the systems will be evaluated to determine the appropriate corrective action path, which may include continued operation, transition to a low-energy or passive system, or complete shutdown.

MCB/MBP Subunit

The recirculation wells were placed in service in February 2002 and were shut down in November 2011. During operation, the eleven recirculation wells removed a total of 21 kg (46 lbs) of VOCs.

An approved corrective action schedule is included in the 2000 RCRA Part B Permit Renewal Application for M-Area and Met Lab HWMFs Postclosure (Volume III). The corrective action schedule was incorporated into the 2014 RCRA Permit Renewal that became effective on September 2, 2017 (SCDHEC 2017).

ABRP Subunit

Operation of the air sparging system began in 2001. The presence of a low permeability zone above the lower air sparging target zone did not allow for the effective recovery of sparge air with entrained VOCs, and led to the lateral expansion of the groundwater plume in the M-Area Aquifer Zone. Operating in pulsed mode and venting the middle sand of the Green Clay Confining Unit were evaluated and determined to likely not result in significant improvement in system performance. Thus, USDOE, USEPA, and SCDHEC agreed to discontinue operation of the system (WSRC 2003).

Groundwater concentrations in the M-Area Aquifer Zone and the upper Lost Lake Aquifer Zone in the vicinity of the system have been declining; 2016 TCE concentrations are below 50 μg/L. 1,4-Dioxane concentrations are greatest at ARP 1A with a concentration of 260 μg/L in 2016 and concentrations exceed 100 μg/L throughout the plume. Additional characterization of the 1,4-dioxane plume is needed to fully understand the extent of the plume. Corrective action for the distal portion of the ABRP/MCB/MBP OU will be evaluated after characterization of the VOC and 1,4-dioxane plumes have been completed. An approved corrective action schedule is included in the 2000 RCRA Part B Permit Renewal Application for M-Area and Met Lab HWMFs Postclosure (Volume III). The corrective action schedule was incorporated into the 2014 RCRA Permit Renewal that became effective on September 2, 2017 (SCDHEC 2017).

A Land Use Control Implementation Plan (LUCIP) is in place for the ABRP/MCB/MBP OU surface units. The LUC requirements for the A/M-Area Groundwater OU are discussed and approved as part of the closure/post-closure/permit application process and are governed by the RCRA Permit Renewal for the SRS (SCDHEC 2017). Therefore, an OU-specific LUCIP is not required for the A/M Area Groundwater OU. As discussed in the RCRA Permit Renewal, institutional controls (i.e., LUCs) are in place to prevent exposure to or ingestion of contaminated groundwater include physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the A/M-Area Groundwater OU for industrial use only (SRS is a secured government facility with land use restrictions), and use restrictions via the SRS Site Use/Site Clearance Program. No activities were observed that would have violated the institutional controls (i.e., LUCs).

Are Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still valid?

The exposure assumptions and toxicity data used at the time of the three interim remedy selections are still valid. There have been no changes in the physical conditions of the site, changes in exposure pathways, land use or contaminant characteristics that would affect the protectiveness of the remedy. The MCLs for PCE and TCE have remained at 0.005 mg/L. A Preliminary Remediation Goal of 0.006 mg/L has been established for 1,4-dioxane, which is monitored for under the RCRA permit renewal.

Fact sheets provided on the USEPA webpage regarding emerging contaminants were reviewed for applicability to this site. None of the listed emerging contaminants were identified as applicable to this OU.

Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that could call into question the protectiveness of the remedy.

VIII. Issues

There are no issues related to current site operations, conditions, or activities that currently prevent the remedy from being protective.

IX. Recommendations and Follow-up Actions

There are no recommendations or follow-up actions for this OU under CERCLA. SRS has submitted corrective action schedules, which propose corrective action technologies to treat the higher concentration parts of the plume, in the 2000 RCRA Part B Permit Renewal Application for M-Area and Met Lab HWMFs Postclosure (Volume III). These corrective action technologies will be approved by the SCDHEC prior to implementation.

X. Protectiveness Statement(s)

The remedies at the A/M-Area Groundwater OU currently protect human health and the environment because groundwater removal and treatment, in situ treatment, and contaminant source treatment have been successful in removing VOC contamination in groundwater and exposure pathways that could result in unacceptable risks are being controlled through institutional controls. However, for the remedy to be protective in the long-term, optimization of the M-1 Air Stripper recovery system and/or other corrective action technologies must be implemented to treat the high concentration part of the plume located outside of the recovery well system zone of capture.

Currently, controls to prevent exposure to or ingestion of contaminated groundwater include physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the A/M-Area Groundwater OU for industrial use only (SRS is a secured government facility with land use restrictions), and use restrictions via the SRS Site Use/Site Clearance Program.

XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Operating Equipment is scheduled for January 2024.

XII. Documents Reviewed

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

SCDHEC, 1995. *South Carolina Hazardous Waste Permit SC1 890 008 989*, RCRA Part B Permit, effective October 5, 1995, Section IIIB.H.11.b for the M-Area HWMF and Section IIIG.H.11.b for the Met Lab HWMF, South Carolina Department of Health and Environmental Control, Columbia, SC

SCDHEC, 2009. Letter, R. Haynes (SCDHEC) to G. Hayford (SRNS), *Re: Treatability Study Test Plan for Demonstration of In Situ Chemical Oxidation for the Degradation of Residual VOCs at the M-Area Chemical Oxidation (MACO) Site, WSRC-RP-2008-4074, Rev. 0, Sept. 2008, Savannah River Site (SRS) SC1 890 008 989, Aiken County*, South Carolina Department of Health and Environmental Control, Columbia, SC

SCDHEC, 2011a. Letter, R. Haynes (SCDHEC) to G. Hayford (SRNS), *Re: Temporary Authorization Request for the AM-Area HWMF: Modification of the Corrective Action Systems at the Southern Sector and A-Are Burning/Rubble Pits and Rubble Pile/ Miscellaneous Chemical Basin/Metals Burning Pit Operable Unit (ABRP/MCB/MBP OU) Letter Hayford to Haynes – dated October 14, 2011 Savannah River Site (SRS) SC1 890 008 989*, SRNS-OS-2011-00239, dated November 11, 2011, South Carolina Department of Health and Environmental Control, Columbia, SC

SCDHEC, 2011b. Letter, R. Haynes (SCDHEC) to G. Hayford (SRNS), *Re: Treatability Study Test Plan for Demonstration of In Situ Chemical Oxidation (ISCO) for the Degradation of Residual VOCs at the M-Area Chemical Oxidation (MACO) Site Phase II: Shallow Water Table Treatability Study, SRNS-RP-2010-01393, Rev. 1, January 2011) Savannah River Site (SRS) SC1 890 008 989 – Aiken County*, South Carolina Department of Health and Environmental Control, Columbia, SC

SCDHEC, 2012. Letter, R. Haynes (SCDHEC) to K. Kostelnik (SRNS), *Re: Temporary Authorization Request for the M-Area Hazardous Waste Management Facility (HWMF): Modification of the Corrective Action System at the A-2 Stripper Letter Kostelnik to Haynes* *dated April 27, 2012 Savannah River Site (SRS) SC1 890 008 989*, SRNS-OS-2012-00118, dated July 24, 2012, South Carolina Department of Health and Environmental Control, Columbia, SC

SCDHEC, 2014. *South Carolina Department of Health and Environmental Control Hazardous and Mixed Waste Permit, Permit Number SC1 898 008 989*, 2014 RCRA Permit Renewal for the Savannah River Site, issued on February 11, 2014, Module III - Postclosure Care and Module IV – Groundwater Requirements, Section A, M-Area and Metallurgical Laboratory Hazardous Waste Management Facilities, South Carolina Department of Health and Environmental Control, Office of Environmental Quality Control, Bureau of Land and Waste Management, Columbia, SC

SCDHEC, 2016a. Letter, D. Scaturo (SCDHEC) to A. J. Meyer (SRNS), *Re: Temporary Authorization Request for the M-Area Hazardous Waste Management Facility: Western Sector In-situ Chemical Oxidation Letter Meyer to Scaturo dated Feb. 23, 2016 Savannah River Site (SRS) SC1 890 008 989*, SRNS-OS-2016-00013, dated March 9, 2016, South Carolina Department of Health and Environmental Control, Columbia, SC

SCDHEC, 2016b. Letter, S. French (SCDHEC) to C. Bergren (SRNS), *Re: Savannah River Site – SC1 89 0008 989 Request for a Contained-In Determination for the Groundwater Contaminated with Listed Waste at Process Wells 905-20A and 905-53A with Risk Assessment for A-Area Production Wells Contained-In Determination (Rev. 0 Dated Oct. 2015) Letter Bergren to French Dated Jan. 5, 2016 Contained-In Determination Email, M. Wilson to Frasier Dated Dec. 6, 2016*, SRNS-OS-2016-00109, dated December 7, 2016, South Carolina Department of Health and Environmental Control, Columbia, SC

SCDHEC, 2017. *South Carolina Department of Health and Environmental Control Hazardous and Mixed Waste Permit, Permit Number SC1 898 008 989*, 2014 RCRA Permit Renewal for the Savannah River Site, issued on February 11, 2014, modified on August 17, 2017 and modification effective on September 2, 2017, Module IV – Groundwater Requirements, Section A, M-Area and Metallurgical Laboratory Hazardous Waste Management Facilities, South Carolina Department of Health and Environmental Control, Office of Environmental Quality Control, Bureau of Land and Waste Management, Columbia, SC

SRNS, 2012. *Western Sector Treatment System (WSTS) Project Description (U)*, SRNS-RP-2012-00230, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS 2016, Letter, C. Bergren (SRNS) to S. French (SCDHEC), *Request for A Contained-In Determination for the Groundwater Contaminated with Listed Waste at Process Wells 905-20A and 905-53A (U)*, SRNS-J2000-2015-00684, dated January 5, 2016, Savannah River Site Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS 2017. *Annual 2016 M-Area and Metallurgical Laboratory Hazardous Waste Management Facilities Groundwater Monitoring and Corrective Action Report (U)*, SRNS-RP-2017-00072, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

USDOE 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 1992. *Interim Action Record of Decision Remedial Alternative Selection A/M Area Groundwater Operable Unit*, WSRC-RP-92-744, Revision 0, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1999a. *Land Use Control Assurance Plan for the Savannah River Site*, WSRC-RP-98-4125, Revision 1.1, latest update, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC 1999b. *Interim Action Record of Decision Remedial Alternative Selection for the Miscellaneous Chemical Basin/Metals Burning Pit (731-4A/5A) Operable Unit (U)*, WSRC-RP-98-4031, Revision 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2000. *Interim Action Record of Decision Remedial Alternative Selection for the A-Area Burning/Rubble Pits (731-A/1A) and Rubble Pit (731-2A) (U)*, WSRC-RP-2000-4001, Revision 0, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC 2003. *Performance Evaluation Report for the A-Area Burning/Rubble Pits (731-A/1A) and Rubble Pit (731-2A) Interim Remedial Action: September 2001-September 2002 (U)*, WSRC-RP-2002-00534, Revision 1.1, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC 2006. *2000 RCRA Part B Permit Renewal Application: M-Area and Metallurgical Laboratory Hazardous Waste Management Facilities (M-Area and Met Lab HWMFs) Post-closure*, WSRC-IM-98-30, Volume III, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

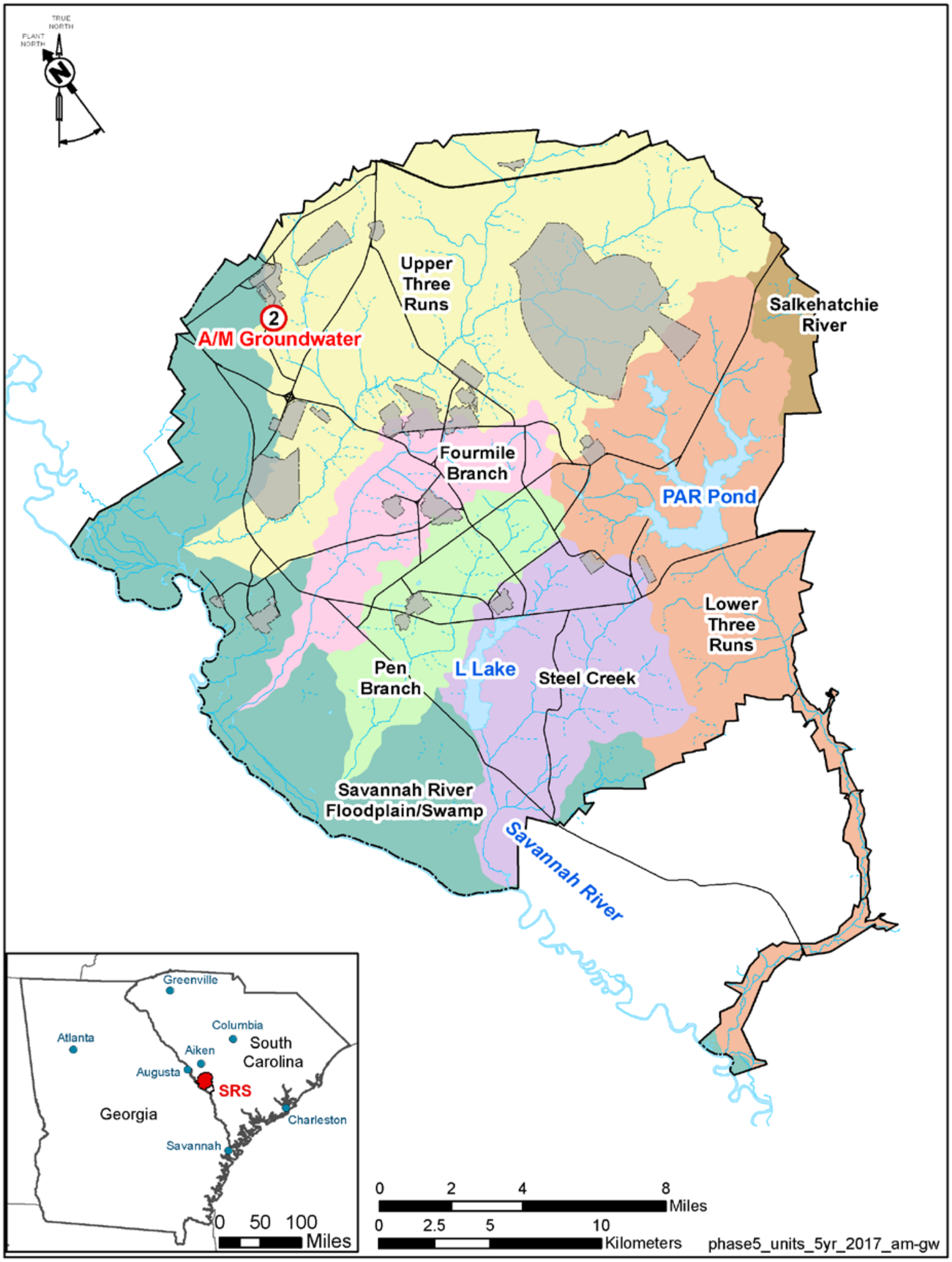

Figure D-1. Location of A/M Groundwater at Savannah River Site

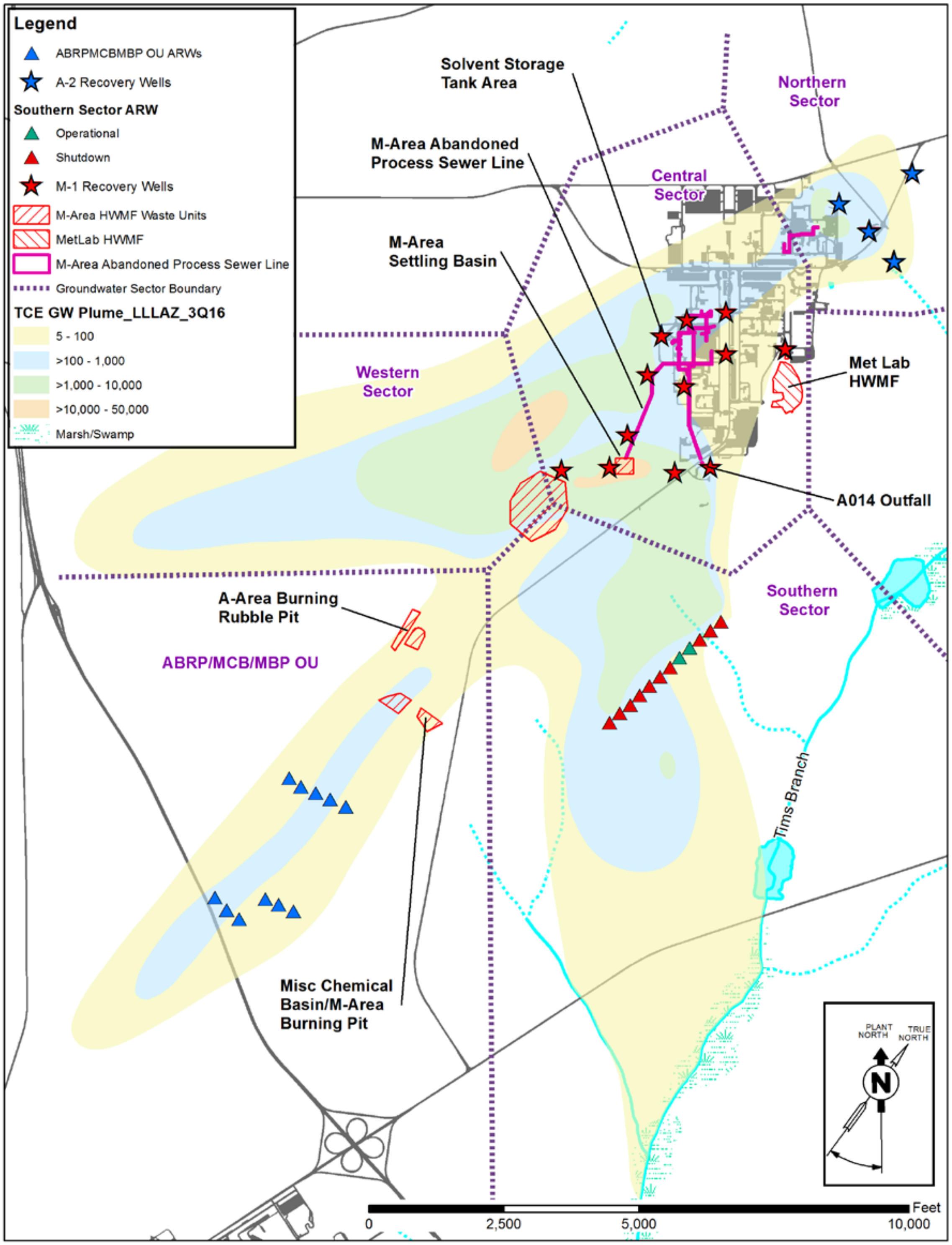

Figure D-2. A/M Area Groundwater OU Plume and Treatment Systems Locations

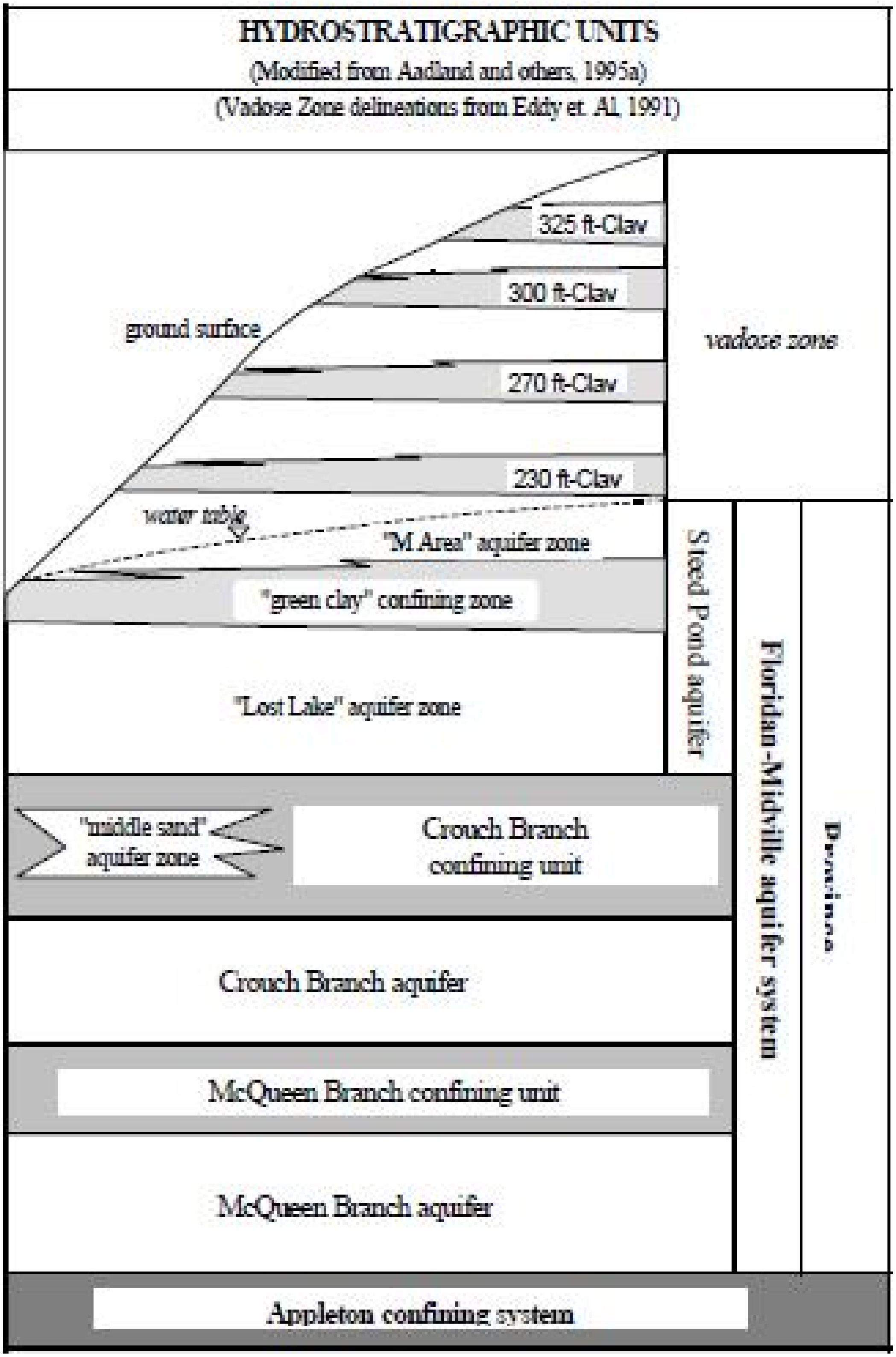

Figure D-3. A/M-Area Groundwater OU General Hydrostratigraphy

Figure D-4. M-1 Air Stripper System (2017)

Figure D-5. High Vacuum SVE Unit (i.e., Mobile #3) at A-014 Outfall (2017)

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Table D-1. Chronology of OU Events

Event	Date
Interim Status Groundwater Monitoring Start / Completion	September 29, 1980 / November 1, 1987
Pilot / Prototype Air Stripper System Testing and Operation Start / Completion	February 1983 / March 1985
M-1 Air Stripper Full Scale Operation Start / Completion	September 9, 1985 / Ongoing
IROD Issuance for A/M Area Groundwater OU	September 16, 1992
IROD Issuance for the MCB/MBP	February 9, 2001
IROD Issuance for the ABRP OU	February 9, 2001
Interim Remedial Action Start / Completion for the ABRP Air Sparging Wells	September 26, 2001 / March 2003
Interim Remedial Action Start / Completion for the MCB In Situ Air Stripping (Recirculation) Wells	February 28, 2002 / November 8, 2011 (Operational Suspension)
Transfer of ABRP/MCB/MBP OU Groundwater Plume to RCRA Program	July 19, 2006*
RCRA Permit Renewals (Effective Dates)	September 30, 1987 / September 5, 1995/ September 30, 2003 / February 11, 2014 /
Previous Five-Year Reviews	June 30, 1997 / February 12, 2004 / January 29, 2009 / February 4, 2014

* Submittal date of the 2000 RCRA Part B Permit Renewal Application (WSRC 2006).

Table D-2. COCs and Interim and Final RGs for ABRP and MCB/MBP subunits

Groundwater COCs and RGs for the ABRP subunit		
COC	**Final RG, MCL (µg/L)**	**Interim RG µg/L**
TCE	5	100*
PCE	5	100*
Dichloromethane	5	100*

Groundwater COCs and RGs for the MCB/MBP subunit				
COC	**Final RG, MCL, Action Level (µg/L)**	**Interim RG, High VOC Concentration Wells (>500 µg/L)†**	**Interim RG, Medium VOC Concentration Wells (ca 200 µg/L)†**	**Interim RG, Low VOC Concentration Wells (<50 µg/L)†**
TCE	5	20	41	20
PCE	5	20	41	20
Carbon tetrachloride	5	20	41	20
Lead	15 (Action Level)	15	15	15

* Interim RGs specified in Interim Action Proposed Plan for ABRP.
† Interim RGs based on modeling results.
COC - constituent of concern
MCL – maximum contaminant level
RG – remedial goal

Table D-3. Summary of Remediation Performance for 2012 – 2016 (lbs of VOCs Removed)

	2012	**2013**	**2014**	**2015**	**2016**
Groundwater Recovery & Treatment					
M-1 Air Stripper	4,798	4,279	3,839	6,562	8,634
A-2 Air Stripper	268	53	1	1	2
Groundwater Recirculation Wells					
Southern Sector ARWs	213	144	72	40	73
MCB ARWs	0	0	0	0	0
Soil Vapor Extraction					
A-014 Outfall (3M)	814	931	427	437	666
A-014 High Vacuum	732	536	368	350	286
Solvent Storage Tank (Post-DUS)	365	374	313	818	292
M-Area Settling Basin (6M)	2,373	1,387	323	22	346
M-Area Settling Basin (MicroBlower™)	-	-	-	89	594

Attachment D-1. Five-Year Review Site Inspection Checklist – A/M-Area Groundwater

I. SITE INFORMATION

Site Name:	**A/M-Area Groundwater**	**Date of Inspection:**	**08/30/2017**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**CERCLIS #36**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**75°F and Cloudy**

Remedy Includes: *(Click all that apply)*

☐ Landfill Cover/Containment

☒ Access Controls

☒ Institutional Controls

☒ Groundwater Pump and Treatment

☐ Surface Water Pump and Treatment

☐ Monitored Natural Attenuation

☐ Groundwater Containment

☐ Vertical Barriers

☒ Other SVE (Active and Passive), Dynamic Underground Stripping, Airlift Recirculation Wells

Attachments: ☐ Inspection team roster attached ☐ Inspection team roster attached

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 10/12/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

Problems/Suggestions: ☐ Report Attached

2. **O&M Staff:** Richard Feagin (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 10/11/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4416

Problems/Suggestions: ☐ Report Attached

Attachment D-1. Five-Year Review Site Inspection Checklist – A/M-Area Groundwater *(continued)*

II. INTERVIEWS *(Click all that apply)(Continued)*

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

Agency: ______________________

Contact: ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ______________________

____

Agency: ______________________

Contact: ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ______________________

____

Agency: ______________________

Contact: ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ______________________

____

4. **Other Interviews** *(Optional):* ☐ Report Attached ______________________

____

____

____

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Click all that apply)*

1. **O&M Documents:**

☒ O&M Manual	☒ Readily Available	☒ Up to Date	☐ N/A
☒ As-Built Drawings	☒ Readily Available	☒ Up to Date	☐ N/A
☒ Maintenance Logs	☒ Readily Available	☒ Up to Date	☐ N/A

Remarks: ______________________

____

Attachment D-1. Five-Year Review Site Inspection Checklist – A/M-Area Groundwater *(continued)*

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)*

2. Health and Safety Plans (HASPs):

☐ Site-Specific Health and Safety Plans ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Contingency Plan/Emergency Response Plan ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.120.HAZWOPER. A SSHASP is prepared if needed.

3. O&M and OSHA Training Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix.

4. Permits and Service Agreements:

☒ Air Discharge Permit ☒ Readily Available ☒ Up to Date ☐ N/A
☒ Effluent Discharge ☒ Readily Available ☒ Up to Date ☐ N/A
☐ Waste Disposal; POTW ☐ Readily Available ☐ Up to Date ☒ N/A
☒ Other Permits ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Underground injection control permits, RCRA Permit Renewal for SRS

5. Gas Generation Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

6. Settlement Monument Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

7. Groundwater Monitoring Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks:

8. Leachate Extraction Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

9. Discharge Compliance Records:

☒ Air ☒ Readily Available ☒ Up to Date ☐ N/A
☒ Water (Effluent) ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks:

10. Daily Access/Security Logs: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

Attachment D-1. Five-Year Review Site Inspection Checklist – A/M-Area Groundwater *(continued)*

IV. O&M COSTS

1. O&M Organization:

☐ State In-House
☐ PRP In-House
☒ Other: SRS
☐ Contractor for State
☐ Contractor for PRP

2. O&M Cost Records:

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review

Total annual cost by year for review period, if available

From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached

3. Unanticipated or Unusually High O&M Costs During Review Period

Describe costs and reasons: ______

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing Damage: ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks: OU-specific perimeter fencing is not required by the interim remedial action.

B. Signs

1. Signs and Other Security Measures: ☐ Location shown on site map ☒ N/A
Remarks:______

Attachment D-1. Five-Year Review Site Inspection Checklist – A/M-Area Groundwater *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Once in 5 years
Responsible Party/Agent: USDOE Savannah River Field Office

Contact:	Karen Adams	Federal Project Director	12/15/17	803-952-7871
	(Name)	(Title)	(Date)	(Phone No.)

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

2. Adequacy: ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks:

D. General

1. Vandalism/Trespassing: ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

2. Land use changes onsite: ☒ N/A
Remarks:

3. Land use changes offsite: ☒ N/A
Remarks:

Attachment D-1. Five-Year Review Site Inspection Checklist – A/M-Area Groundwater *(continued)*

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. Roads damaged: ☐ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks:

B. Other Site Conditions

Remarks:

VII. LANDFILL COVER/CONTAINMENT ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. Pumps, Wellhead Plumbing, and Electrical:

☒ Good Condition ☒ All required wells located ☐ Needs Maintenance ☐ N/A

Remarks:

2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances:

☒ Good Condition ☐ Needs Maintenance

Remarks:

3. Spare Parts and Equipment:

☒ Readily Available ☒ Good Condition ☐ Requires Upgrade ☐ Needs to be provided

Remarks:

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

Attachment D-1. Five-Year Review Site Inspection Checklist – A/M-Area Groundwater *(continued)*

IX. GROUNDWATER/SURFACE WATER REMEDIES *(Continued)*

C. Treatment System ☒ Applicable ☐ N/A

1. Treatment Train (Check components that apply)**:**

☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☒ Air stripping ☐ Carbon adsorbers
☐ Filters__________
☐ Additive (e.g., chelation agent, flocculent)__________
☐ Others__________
☒ Good Condition ☐ Needs maintenance
☒ Sampling ports properly marked and function
☐ Sampling/maintenance log displayed and up-to-date
☒ Equipment properly identified
☒ Quantity of groundwater treatment annually Approximately 215,000,000 gallons at the M-1 and A-2 Air Strippers
☐ Quantity of surface water treatment annually__________
Remarks:__________

2. Electrical Enclosures and Panels *(properly rated and function)***:**

☐ N/A ☒ Good Condition ☐ Needs maintenance
Remarks:__________

3. Tanks, Vaults, Storage Vessels:

☐ N/A ☒ Good Condition ☐ Proper secondary containment ☐ Needs maintenance
Remarks:__________

4. Discharge Structure Appurtenances:

☐ N/A ☒ Good Condition ☐ Needs maintenance
Remarks:__________

5. Treatment Building(s):

☐ N/A ☒ Good Condition (especially roof and doorways ☐ Needs repair
☒ Chemicals and equipment properly stored
Remarks:__________

Attachment D-1. Five-Year Review Site Inspection Checklist – A/M-Area Groundwater *(continued)*

IX. GROUNDWATER/SURFACE WATER REMEDIES *(Continued)*

6. Monitoring Wells *(pump and treatment remedy)***:**

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs maintenance ☐ N/A

Remarks:____

D. Monitoring Data ☒ Applicable ☐ N/A

1. Monitoring Data:

☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring Data:

☐ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

E. Monitored Natural Attenuation ☐ Applicable ☒ N/A

1. Monitoring Wells *(natural attenuation remedy)***:**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs maintenance ☐ N/A

Remarks:____

X. OTHER REMEDIES

If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

A. Soil Vapor Extraction System ☒ Applicable ☐ N/A

1. Blowers, Wellhead Plumbing, and Electrical:

☒ Good Condition ☒ All required wells located ☐ Needs maintenance ☐ N/A

Remarks: Active and Passive SVE systems in service.

2. Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances:

☒ Good Condition ☐ Needs maintenance

Remarks:____

3. Spare Parts and Equipment:

☒ Readily Available ☒ Good Condition ☐ Requires Upgrade ☐ Needs to be provided

Remarks:____

Attachment D-1. Five-Year Review Site Inspection Checklist – A/M-Area Groundwater *(continued/end)*

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

The remedies at the A/M Area Groundwater OU currently protects human health and the environment because groundwater removal and treatment, in situ treatment, and contaminant source treatment have been successful in removing VOC contamination in groundwater and exposure pathways that could result in unacceptable risks are being controlled through institutional controls (i.e., LUCs). However, in order for the remedy to be protective of the environment in the long-term, the M-1 Air Stripper recovery system should be optimized and/or other corrective action technologies must be implemented to treat the high concentration part of the plume located outside of the recovery well system zone of capture. After successfully reducing VOC concentrations in the main source area of the plume, the highest dissolved concentrations of VOCs currently are located outside (west) of the zone of capture zone of the recovery system.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The O&M procedures consisting of site inspections and site maintenance and site controls (SRS Site Use and Site Clearance Programs) have been implemented. O&M programs are well established and functioning to ensure that the remedial systems remain in effective service.

C. Early Indicators of Potential Remedy Failure

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

SRS has submitted corrective action schedules in the 2000 RCRA Part B Permit Renewal Application Volume III for M-Area and Met Lab HWMFs Postclosure (Volume III), which proposes to optimize the M-1 Air Stripper recovery system to treat the higher concentration parts of the plume.

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A-AREA MISCELLANEOUS RUBBLE PILE (731-6A) OPERABLE UNIT

I. Introduction

This report is the third five-year review for the A-Area Miscellaneous Rubble Pile (731-6A) (AMRP) Operable Unit (OU). The review was conducted from August 2017 through November 2017. Contaminants have been left in place at the AMRP OU at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the AMRP OU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table E-1 lists the chronology of site events for the AMRP OU.

III. Background

The AMRP OU is listed as a Resource Conservation and Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) unit in Appendix C of the Federal Facility Agreement (FFA) for Savannah River Site (SRS) (FFA 1993). The media of concern is soil. Groundwater is not of concern at the AMRP OU because investigations have determined that groundwater beneath AMRP OU has not been impacted by the unit.

The scope of the AMRP OU remedial action includes three subunits: the Piles Area, the Ash Area, and the Trenches Area.

Physical Characteristics

AMRP OU is located in the northwest part of the SRS within A Area and immediately east of M Area (Figure E-1). The unit covers approximately 2.3 hectares (5.8 acres) and is bounded on the southwest and southeast by outfall drainages that coalesce on the south side of the unit (Figure E-2).

The subunits that comprise AMRP OU are described below (WSRC 2003):

- The Piles Area consisted of many small mounds of construction debris including shingles and siding, concrete, brick, electrical boxes, roofing and wall board materials, empty paint cans, empty drums and buckets, building materials, scrap metal, insulation, tar, plastic, glass, timbers, and transite containing non-friable asbestos. The Piles Area comprises approximately 0.9 hectares (2.3 acres).
- The Ash Area is located in the south-central portion of the unit and is approximately 0.7 hectares (1.8 acres). It is comprised of buried construction debris (including transite) and an ash layer. The ash layer was primarily in the upper 1.2 m (4 ft) and consisted of a dark-gray, low-density material.
- The Trenches Area is located in the westernmost portion of the AMRP OU. It consists of a T-shaped trench that covers approximately 0.6 hectares (1.6 acres).

Land and Resource Use

According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The *Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999) designates the AMRP OU as being within an industrial area. The future land use for the AMRP OU is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

Beginning in the early 1950s AMRP OU was used as a disposal location for construction debris and ash material. In the Piles Area construction debris was disposed of in small mounds (0.6 to 1.5 m [2 to 5 ft] high) directly on the ground surface. Soil investigations conducted during Phases I (1997) and II (1998) for the development of the RCRA Facility Investigation/Remedial Investigation with Baseline Risk Assessment report (WSRC 2000) determined that metals (arsenic and lead), polychlorinated biphenyls (PCBs) (Aroclor 1254) and polycyclic aromatic hydrocarbons (PAHs) (benzo[a]pyrene) were present in surface soils and identified as constituents of concern (COC). In the Ash Area, construction debris was buried under an ash layer approximately 1.2 m (4 ft) thick. Arsenic was identified as a COC for the Ash Area in surface soil. In the Trenches Area, construction debris was disposed of in the T-shaped trench. The exact dates of operation and specific materials disposed are unknown. PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[a]fluoranthene, dibenzo[a,h]anthracene) were identified as COCs in surface soil. No records of subsurface disposal or burial are known to exist. However, volatile organic compounds (VOCs), including trichloroethylene (TCE) and tetrachloroethylene (PCE), were identified as contaminant migration COCs in subsurface soil in the Trenches Area.

Initial Response

The results of soil and groundwater investigations indicated that the contaminated soil has not contributed to groundwater contamination adjacent to or beneath the AMRP OU. Groundwater beneath this unit has been impacted by SRS operations not associated with this unit and is being addressed under the RCRA corrective action program for A/M-Area Groundwater. After disposal operations ceased at the AMRP OU, the area was naturally re-vegetated predominantly by trees.

Basis for Taking Action

The findings from the risk assessment and contaminant fate and transport analysis indicate that concentrations of metals, PAHs, PCBs, PCE, and TCE in the soils at the AMRP OU pose unacceptable risks to human health and the environment and are discussed in the following text.

At the Piles Area, refined COCs include arsenic (human health [2E-06 risk]), lead (applicable or relevant and appropriate requirement [ARAR] and human health), Aroclor 1254 (ARAR and human health [4E-06 risk]), and benzo[a]pyrene (principle threat source material [PTSM]). These constituents are associated with the PCB/PAH waste pile

(Aroclor 1254 and benzo[a]pyrene), lead "hot spot" (lead and arsenic), or the PCB "hot spot" (Aroclor 1254).

At the Ash Area, the human health refined COC is arsenic. This COC is associated with the ash in the soils at the unit. The surface soil contains levels of arsenic associated with the ash source that pose a risk of 2E-06 risk to the future industrial worker.

At the Trenches Area, refined COCs include arsenic (human health – 3E-05 risk), benzo[a]pyrene (human health [5E-05 risk]), benzo[a]anthracene (human health [6E-06 risk]), benzo[b]fluoranthene (human health [7E-05 risk]), dibenzo[a,h]anthracene (human health [8E-06 risk]), PCE (contaminant migration), and TCE (contaminant migration). The concentrations of PCE and TCE in fill material in the Trenches Area were predicted to impact groundwater above MCLs in approximately 504 and 226 years, respectively, and were identified as contaminant migration COCs (WSRC 2000).

The results of the soil and groundwater investigation indicate that the contaminated soil has not contributed to groundwater contamination adjacent to or beneath the AMRP OU. Groundwater beneath this unit has been impacted by SRS operations not associated with this unit. The groundwater contamination is being addressed under the RCRA corrective action program for A/M-Area Groundwater OU.

The specific remedial goals (RGs) identified for the AMRP OU are based on the future industrial worker scenario and achieving ARARs. The RGs established in the Record of Decision (ROD) for the AMRP OU (WSRC 2003) are listed in Table E-2.

IV. Remedial Actions

Remedy Selection

As stated in the ROD (WSRC 2003), the remedial action objectives (RAOs) for the AMRP OU are as follows:

Piles Area

- Protect the future industrial worker or resident from exposure to arsenic and lead in the lead hot spot above the RGs of 4.4 mg/kg and 400 mg/kg, respectively; and
- Protect the future industrial worker or resident from exposure to Aroclor 1254 (PCB) and benzo[a]pyrene (PAH) in the PCB/PAH waste pile above the RGs of 1 mg/kg and 0.052 mg/kg, respectively.

Ash Area

- Protect the future industrial worker from exposure to elevated levels of arsenic in the surface soil above the RG of 4.4 mg/kg.

Trenches Area

- Protect the future industrial worker from exposure to arsenic and PCBs/PAHs in the soil above their respective RGs; and
- Prevent leaching of TCE and PCE to groundwater above the MCL (5 µg/L).

As stated in the ROD (WSRC 2003), the following remedial actions were selected for AMRP OU to meet the RAOs:

Piles Area

- Removal of the two hot spots and transportation from SRS to a permitted offsite disposal facility.

Ash Area

- Implement institutional controls (i.e. land use controls [LUCs]).

Trenches Area

- Placement of a 0.3-m (1-ft) soil cover over the contaminated area;
- Implement the active soil vapor extraction (SVE) system; and
- Implement institutional controls (i.e., LUCs).

LUCs are required for the Ash Area and the Trenches Area to prohibit future residential land use, restrict access to and activities at the AMRP OU by future workers, and prevent access by trespassers. In addition, LUCs are required to maintain the integrity of the soil cover and SVE system at the Trenches Area.

Remedy Implementation

The selected remedies were implemented to meet the RAOs and included the following activities:

Piles Area

- Removing a PCB/PAH hot spot (16.8 m^3 [22 yd^3]) and a lead hot spot (1.3 m^3 [1.7 yd^3]) and transporting from SRS to a permitted offsite disposal facility. Residential RGs were achieved and no LUCs are needed for the Piles Area.

Ash Area

- Establishing LUCs for approximately 0.7 hectares (1.8 acres).

Trenches Area

- Installing a 0.49-hectare (1.2-acre) soil cover over the contaminated area consisting of 0.3-m (1-ft) thick common fill material, except for southwest leg of the T-shaped trench where a 0.6-m (2-ft) thick low permeability soil was placed to enhance the SVE process.
- Installing an active SVE system consisting of seven SVE wells connected to the existing 782-3M SVE Unit located between the subunit and the A-014 Outfall. The active SVE is designed to treat approximately 4,590 m^3 (6,000 yd^3) of TCE- and PCE-contaminated media. Additionally, twelve wells were installed along the trench perimeter to monitor the zone of influence of the active SVE.
- Establishing LUCs for 1.25 hectares (3.08 acres).

Figures E-3 and E-4 show photographs of AMRP OU before remediation and as it currently appears (2017).

System Operation/Operation and Maintenance

The seven active SVE started full operation in 2004 and operated until they were physically disconnected from the 782-3M soil vapor extraction unit (SVEU) on March 14, 2017, to allow modification of the seven active SVE wells and twelve monitoring wells into nineteen passive SVE wells. The nineteen (19) passive SVE wells began operating on June 14, 2017.

The following maintenance activities have been implemented for both the Ash Area and the Trenches Area:

- Visual inspections for evidence of damage to the cover system due to erosion or intrusion by burrowing animals and to address upkeep of the vegetative cover and access control barriers (e.g., the warning signs) are performed annually.
- Necessary repairs (e.g., replacing eroded or disturbed soil, sign repair, etc.) and vegetation management (e.g., mowing, removal of larger vegetation, etc.) are being performed when required.

Table E-3 compares the actual operation and maintenance (O&M) costs for the five-year remedy review period to the estimated direct O&M costs from the ROD (WSRC 2003). The estimated cost for Fiscal Year (FY) 2012 to FY2017 is $299,200 for the soil cover and LUCs. The actual O&M cost for FY2012 to FY2017 is $538,752. The O&M cost estimate was based on five years of active SVE operation. After thirteen years, the active SVE ended operations in FY2017 as documented in the *Explanation of Significant Differences (ESD) for the Revision 1.3 A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit Record of Decision (U)* (SRNS 2014a). The O&M costs from FY2012 to FY2017 are higher than estimated because the operational life of the active SVE systems was longer than expected and the cost to operate the 782-3M SVEU is no longer shared by the A-014 Outfall project.

V. Progress Since Last Review

The previous protectiveness statement concluded that the remedial actions at AMRP OU are expected to be protective, and in the interim, exposure pathways that could result in unacceptable risks are being controlled by the operation of an active SVE along with institutional controls (i.e., LUCs) that have been functioning properly.

There were no recommendations or follow-up actions from the last five-year review.

VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII, Documents Reviewed;
- Confirmed the implementation of the remedial action;
- Reviewed all process and performance monitoring data provided by the annual performance evaluation reports (PERs) and provided a technical assessment of whether the SVE system is functioning as intended by the ROD and whether the shutdown criteria has been achieved;
- Inspected the OU, interviewed maintenance personnel and documented the results on the Inspection Checklist provided in Attachment E-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance.

Data Review

At the AMRP OU Trench Area, full scale operation of the seven active SVE wells began on April 26, 2004. The seven active SVE wells were alternated between the odd and even numbered wells, monthly, to optimize the mass removal from the subunit. Compliance, performance, and process monitoring was conducted quarterly at the seven active SVE wells and twelve monitoring wells. No operational process monitoring data was collected after March 2017 because the system was under modifications to transition from active to passive SVE. The transition to passive SVE was completed on June 14, 2017. This data is reported annually in a PER (SRNS 2013, SRNS 2014b, SRNS 2015a, SRNS 2016, and SRNS 2017). Since operation began, mass removal rates have fluctuated (Figure E-5), but the system is operating as designed and continues to remove mass from the subsurface. The cumulative mass removed is estimated to be 42 kg (93 lbs) of VOCs (Figure E-6).

Summary of Inspections and Interviews

Interviews were conducted with Richard Feagin, O&M Staff member, on October 11, 2017 and George Joyner, O&M Site Manager, on October 12, 2017 at the O&M organization offices. No issues were identified for the AMRP OU during these interviews.

The AMRP OU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) and the USDOE personnel on December 15, 2017. No issues were identified for the AMRP OU during this inspection.

A site inspection will be conducted by U. S. Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control (SCDHEC) personnel, accompanied by USDOE and SRNS personnel, prior to submittal of the Revision 1 of this document. It is anticipated that no significant problems regarding this OU will be identified during the inspection.

Scheduled annual site inspections conducted from FY2012 through FY2017 identified the presence of ant mounds, small depression on the soil cover, trees and brush that needed removal/trimming, vegetation growing around signs, and evidence of hog damage to soil cover. These findings were documented on the field inspection checklist and resolved soon after discovery.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The remedy is functioning as intended as demonstrated below:

The Land Use Control Implementation Plan for AMRP OU is included as Appendix C of the Post Construction Report and governs LUC implementation, maintenance, monitoring, reporting, and enforcement of LUCs (WSRC 2004). The LUCs that are in place include physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), use restrictions to prevent unauthorized contact, removal or excavation of contaminated soils, restrictions to prevent unauthorized access to or use of groundwater until cleanup levels are met, and restrictions to prevent disturbance of the Trenches Area soil cover system. Warning signs are in good condition, and no activities were observed that would have violated the LUCs. All LUC objectives are being met.

The removal and disposal actions at the Piles Area are effective in preventing the future industrial worker or resident from exposure to arsenic, lead, Aroclor 1254, and benzo(a)pyrene in soils. The cover system maintenance program for the Trenches Area, and LUCs for the Trenches Area and the Ash Area have been effective in maintaining the integrity of the cover system. The annual inspection reports indicate no significant deficiencies.

A PER is submitted annually to the USEPA and SCDHEC and provides the results and analysis of the baseline sampling prior to active SVE operation and all process and performance monitoring during operation. The SVE system in the Trenches Area is effective in preventing the leaching of TCE and PCE to groundwater above MCLs (Figures E-5 and E-6). The extraction well network continues to remove contaminant mass from the subsurface although mass removal rates have dropped significantly (SRNS 2017).

Are Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still valid?

The exposure assumptions, toxicity data, and cleanup levels used at the time of remedy selection are still valid. There have been no changes in standards or to-be-considered guidance identified in the ROD that call into question the protectiveness of the remedy.

The USEPA standards and toxicity values have been updated since the last five-year remedy review as shown in Appendix B. The changes to the values for COCs at the AMRP

OU were not significant, and the RAOs continue to be met by the remedial action. No new standards or to-be-considered guidance have been identified that call into question the protectiveness of the remedy.

Fact sheets provided on the USEPA webpage regarding emerging contaminants were reviewed for applicability to this site. None of the listed emerging contaminants were identified as applicable to this OU.

Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that could call into question the protectiveness of the remedy.

VIII. Issues

The following issue has been identified during this remedy review:

- Soil RGs have likely been achieved and operation of the passive SVE system may no longer be needed for future protectiveness.

IX. Recommendations and Follow-up Actions

Recommendations and follow-up actions for the AMRP OU are provided in Table E-4.

X. Protectiveness Statement(s)

The remedy at the AMRP OU is protective of human health and the environment.

Exposure pathways that could result in unacceptable risks are being controlled by the SVE system and institutional controls (i.e., LUCs) to prevent exposure to or ingestion of contaminated media. All threats to contaminated media at the AMRP OU have been addressed through implementation of the SVE system, physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain this site for industrial use only (SRS is a secured government facility with land use restrictions), and warning signs and use restrictions via the SRS Site Use/Site Clearance Program.

XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Operating Equipment is scheduled for January 2024.

XII. Documents Reviewed

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

SRNS, 2013. *Performance Evaluation Report for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit: April 2012 to April 2013 (U)*, SRNS-RP-2013-00338, Revision 0, Savanah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2014a. *Explanation of Significant Differences (ESD) for Rev. 1.3 for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit Record of Decision (U)*, SRNS-RP-2014-00443, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken SC

SRNS, 2014b. *Performance Evaluation Report for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit: April 2013 to April 2014 (U)*, SRNS-RP-2014-00461, Revision 0, Savanah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2015a. *Performance Evaluation Report for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit: April 2014 to April 2015 (U)*, SRNS-RP-2015-00263, Revision 0, Savanah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2015b. *Sampling and Analysis Plan for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit (U)*, SRNS-RP-2015-00007, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2016. *Performance Evaluation Report for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit: April 2015 to April 2016 (U)*, SRNS-RP-2016-00392, Revision 0, Savanah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2017. *Performance Evaluation Report for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit: April 2016 to April 2017 (U)*, SRNS-RP-2017-00217, Revision 0, Savanah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 1999. *Land Use Control Assurance Plan for the Savannah River Site*, WSRC-RP-98-4125, Revision 1.1, latest update, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC, 2000. *RCRA Facility Investigation / Remedial Investigation with Baseline Risk Assessment for the A-Area Miscellaneous Rubble Pile (731-6A) (U)*, WSRC-RP-98-4208, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2003. *Record of Decision for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit (U)*, WSRC-RP-2001-4197, Revision 1.3, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2004. *Post-Construction Report (PCR) for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit (U)*, WSRC-RP-2004-4088, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

Various – Inspection Data Sheets - *Field Inspection Checklist for A-Area Miscellaneous Rubble Pile OU (731-6A)*, ER-IDS-019-029, Inspection Period 2012 through 2017 (annually)

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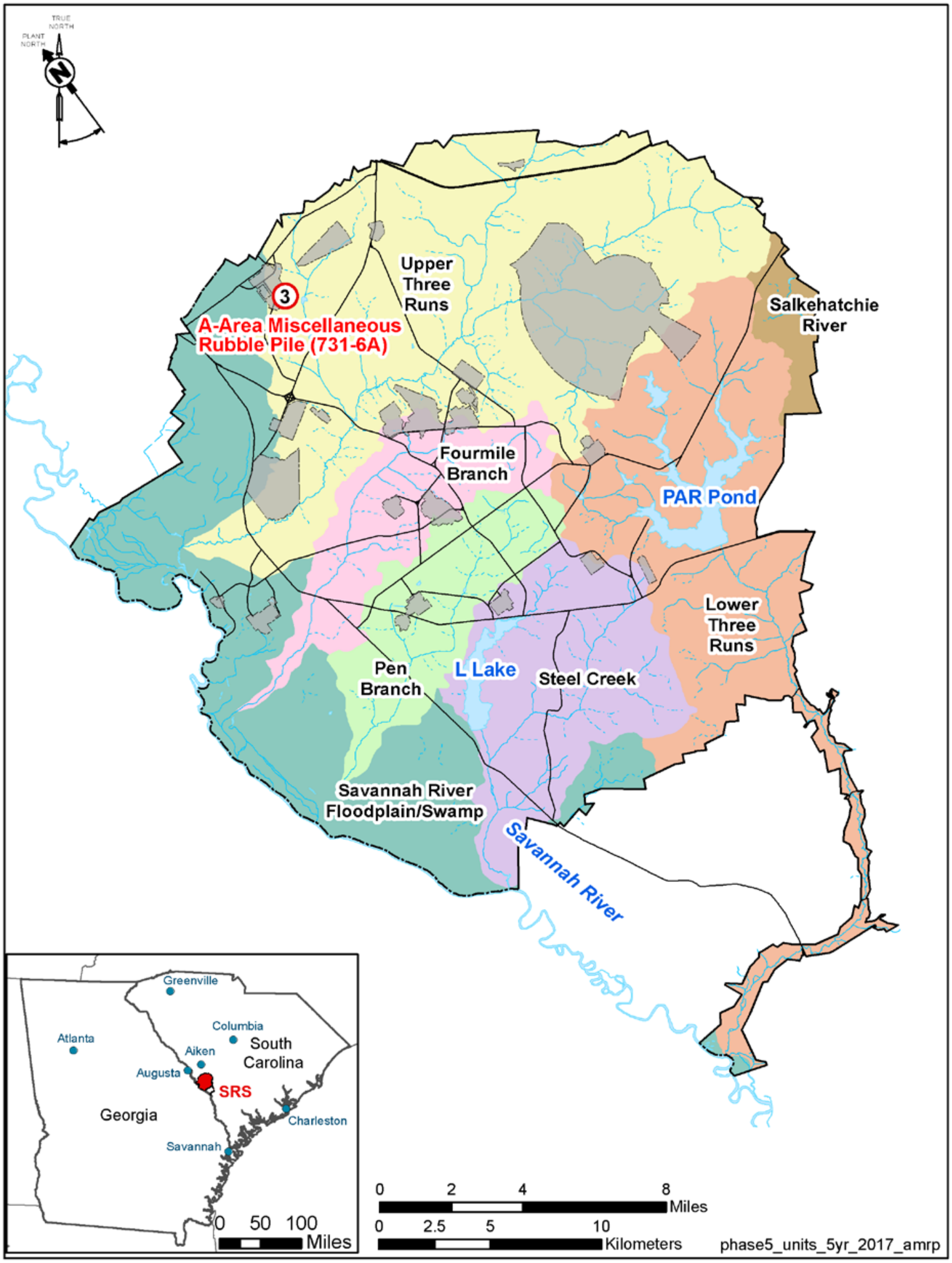

Figure E-1. Location of AMRP OU at Savannah River Site

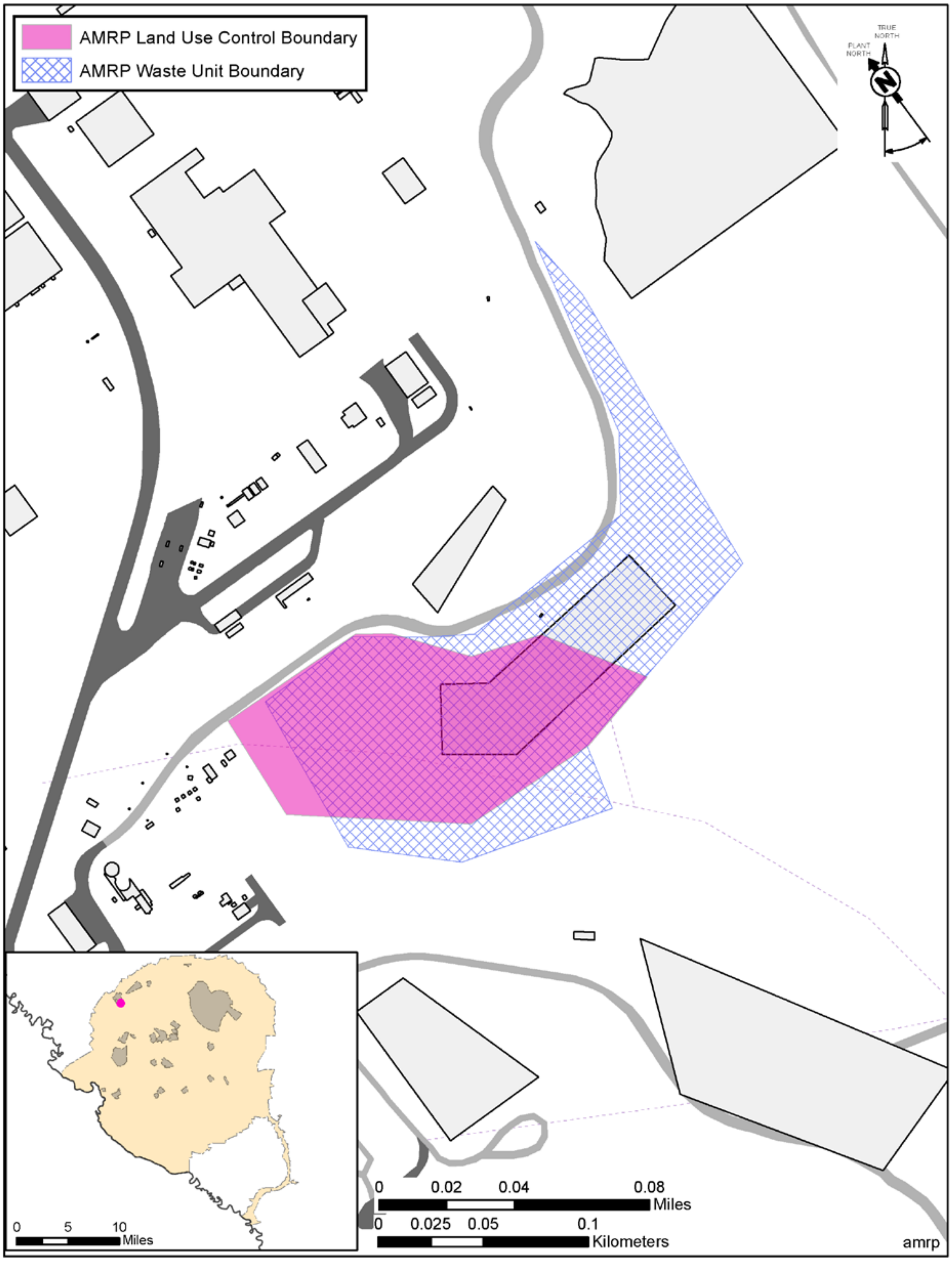

Figure E-2. **AMRP Operable Unit (731-6A)**

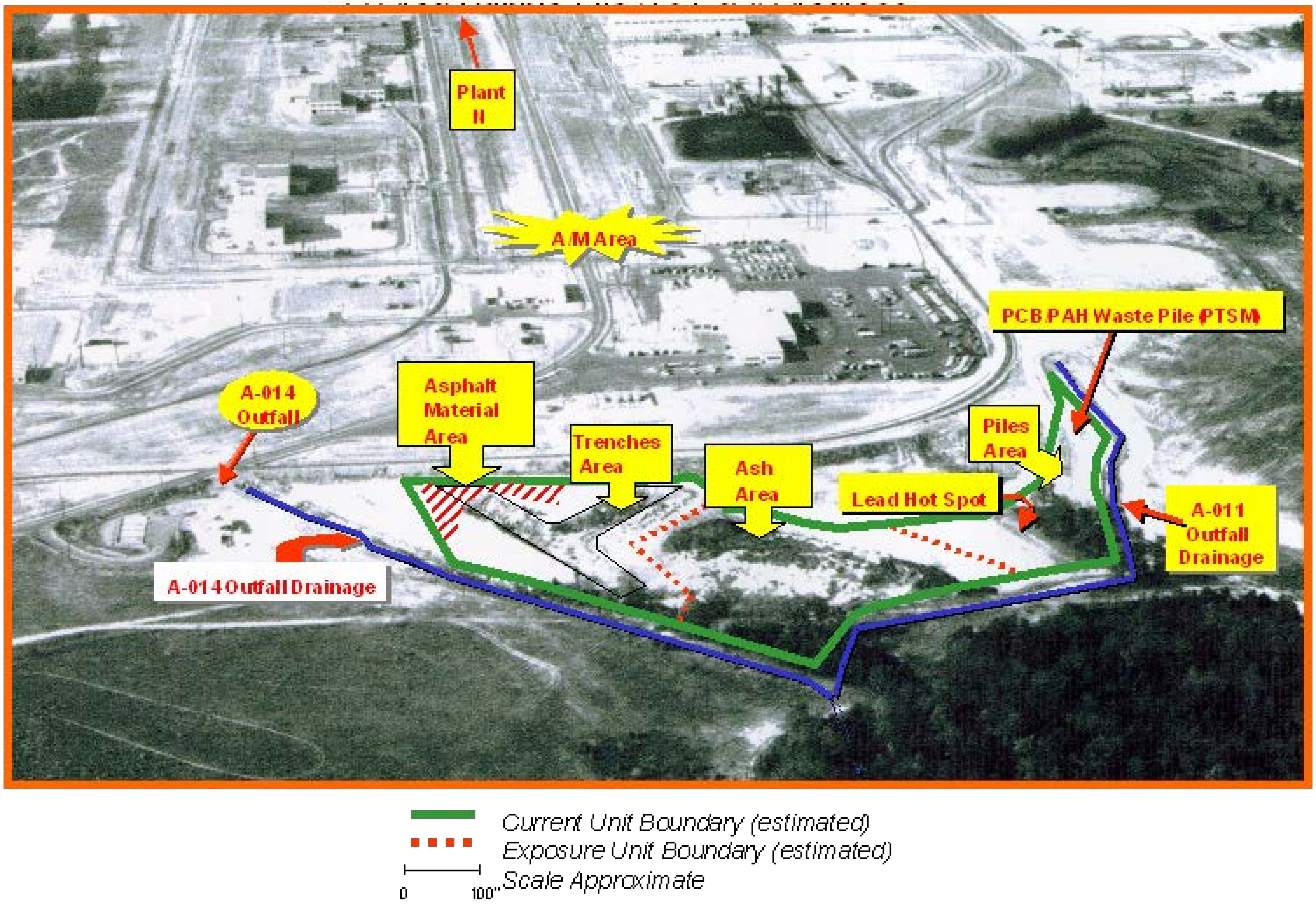

Figure E-3. 1953 Aerial Photograph Showing AMRP OU

Figure E-4. Current Photographs of AMRP OU (2017)

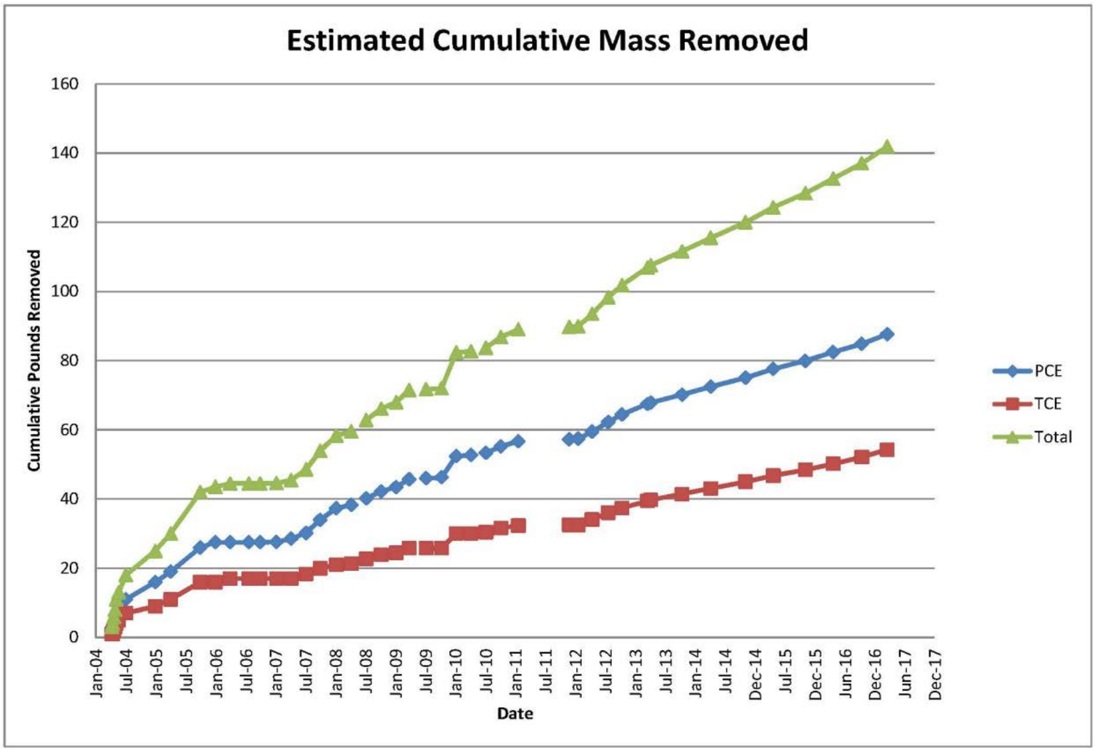

Figure E-5. **AMRP OU Performance Monitoring – Estimated Mass Removed**

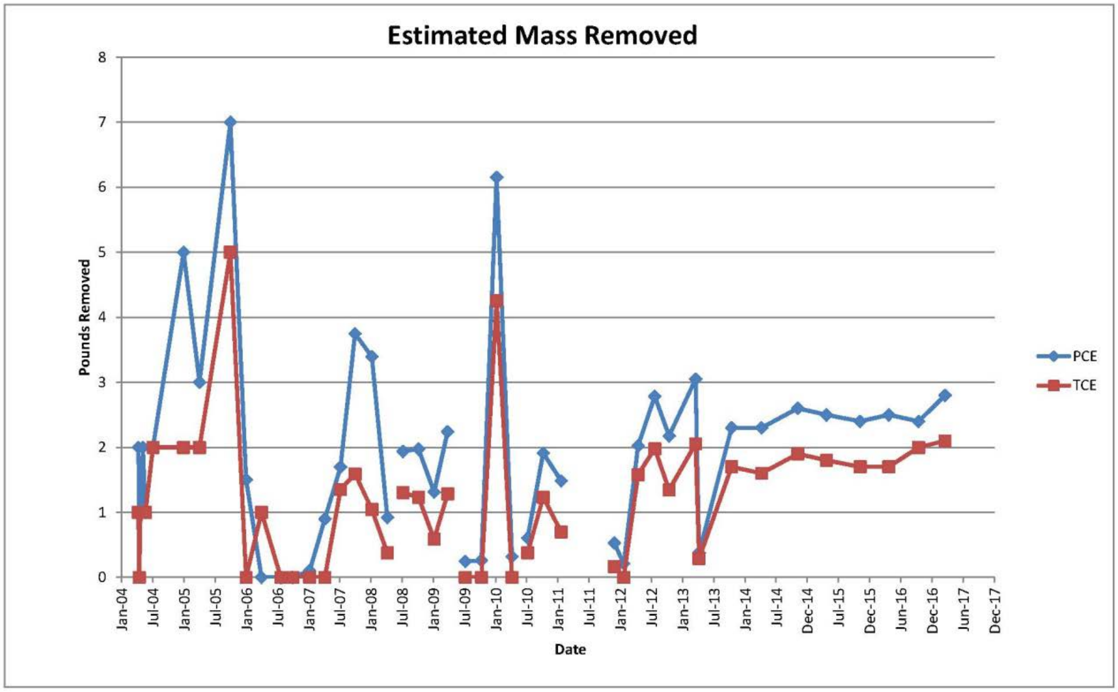

Figure E-6. **AMRP OU Performance Monitoring – Estimated Cumulative Mass Removal**

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Table E-1. Chronology of OU Events

Event	Date
RFI/RI Field Start	November 10, 1997
Record of Decision (ROD) issuance	August 11, 2003
Remedial Action Construction Start / Complete	September 8, 2003/ June 30, 2004
Remedial Action Operations Start	April 26, 2004
Previous Five-Year Reviews Issuance	January 29, 2009 / February 4, 2014

Table E-2. Remedial Goals for OU Soil under Industrial Land Use

		Type of COC				
Subunit	**Refined COCs**	**ARAR**	**HH**	**CM**	**RG (mg/kg)**	**Basis**
Piles Area	Arsenic		X		4.4	2X average background
	Lead		X		400	USEPA TBC criteria
	PCB-1254	X			1	TSCA action level
	Benzo[a]pyrene		X		0.052	1E-06 risk level*
Ash Area	Arsenic		X		4.4	2X average background
Trenches Area	Arsenic		X		4.4	2X average background
	Benzo[a]anthracene		X		2.56	1E-06 risk level
	Benzo[a]pyrene		X		0.256	1E-06 risk level
	Benzo[b]fluoranthene		X		2.56	1E-06 risk level
	Dibenzo[a,h]anthracene		X		0.256	1E-06 risk level
	TCE			X	0.0877	CM soil clean up level
	PCE			X	0.656	CM soil clean up level

ARAR – Applicable or Relevant and Appropriate Requirements
CM – contaminant migration
COC – constituent of concern
HH – human health
RG – remedial goal
TBC – to be considered
TSCA - Toxic Substances Control Act, 1976
*The 1E-06 risk level is based on a resident, consistent with unrestricted use in the Piles Area

Table E-3. Actual versus Estimated O&M Costs

	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	Five-Year Total
Total Actual O&M Costs ($)	84,377	109,106	98,011	43,585	127,485	76,188	538,752
Total ROD Estimated Direct O&M Costs ($)	83,200	33,200	33,200	33,200	33,200	83,200	299,200

Table E-4. Recommendations and Follow-up Actions for AMRP OU

Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
					Current	Future
Soil RGs have likely been achieved and operation of the passive SVE system may no longer be needed for future protectiveness.	In accordance with the *Sampling and Analysis Plan for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit (U)* (SRNS 2015b) to determine if RGs have been achieved for TCE and PCE, additional characterization of the ash layer and vadose zone soils should be conducted. If the soil RGs have been met, the passive SVE system could be shutdown.	USDOE	SCDHEC/ USEPA	June 2018	N	N

Attachment E-1. Five-Year Review Site Inspection Checklist – A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit

I. SITE INFORMATION

Site Name:	**A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit**	**Date of Inspection:**	**08/9/2017**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**CERCLIS #30**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**80°F and Cloudy**

Remedy Includes: *(Click all that apply)*

☒ Landfill Cover / Containment
☒ Access Controls
☒ Institutional Controls
☐ Groundwater Pump and Treatment

☐ Surface Water Pump and Treatment
☐ Monitored Natural Attenuation
☐ Groundwater Containment
☐ Vertical Barriers

☒ Other Excavation, Soil Vapor Extraction

Attachments: ☐ Inspection team roster attached ☐ Inspection team roster attached

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 10/12/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

Problems/Suggestions: ☐ Report Attached

2. **O & M Staff** Richard Feagin (Name) EC&ACP Post-Closure Waste Site Inspector/Maintenance Coord. (Title) 10/11/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No. 952-4416

Problems, suggestions: ☐ Report Attached

Attachment E-1. Five-Year Review Site Inspection Checklist – A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit *(continued)*

II. INTERVIEWS *(Click all that apply)(Continued)*

2. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

Agency: ______

Contact: ______ (Name) ______ (Title) ______ (Date) ______ (Phone No.)

Problems/Suggestions: ☐ Report Attached ______

Agency: ______

Contact: ______ (Name) ______ (Title) ______ (Date) ______ (Phone No.)

Problems/Suggestions: ☐ Report Attached ______

Agency: ______

Contact: ______ (Name) ______ (Title) ______ (Date) ______ (Phone No.)

Problems/Suggestions: ☐ Report Attached ______

3. **Other Interviews** *(Optional):* ☐ Report Attached ______

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Click all that apply)*

1. **O&M Documents:**

☐ O&M Manual	☐ Readily Available	☐ Up to Date	☐ N/A
☒ As-Built Drawings	☒ Readily Available	☒ Up to Date	☐ N/A
☐ Maintenance Logs	☐ Readily Available	☐ Up to Date	☐ N/A

Remarks: See *Waste Unit Inspection and Maintenance*, ER-SOP-019 and *Field Inspection Checklist for A-Area Miscellaneous Rubble Pile OU*, ER-IDS-019-029

Attachment E-1. Five-Year Review Site Inspection Checklist – A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit *(continued)*

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)*

2. Health and Safety Plans (HASPs):

☐ Site-Specific Health and Safety Plans ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Contingency Plan/Emergency Response Plan ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks: Routine O&M activities do not require an SSHASP under 29 CFR 1910.120, HAZWOPER. An SSHASP is prepared if needed.

3. O&M and OSHA Training Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix

4. Permits and Service Agreements:

☒ Air Discharge Permit ☒ Readily Available ☒ Up to Date ☐ N/A
☐ Effluent Discharge ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Waste Disposal; POTW ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Other Permits ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

5. Gas Generation Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

6. Settlement Monument Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

7. Groundwater Monitoring Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks:

8. Leachate Extraction Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

9. Discharge Compliance Records:

☒ Air ☒ Readily Available ☒ Up to Date ☐ N/A
☐ Water (Effluent) ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

10. Daily Access/Security Logs: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

Attachment E-1. Five-Year Review Site Inspection Checklist – A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit *(continued)*

IV. O&M COSTS

1. O&M Organization:

☐ State In-House ☐ Contractor for State
☐ PRP In-House ☐ Contractor for PRP
☒ Other: SRS

2. O&M Cost Records:

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review

Total annual cost by year for review period, if available

From:_______ To:_______ _________ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:_______ To:_______ _________ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:_______ To:_______ _________ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:_______ To:_______ _________ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:_______ To:_______ _________ ☐ Breakdown attached
(Date) (Date) (Total Cost)

3. Unanticipated or Unusually High O&M Costs During Review Period

Describe costs and reasons: __________

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing Damage: ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks: OU-specific fencing is not required by the remedial action.

B. Signs

1. Signs and Other Security Measures: ☐ Location shown on site map ☐ N/A
Remarks: Signs are in good condition.

Attachment E-1. Five-Year Review Site Inspection Checklist – A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Once in 5 years
Responsible Party/Agent: USDOE Savannah River Field Office

	(Name)	(Title)	(Date)	(Phone No.)
Contact:	Karen Adams	Federal Project Director	12/15/17	803-952-7871

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

2. Adequacy: ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks: Survey markers were located and are in good condition.

D. General

1. Vandalism/Trespassing: ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

2. Land use changes onsite: ☒ N/A
Remarks:

3. Land use changes offsite: ☒ N/A
Remarks:

Attachment E-1. Five-Year Review Site Inspection Checklist – A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit *(continued)*

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. Roads damaged: ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks:____

B. Other Site Conditions

Remarks: Annual site inspections identified the presence of ant mounds, small depression on the soil cover, Trees, and brush that needed removal/trimming, vegetation growing around signs, and evidence of hog Damage to soil cover. These finding were resolved soon after discovery.

VII. LANDFILL COVER /CONTAINMENT ☒ Applicable ☐ N/A

A. Landfill Surface

1. Settlement (Low spots)**:** ☐ Location shown on site map ☒ Settlement not evident
Areal extent__________________ Depth______________________
Remarks:____

2. Cracks: ☐ Location shown on site map ☒ Cracking not evident
Lengths______________________ Widths_____________________ Depths______________________
Remarks:____

3. Erosion: ☐ Location shown on site map ☒ Erosion not evident
Areal extent__________________ Depth______________________
Remarks:____

4. Holes: ☐ Location shown on site map ☒ Holes not evident
Areal extent__________________ Depth______________________
Remarks:____

5. Vegetative Cover: ☒ Grass ☒ Cover properly established ☐ No signs of stress
Areal extent__________________ Depth______________________
Remarks: Vegetative cover is mowed routinely

Attachment E-1. Five-Year Review Site Inspection Checklist – A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit *(continued)*

VII. LANDFILL COVER/CONTAINMENT *(Continued)*

6. Alternative Cover (armored rock, concrete, etc.): ☒ N/A
Remarks:______________________________
____

7. Bulges: ☐ Location shown on site map ☒ Bulges not evident
Areal extent__________ Depth__________
Remarks:______________________________
____

8. Wet Areas / Water Damage: ☒ Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent__________
☐ Ponding ☐ Location shown on site map Areal extent__________
☐ Seeps ☐ Location shown on site map Areal extent__________
☐ Soft subgrade ☐ Location shown on site map Areal extent__________
Remarks:______________________________
____

9. Slope Instability: ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability
Areal extent__________
Remarks:______________________________
____

B. Benches ☐ Applicable ☒ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel)

C. Letdown Channels ☐ Applicable ☒N/A

(Channel lined with erosion control mates, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies)

Attachment E-1. Five-Year Review Site Inspection Checklist – A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit *(continued)*

VII. LANDFILL COVER / CONTAINMENT *(Continued)*

D. Cover Penetrations ☒ Applicable ☐ N/A

1. Gas Vents: ☒ Active ☒ Passive
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good Condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A
Remarks: SVE wells

2. Gas Monitoring Probes:
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good Condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A
Remarks: Monitoring wells

3. Monitoring Wells:
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A
Remarks:

4. Leachate Extraction Wells:
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A
Remarks:

5. Settlement Monuments: ☐ Located ☐ Routinely Surveyed ☒ N/A
Remarks:

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

F. Cover Drainage Layer ☐ Applicable ☒ N/A

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

H. Retaining Walls ☐ Applicable ☒ N/A

I. Perimeter Ditches/Offsite Discharge ☐ Applicable ☒ N/A

Attachment E-1. Five-Year Review Site Inspection Checklist – A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit *(continued)*

VIII. VERTICAL BARRIER WALLS ☐ **Applicable** ☒ **N/A**

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A

X. OTHER REMEDIES

If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

A. Soil Vapor Extraction System ☒ Applicable ☐ N/A

1. Blowers, Wellhead Plumbing, and Electrical:

☒ Good Condition ☒ All required wells located ☐ Needs maintenance ☐ N/A

Remarks: SVE system is in service

2. Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances:

☒ Good Condition ☐ Needs maintenance

Remarks:

3. Spare Parts and Equipment:

☒ Readily Available ☒ Good Condition ☐ Requires Upgrade ☐ Needs to be provided

Remarks:

Attachment E-1. Five-Year Review Site Inspection Checklist – A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit *(continued/end)*

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

The remedial action for the Piles Area is removal and disposal to remove all unacceptable risk (PTSM) from small-localized hot spots of lead and PCB/PAH. The remedial action chosen for the Ash Area is institutional controls (i.e., LUCs) to protect future industrial workers and potential residents from exposure to elevated levels of arsenic. Institutional controls (i.e., LUCs) have been established for this subunit. The remedial action chosen for the Trenches Area is active SVE to permanently remove TCE and PCE from the soil and institutional controls (i.e., LUCs) and a soil cover to protect remedial workers and future industrial workers from unacceptable exposure to arsenic and PAHs (benzo[a]pyrene) in the surface soil. The active SVE system was transitioned to a passive system in June 2017. Annual PERs demonstrate that these actions are effective and that the remedies are functioning as designed.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The O&M procedures consisting of annual site inspections and site maintenance (repair of erosion damage, cover maintenance, and warning signs) and site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the OU) have been implemented. The O&M procedures are adequately maintaining the integrity of the SVE system, which in turn maintains the effectiveness of the SVE system to mitigate leaching. There are no issues requiring corrective actions.

C. Early Indicators of Potential Remedy Failure

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Recommendations are provided in the OU-specific review report (Table E-4).

C-AREA BURNING/RUBBLE PIT OPERABLE UNIT (131-C) AND OLD C-AREA BURNING/RUBBLE PIT (NBN)

I. Introduction

This report is the fourth five-year review for the C-Area Burning/Rubble Pit (131-C) and Old Burning/Rubble Pit (No Building Number [NBN]) (CBRP) Operable Unit (OU). This review was conducted from August 2017 through November 2017. Contaminants have been left in place at the CBRP OU at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the CBRP OU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table F-1 lists the chronology of site events for the CBRP OU.

III. Background

The CBRP OU is listed as a Resource Conservation Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act unit in Appendix C of the Federal Facility Agreement (FFA) for Savannah River Site (SRS) (FFA 1993). The media associated with this OU are soil and groundwater.

The scope of the CBRP OU remedial action includes seven subunits: CBRP disposal pit (surface and subsurface soil), vadose zone (soil beneath CBRP), Old CBRP (surface and subsurface soil), the Mounded Area north of CBRP, concrete drainage ditch south of CBRP (adjacent surface soil), groundwater plume, and surface water.

Physical Characteristics

The CBRP OU comprises approximately 53 hectares (130 acres) including all groundwater contaminated above maximum contaminant levels (MCLs). Figure F-1 shows the location of the CBRP OU at SRS. Figures F-2 and F-3 presents the CBRP OU boundary and monitoring stations.

A description of the CBRP OU subunits is as follows:

- CBRP was a shallow, unlined excavation, approximately 7.5 m (25 ft) wide by 105 m (350 ft) long with depths ranging between 2.4 to 3.6 m (8 to12 ft). It had a volume of approximately 2,477 m^3 (3,240 yd^3).
- Old CBRP was constructed in 1951 for use as a burning pit. Aerial photographs indicated that Old CBRP was located approximately 50 m (165 ft) northeast of the CBRP. The Old CBRP was replaced by CBRP in the early 1960s. No surface expression of the old CBRP OU remains.
- The Mounded Area is located directly north of CBRP and is approximately 9 m (30 ft) high. This man-made mound contains rubble from the construction of the C-Reactor Building (105-C). It is covered with soil from the excavation of the C-Reactor Retention Basin (904-89G), which included 70% of the Old CBRP.
- The concrete drainage ditch south of CBRP (adjacent surface soil) may have carried overflow water from the CBRP OU, which is located south of the Pit Area. It is not known whether overflow water from the pit ever actually entered the drainage ditch.
- The surface water in Fourmile Branch and Twin Lakes receives contaminated groundwater from the CBRP. CBRP is a source of volatile organic compound (VOC) groundwater contamination, primarily trichloroethylene (TCE). The plume extends to a section of Fourmile Branch and the entire reach of the unnamed tributary in the Twin Lakes area, where contaminated groundwater seeps into the stream.
- Past activities associated with C-Reactor operations have resulted in groundwater contamination beneath CBRP OU. The groundwater plume extends from CBRP to the surface waters of Twin Lakes and Fourmile Branch. During operations at CBRP, TCE and tetrachloroethylene (PCE) were released to the environment, resulting in a groundwater contamination plume beneath CBRP OU. Past activities associated with C-Reactor operations have resulted in tritium contamination beneath the CBRP OU. The tritium contamination is being addressed as part of the C-Area Groundwater OU.

Land and Resource Use

According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The *Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999) designates CBRP OU as being within the site industrial support area. The future land use for CBRP OU is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

The CBRP disposal pit began operation during the early to mid-1960s to replace the Old CBRP. During operation, the CBRP disposal pit served as a repository for organic materials of unknown use and origin, which included scrap lumber, rubber drive belts, waste oils, organic solvents, paper, and plastics. Disposal records, including composition, origin, and use of materials disposed, were not kept for this unit during its period of operation. The collected materials were burned periodically to reduce the overall waste volume. SRS suspended burning of waste in open pits in October 1973. At this time, the pit contents were covered with a thin layer of soil. The pit was then used for the disposal of inert rubble. Rubble pit operations were terminated prior to 1981 and SRS backfilled CBRP with approximately 0.6 m (2 ft) of native soil to grade level. Figures F-4 and F-5 present photographs of the CBRP OU before remediation and currently (2017).

The VOC groundwater plume originated beneath the west end of CBRP and migrated west toward Twin Lakes and Fourmile Branch. TCE is the principal VOC in the groundwater. PCE, cis-1,2-Dichloroethylene (cDCE), 1,1-Dichloroethylene (DCE) and vinyl chloride (VC) also exceeded MCLs. Contaminant levels in groundwater emerging along Twin Lakes and Fourmile Branch seeplines exceeded MCLs during the RCRA Facility Investigation (RFI)/Remedial Investigation (RI).

Initial Response

An Interim Record of Decision (IROD) was issued for the CBRP OU (131-C) in 1999 (WSRC 1998) to minimize the impact of the CBRP on the Fourmile Branch watershed. The interim action was principally designed to control the migration of high concentration of VOCs in the saturated zone. The interim remedial action objectives (RAOs) are as follows:

- Prevent direct contact with the contaminants of concern (COC) contaminated soils and reduce infiltration to minimize further migration of contaminant migration COCs to the groundwater from soils within and beneath the CBRP; and

- Treat the area in the vicinity of the pit, within the 25,000 µg/L VOC isoconcentration contour within the groundwater, with an objective to reduce concentrations and control the migration of VOCs within the 25,000 µg/L VOC contour.

The interim remedial action included the following activities (WSRC 2001):

- Placement of a 0.24-hectares (0.6-acres) cover system over the CBRP disposal pit consisting of 0.9-m (3-ft) thick, 1E-05 cm/s low permeability soil layer covered by 0.15 m (0.5-ft) thick topsoil/vegetative layer to provide a barrier to human and ecological receptors and to reduce infiltration though the waste.
- Installation and operation of an active soil vapor extraction (SVE) system, consisting of 43 SVE wells, which operated from September 1999 to 2004 to treat the vadose zone. The system removed more than 953 kg (2,100 lbs) of VOCs and subsequently, reduced groundwater concentrations from greater than 130,000 µg/L to approximately 100 µg/L at well CRP-27DU located adjacent to the source zone.
- Installation and operation of an air sparging (AS) network consisting of 17 AS wells, which operated from June 2000 to August 2002 to strip VOCs from the local groundwater. The AS network contributed to the reduction of groundwater TCE concentrations below CBRP until the water table dropped below the well screens due to drought conditions during 2002.

Basis for Taking Action

Releases of VOCs (predominantly TCE and PCE) have occurred into the environment at CBRP OU resulting in a groundwater plume with contaminant concentrations above MCLs. Contaminant levels in groundwater emerging along the Twin Lakes and Fourmile Branch seeplines exceeded MCLs during the RFI/RI investigation. Dioxins, in the form of 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD), were found in the surface soils of the CBRP disposal pit as a result of burning activities. In addition, a TCE source was found in vadose zone soils between 7.5 and 9 m (25 and 30 ft) below ground surface at the west end of the CBRP disposal pit. The refined contaminants of concern (RCOCs) and remedial goals (RGs) for the CBRP disposal pit, groundwater, and surface water (Twin Lakes and Fourmile Branch) are listed in Table F-2. A remedial action was needed at this OU because dioxins in soil at the CBRP Disposal Pit may pose an unacceptable risk to future residents and ecological receptors. In addition, VOCs in groundwater and surface water above MCLs may pose an unacceptable risk to future residents.

The RFI/RI Report with Baseline Risk Assessment (BRA) for CBRP did not identify any RCOCs for the Old CBRP, the mounded area or the concrete drainage ditch. No Action was the selected remedy for these three subunits.

IV. Remedial Actions

Remedy Selection

- As stated in the CBRP OU ROD (WSRC 2008), the final RAOs are as follows:
- Disposal Pit Surface Soil
    - Prevent exposure of ecological receptors to HpCDD in the pit surface soils
- Vadose Zone Beneath the CBRP
    - Prevent migration of TCE vapor from vadose zone soils to groundwater at levels that will exceed the MCL. The RAO for TCE has been attained due to the interim action soil cover, SVE system, and AS system.
- Groundwater Plume

  - Treat and/or mitigate groundwater contaminated above MCLs;
  - Prevent human exposure to groundwater contaminated with VOCs (i.e., TCE and PCE) above MCLs (5 µg/L);
  - Reduce the concentration of VOCs (i.e., TCE and PCE) in the groundwater to levels at or below their MCLs, and attenuate the groundwater plume to the extent practicable; and
  - Prevent discharge of contaminated groundwater to surface water resulting in concentrations exceeding their MCLs.
- Surface Water
  - Reduce the levels for TCE, DCE, and VC in surface water at or below MCLs
- Natural attenuation parameters were evaluated using three existing surface water stations and 26 monitored natural attenuation (MNA) wells that were installed between September 2000 and March 2001.

Based on Effectiveness Monitoring Reports (EMRs), the Core Team agreed in September 2004 that the interim remedial action had achieved the remedial goals. In December 2004, the SVE/AS systems were shut down, and replaced with an active solar-powered MicroBlower^{TM} system in order to continue residual vapor extraction.

All RAOs have not been met, but as TCE concentrations continue to decline, it is anticipated that RAOs will be met by SVE, MNA, and land use controls (LUCs) (SRNS 2009b). The CBRP OU includes the following LUC objectives:

- Restrict on-site worker access and prevent unauthorized contact, removal, or excavation of contaminated media (i.e., surface and vadose zone soils);
- Maintain the integrity of any current or future remediation or monitoring systems (i.e., soil cover, SVE systems, and groundwater monitoring wells);
- Prevent access to or use of groundwater and surface water until remedial goal options are attained;

- Prohibit the development and use of property for residential housing, elementary schools, childcare facilities, and playgrounds; and
- Prevent construction of inhabitable buildings without an evaluation of indoor air quality to address vapor intrusion.

Remedy Implementation

The selected final remedy for the CBRP OU is a combination of the preferred alternatives for each of the subunits that provide the greatest level of protection to human and ecological receptors. As part of the Declaration for the issued Record of Decision (ROD), the interim actions for the soil cover cap, the active soil vapor extraction and the air sparging were accepted as a final remedial action. The final remedy documented in the ROD (WSRC 2008) includes the following:

- Continued maintenance of the installed 0.24 hectares (0.6-acre), 1E-05 cm/s soil cover system installed during the interim remedial action;
- Continued operation of the four active MicroBlower^{TM} SVE wells installed during the interim remedial action;
- Installation of a groundwater monitoring network to support MNA consisting of eighteen monitoring wells, twelve MNA monitoring wells, and five surface water stations;
- Abandonment of the no longer needed SVE and AS wells from the interim remedial action in accordance with SRS procedures and R.61-71, South Carolina Well Standards. Three AS wells were not abandoned due to their geologically significant location relative to plume geometry and the waste unit; and
- Expanded LUCs to 57.1 hectares (141.2 acres) to include the groundwater plume area consisting of general site access controls, groundwater use restrictions, the SRS Site Use/Site Clearance program, and deed restrictions and notifications.

System Operations/Operations and Maintenance

The following system operations are ongoing:

- Operation and Maintenance (O&M) of the MicroBlower^{TM} SVE system will continue until the vadose zone source is no longer a threat to increase groundwater contamination levels above MCLs.

The following maintenance activities are ongoing:

- Annual sampling of the wells and surface water stations. Sampling will continue until MCLs have been attained, the MNA has achieved its RAOs and the remedial action is complete. In 2011, an agreement was reached to decrease reporting to biennially. The MNA remedy will be evaluated biennially based on groundwater monitoring data as defined in the approved Corrective Measures Implementation/Remedial Action Implementation Plan for the CBRP OU (WSRC 2009a). The MNA remedy is expected to reduce groundwater concentrations to below MCLs within a reasonable timeframe (70 years).
- Annual site inspections and site maintenance (repair of erosion damage, cover maintenance, and warning signs).
- Site controls and land use restrictions via the SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the CBRP OU.

Table F-3 compares the actual O&M costs for the five-year remedy review period to the estimated direct O&M costs from the ROD (WSRC 2008). The estimated cost for fiscal year (FY) 2012 to FY2017 is $228,000 for the SVE systems, soil cover, institutional controls (i.e., LUCs), and five-year remedy reviews. The actual O&M cost for FY2012 to FY2017 is $701,179. The O&M costs from FY2012 to FY2017 are higher than estimated due to the increased cost associated with MNA monitoring and reporting.

V. Progress since Last Review

The previous protectiveness statement concluded that the remedial actions at the CBRP OU are expected to be protective of human health and the environment. Exposure pathways that could result in unacceptable risks are being addressed through the low permeability soil cover system with low-energy SVE, MNA, and institutional controls (i.e., LUCs).

There were no recommendations or follow-up actions from the last five-year review.

VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed documents listed in Section XII. References
- Reviewed the groundwater monitoring data (Table F-4);
- Confirmed implementation of the remedial action;
- Inspected the OU, interviewed maintenance personnel, and documented the results on the Inspection Checklist provided in Attachment F-1, with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance.

Data Review

The Interim Action for the CBPP OU started in January 1999 and included a soil cover cap over the disposal pit, installation of an SVE system and installation of an air sparging system. The final ROD issued in July 2008 suspended the air sparge system, but continued the SVE system (MicroBlowers^{TM} only), inspections of the soil cover, and added MNA for the groundwater plume. The last two years of available data show the MicroBlowers^{TM} system has removed approximately 16.8 kg/yr (37 lbs/yr) of TCE, which exceeds the minimal recovery rate necessary to prevent migration of TCE to the groundwater (0.8 kg/yr [1.8 lbs/yr]). The MNA wells and surface water sampling show decreasing contaminants over time except for two wells (CRW 12C and CRW010CU) that display concentrations exceeding the TCE trigger level. TCE degradation products (i.e., cDCE, VC and ethylene) are observed in monitoring wells and are proof of a MNA degradation scheme, especially in the wetlands of Twin lakes.

Summary of Inspections and Interviews

Interviews were conducted with Richard Feagin, O&M Staff member, on October 11, 2017 and George Joyner, O&M Site Manager, on October 12, 2017 at the O&M organization offices. No issues were identified as an outcome of these interviews.

The CBRP OU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) and USDOE personnel on December 15, 2017. No issues were identified for the CBRP OU during this inspection.

A site inspection will be conducted by U.S. Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control personnel, accompanied by USDOE and SRNS personnel, prior to submittal of the Revision 1 of this document. It is anticipated that no significant problems regarding this OU will be identified during the inspection.

Scheduled annual site inspections conducted from FY2012 through FY2017 identified the presence of ant mounds and minor subsidence. These findings were documented on the field inspection checklist and resolved soon after discovery.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The remedy is functioning as intended as demonstrated below:

- The cover system is effective in preventing ecological exposure to HpCDD in the pit surface soils and human exposure to TCE and PCE in the groundwater. The cover system maintenance program and LUCs have been effective in maintaining the integrity of the cover system. The annual inspection reports indicate no significant deficiencies.

- The MicroBlower^{TM} system and cover system have been effective in preventing the migration of VOCs to the groundwater and surface water above MCLs. The MicroBlower^{TM} system has recovered more than the 0.82 kg/yr (1.8 lbs/yr) minimum extraction rate needed to control the TCE source. Both groundwater and surface water monitoring data indicate a decreasing trend of TCE concentration over time (Table F-4).
- The MNA program and monitoring well network provides sufficient data to assess the progress of natural attenuation within the groundwater as evidenced by the decreasing concentrations of TCE and PCE in the groundwater (Table F-4). The surface water sampling locations provide sufficient data to monitor groundwater outcropping to Fourmile Branch and Twin Lakes and report trend data below MCLs. The LUCs are sufficient to prevent human exposure to groundwater contaminated with VOCs above MCLs.

The above remedial activities are meeting the RGs established for the CBRP OU, by eliminating or controlling all routes of exposure to human health and ecological receptors.

The Land Use Control Implementation Plan for CBRP OU governs LUC implementation, maintenance, monitoring, reporting, and enforcement (WSRC 2009b). The LUCs that are in place include physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), use restrictions to prevent unauthorized contact, removal or excavation of contaminated soils, restrictions to prevent unauthorized access to or use of groundwater until cleanup levels are met, and restrictions to prevent disturbance of the CBRP Disposal Pit soil cover system. Warning signs are in good condition, and no activities were observed that would have violated the LUCs. All LUC objectives are being met.

Are Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still valid?

The exposure assumptions, toxicity data, and cleanup levels used at the time of final remedy selection are still valid. There have been no changes in standards or physical conditions of the CBRP OU that would affect the protectiveness of the remedy.

The USEPA standards and toxicity values have been updated since the last five-year remedy review as shown in Appendix B. The changes to the values for COCs at the CBRP OU were not significant, and the RAOs continue to be met by the remedial action. No new standards or to-be-considered guidance have been identified that call into question the protectiveness of the remedy.

Fact sheets provided on the USEPA webpage regarding emerging contaminants were reviewed for applicability to this site. None of the listed emerging contaminants were identified as applicable to this OU.

Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No new information has come to light that could call into question the protectiveness of the remedy.

VIII. Issues

There are no issues related to current site conditions or activities that currently prevent the remedy for CBRP OU from being protective.

IX. Recommendations and Follow-up Actions

There are no recommendations or follow-up actions for CBRP OU.

X. Protectiveness Statement(s)

The remedy at CBRP OU is protective of human health and the environment.

Exposure pathways that could result in unacceptable risks are being controlled by institutional controls (i.e., LUCs) to prevent exposure to or ingestion of contaminated groundwater and soil media. Contamination at the CBRP OU is being addressed through implementation of the soil cover, physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the CBRP OU for industrial use only, and warning signs and use restrictions via the SRS Site Use/Site Clearance Program.

XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Operating Equipment is scheduled for January 2024.

XII. Documents Reviewed

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

USDOE, 1996. *Savannah River Site Future Use Project Report,* U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 1998. *Interim Record of Decision for the C-Area Burning/Rubble Pit Operable Unit (131-C) (U),* WSRC-RP-98-4039, Revision 0, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1999. *Land Use Control Assurance Plan for the Savannah River Site,* WSRC-RP-98-4125, Revision 1.1, latest update, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC, 2001. *Post-Construction Report (PCR) for the C-Area Burning/Rubble Pit (131-C)(U),* WSRC-RP-2000-4094, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2002. *RCRA Facility Investigation/Remedial Investigation Report with Baseline Risk Assessment for the C-Area Burning/Rubble Pit (131-C) (U)*, WSRC-RP-96-170, Revision 1.4, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2008. *Record of Decision for Remedial Alternative Selection for the C-Area Burning/Rubble Pit Operable Unit (131-C) and Old C-Area Burning/Rubble Pit (NBN) (U)*, WSRC-RP-2007-4082, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2009a. *Corrective Measures Implementation/Remedial Action Implementation Plan for the C-Area Burning/Rubble Pit Operable Unit (131-C) and Old C-Area Burning/Rubble Pit (NBN) (U)*, WSRC-RP-2008-4051, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2009b. *Land Use Control Implementation Plan for the C-Area Burning/Rubble Pit Operable Unit (131-C) and Old C-Area Burning/Rubble Pit (NBN) (U)*, WSRC-RP-2008-4050, Revision 1.1, Washington Savannah River Company, Savannah River Site, Aiken, SC

Various - *Inspection Data Sheets – Field Inspection Checklist C-Area Burning Rubble Pit (131-C) (U)*, ER-IDS-019-016, Inspection period 2012 through 2017 (annually)

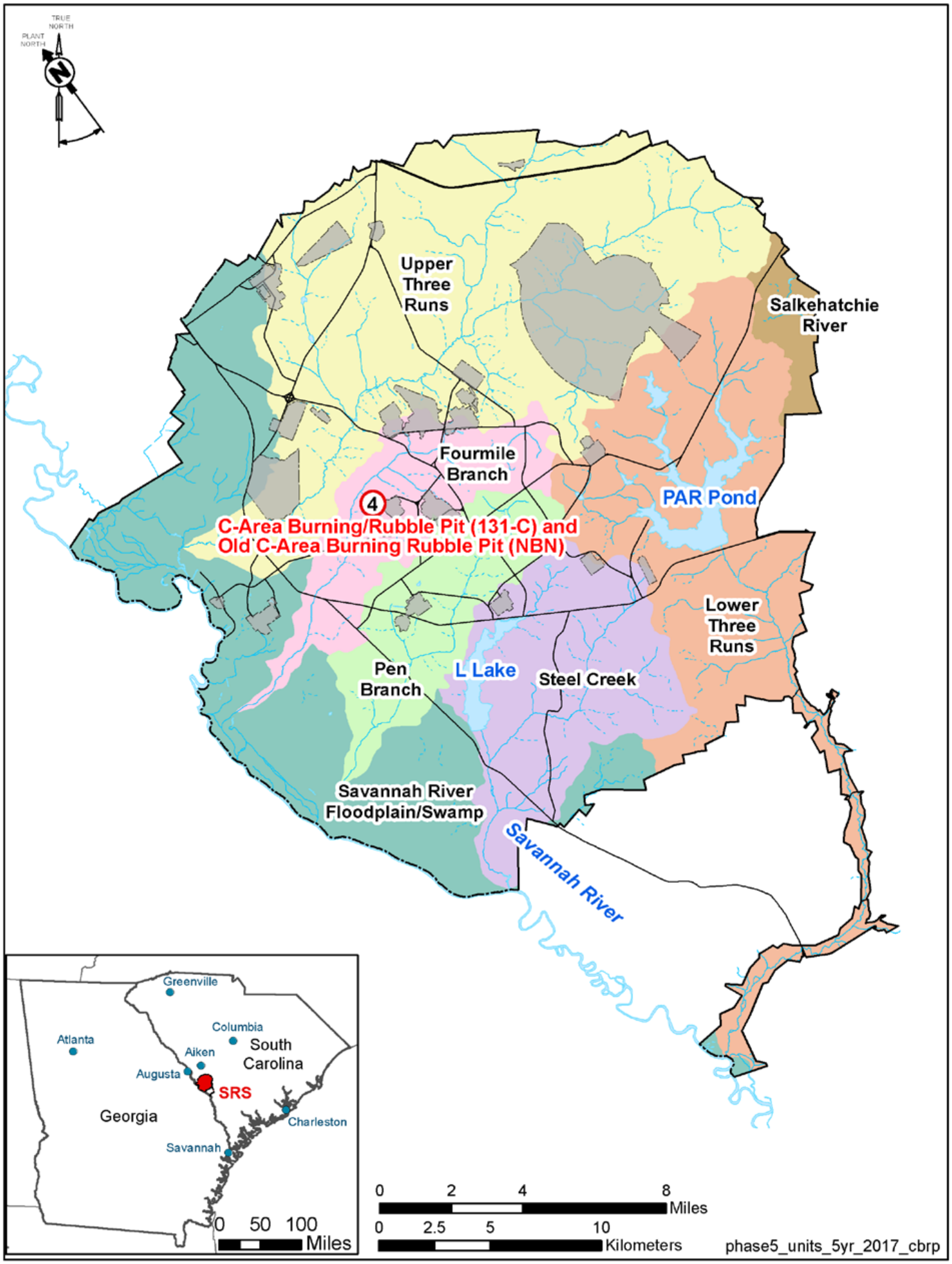

Figure F-1. Location of C-Area Burning/Rubble Pit Operable Unit (131-C) at SRS

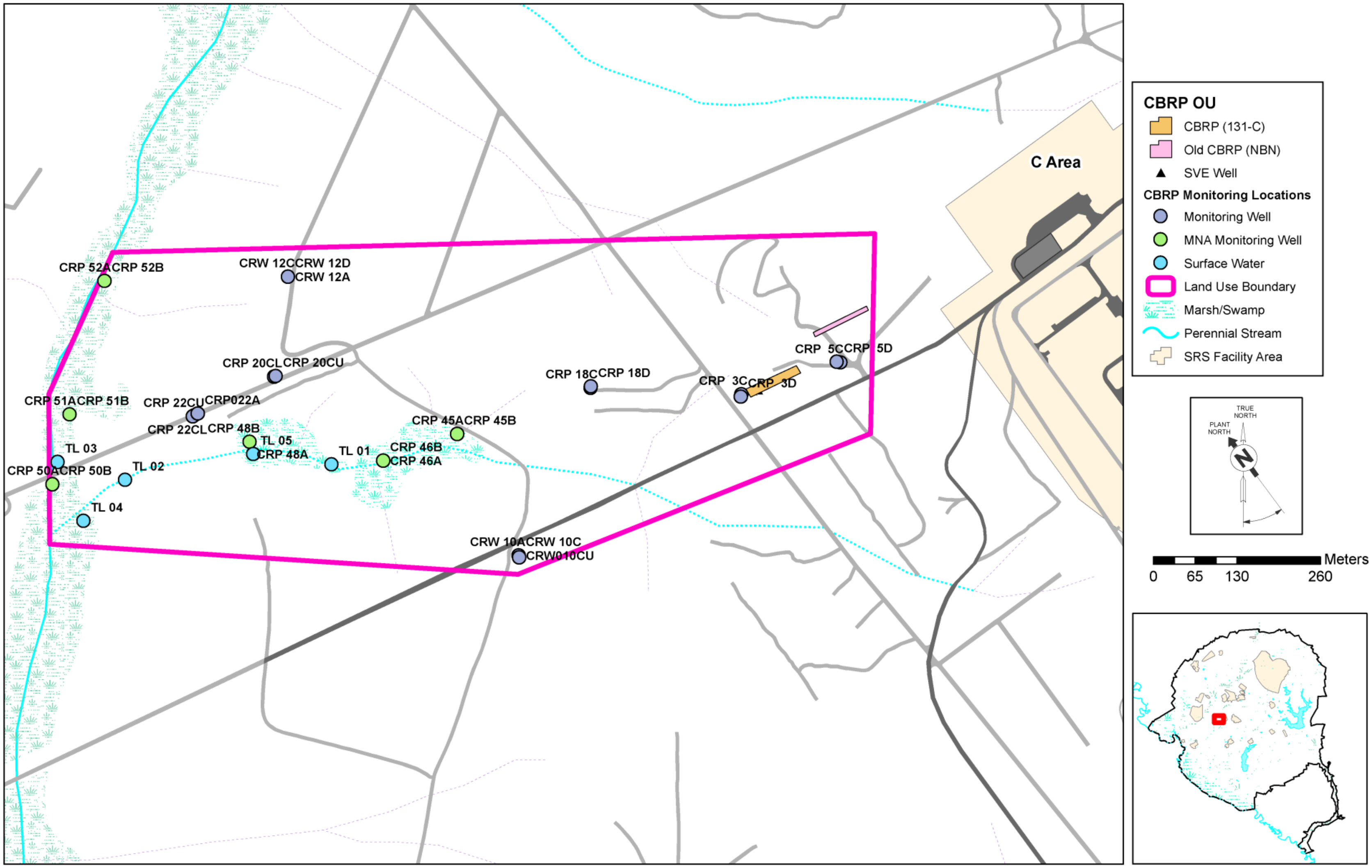

Figure F-2. CBRP OU LUC Boundary and Monitoring Stations

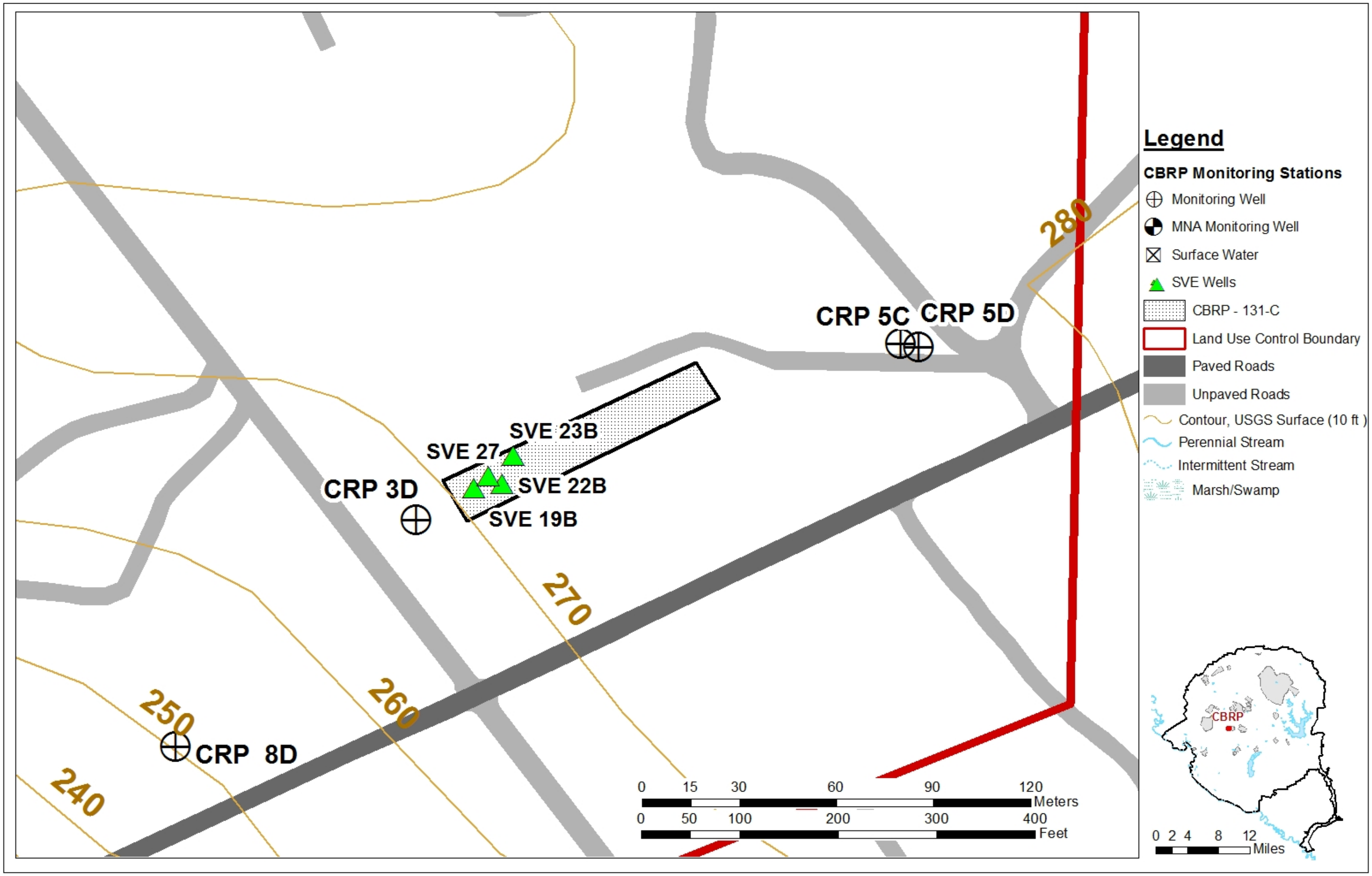

Figure F-3. CBRP OU SVE Stations

Figure F-4. Photo of CBRP Before Remediation Activities (1973)

Figure F-5. Current Photo of CBRP (2017)

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Table F-1. Chronology of OU Events

Event	Date
RFI/RI Field Start / Complete	August 22, 1995/ July 2001
Interim ROD Issuance	May 7, 1999
Interim Remedial Action Start / Complete	January 12, 1999 / June 2000
Interim RA Operations Start / Complete	September 1999 / ongoing
ROD Issuance	July 9, 2008
Remedial Action Start/Complete	May 13, 2009 /June 2009
Remedial Action Operations (MNA) Start / Complete	December 2009 /ongoing
Previous Five-Year Reviews Issuance	February 12, 2004 / January 29, 2009 February 4, 2014

Table F-2. CBRP RCOCs

Media	Subunits	RCOCs	Basis/Receptor	RG
Soil	Disposal Pit	HpCDD	Ecological hazard to small burrowing animals (shrew)	0.07 µg/kg
	Vadose Zone	TCE	CM RCOC, exceeds MCL in <10 yrs	58 µg/kg
Groundwater	Groundwater Plume	PCE	ARAR RCOC, exceeds MCL	5 µg/L
		TCE	Risk/hazard to future industrial worker, exceeds MCL	5 µg/L
		DCM	ARAR RCOC, exceeds MCL	5 µg/L
		DCE	Risk to future industrial worker	7 µg/L
		cDCE	Hazard to future industrial worker	70 µg/L
		VC	Risk to future industrial worker	2 µg/L
Surface Water	Twin Lakes	PCE	Exceeds surface water ARAR (MCL)	5 µg/L
		TCE	Exceeds surface water ARAR (MCL)	5 µg/L
		VC	Exceeds surface water ARAR (MCL)	2 µg/L
	Fourmile Branch	VC	Exceeds surface water ARAR (MCL)	2 µg/L

Risk and hazard for most likely future human health exposure scenario (future industrial worker)
* CM RCOC, determined based on MCL exceedance, not risk-based
** ARAR RCOC due to MCL exceedance, not risk-based
DCM – dichloromethane (methylene chloride)

Table F-3. Actual versus Estimated O&M Costs

Project Cost	**FY2012**	**FY2013**	**FY2014**	**FY2015**	**FY2016**	**FY2017**	**5-Year Total**
Total Actual O&M Costs ($)	166,024	144,489	141,348	64,058	93,169	92,091	701,179
Total Plug-In ROD Estimated Direct O&M Costs ($)	66,000	24,000	24,000	24,000	24,000	66,000	228,000

Table F-4. Summary of the Monitoring Data for the CBRP OU (2012 to 2016)

RCOC	**% Detect**	**Number of Detects**	**Total Samples**	**Maximum Concentration (µg/L)**	**RG (µg/L)**
Surface Water					
Chloroethene (Vinyl Chloride)	4.35%	2	46	1.9	2
Trichloroethylene (TCE)	23.2%	13	56	9.70	5
Groundwater					
1,1-Dichloroethylene	1.75%	2	114	1.39	7
Chloroethene (Vinyl Chloride)	25.9%	36	139	209	2
cis-1,2-Dichloroethylene	36.7%	51	139	181	70
Dichloromethane (Methylene Chloride)	8.63%	12	139	2.60	5
Tetrachloroethylene (PCE)	16.5%	23	139	10.9	5
Trichloroethylene (TCE)	36.7%	51	139	1700	5

Attachment F-1. Five-Year Review Site Inspection Checklist – C-Area Burning/ Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) Operable Unit

I. SITE INFORMATION

Site Name:	**C-Area Burning/ Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) Operable Unit**	**Date of Inspection:**	**08/23/2017**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**CERCLIS #31**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**91°F and clear**

Remedy Includes: *(Click all that apply)*

☒ Landfill Cover / Containment
☒ Access Controls
☒ Institutional Controls
☐ Groundwater Pump and Treatment
☐ Surface Water Pump and Treatment
☒ Monitored Natural Attenuation
☐ Groundwater Containment
☐ Vertical Barriers
☒ Other Operation of existing active MicroBlower^{TM} SVE System

Attachments: ☐ Inspection team roster attached ☐ Inspection team roster attached

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** Gregory Joyner (Name) Post Closure Manager (Title) 10/12/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-7927

Problems/Suggestions: ☐ Report Attached

2. **O&M Staff:** Richard Feagin (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 10/11/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4416

Problems/Suggestions: ☐ Report Attached

Attachment F-1. Five-Year Review Site Inspection Checklist – C-Area Burning/ Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) Operable Unit *(continued)*

II. INTERVIEWS *(Click all that apply) (Continued)*

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

Agency: ____________________

Contact: __________ __________ __________ __________
(Name) (Title) (Date) (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

____

Agency: ____________________

Contact: __________ __________ __________ __________
(Name) (Title) (Date) (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

____

Agency: ____________________

Contact: __________ __________ __________ __________
(Name) (Title) (Date) (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

____

4. **Other Interviews** *(Optional):* ☐ Report Attached ____________________

____

____

____

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Click all that apply)*

1. **O&M Documents:**

☐ O&M Manual	☐ Readily Available	☐ Up to Date	☒ N/A
☒ As-Built Drawings	☒ Readily Available	☒ Up to Date	☐ N/A
☐ Maintenance Logs	☐ Readily Available	☐ Up to Date	☒ N/A

Remarks: See *Waste Unit Inspection and Maintenance, ER-SOP-019, Field Inspection Checklist for C-Area Burning/Rubble Pit, 131-C*, ER-IDS-019-016.

____

Attachment F-1. Five-Year Review Site Inspection Checklist – C-Area Burning/ Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) Operable Unit *(continued)*

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)*

2. Health and Safety Plans (HASPs):

☐ Site-Specific Health and Safety Plans ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Contingency Plan/Emergency Response Plan ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.120120 HAZWOPER. A SSHASP will be prepared if needed.

3. O&M and OSHA Training Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix.

4. Permits and Service Agreements:

☒ Air Discharge Permit ☒ Readily Available ☒ Up to Date ☐ N/A
☐ Effluent Discharge ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Waste Disposal; POTW ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Other Permits ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

5. Gas Generation Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

6. Settlement Monument Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

7. Groundwater Monitoring Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

8. Leachate Extraction Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

9. Discharge Compliance Records:

☒ Air ☒ Readily Available ☒ Up to Date ☐ N/A
☐ Water (Effluent) ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

10. Daily Access/Security Logs: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

Attachment F-1. Five-Year Review Site Inspection Checklist – C-Area Burning/ Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) Operable Unit *(continued)*

IV. O&M COSTS

1. O&M Organization:

☐ State In-House ☐ Contractor for State
☐ PRP In-House ☐ Contractor for PRP
☒ Other: SRS

2. O&M Cost Records:

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

Total annual cost by year for review period, if available

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

3. Unanticipated or Unusually High O&M Costs During Review Period

Describe costs and reasons: ______

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing Damage:** ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks: OU-specific fencing is not required by the remedial action.

B. Signs

1. **Signs and Other Security Measures:** ☐ Location shown on site map ☐ N/A
Remarks: Signs are in good condition.

Attachment F-1. Five-Year Review Site Inspection Checklist – C-Area Burning/ Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) Operable Unit *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Once in 5 years
Responsible Party/Agent: USDOE Savannah River Field Office
Contact: Karen Adams (Name) Federal Project Director (Title) 12/15/2017 (Date) 803-952-7871 (Phone No.)

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

2. Adequacy: ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks:

D. General

1. Vandalism/Trespassing: ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

2. Land use changes onsite: ☒ N/A
Remarks:

3. Land use changes offsite: ☒ N/A
Remarks:

Attachment F-1. Five-Year Review Site Inspection Checklist – C-Area Burning/ Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) Operable Unit *(continued)*

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. Roads damaged: ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks:______

B. Other Site Conditions

Remarks:______

VII. LANDFILL COVER / CONTAINMENT ☒ Applicable ☐ N/A

A. Landfill Surface

1. Settlement (Low spots)**:** ☐ Location shown on site map ☒ Settlement not evident
Areal extent______ Depth______
Remarks:______

2. Cracks: ☐ Location shown on site map ☒ Cracking not evident
Lengths______ Widths______ Depths______
Remarks:______

3. Erosion: ☐ Location shown on site map ☒ Erosion not evident
Areal extent______ Depth______
Remarks:______

4. Holes: ☐ Location shown on site map ☒ Holes not evident
Areal extent______ Depth______
Remarks:______

5. Vegetative Cover: ☒ Grass ☒ Cover properly established ☐ No signs of stress
Areal extent______ Depth______
Remarks: Vegetation mowed routinely.

Attachment F-1. Five-Year Review Site Inspection Checklist – C-Area Burning/ Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) Operable Unit *(continued)*

VII. **LANDFILL COVER / CONTAINMENT** *(Continued)*

6. Alternative Cover (armored rock, concrete, etc.): ☒ N/A

Remarks:____

7. Bulges: ☐ Location shown on site map ☒ Bulges not evident

Areal extent__________ Depth__________

Remarks:____

8. Wet Areas / Water Damage: ☒ Wet areas/water damage not evident

☐ Wet areas ☐ Location shown on site map Areal extent__________

☐ Ponding ☐ Location shown on site map Areal extent__________

☐ Seeps ☐ Location shown on site map Areal extent__________

☐ Soft subgrade ☐ Location shown on site map Areal extent__________

Remarks:____

9. Slope Instability: ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability

Areal extent__________

Remarks:____

B. Benches ☐ Applicable ☒ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel)

C. Letdown Channels ☐ Applicable ☒ N/A

(Channel lined with erosion control mates, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies)

Attachment F-1. Five-Year Review Site Inspection Checklist – C-Area Burning/ Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) Operable Unit *(continued)*

VII. COVER SYSTEMS *(Continued)*

D. Cover Penetrations ☒ Applicable ☐ N/A

1. Gas Vents: ☐ Active ☐ Passive
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A
Remarks:______________________________

2. Gas Monitoring Probes:
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A
Remarks:______________________________

3. Monitoring Wells:
☒ Properly secured/locked ☒ Functioning ☐ Routinely sampled ☒ Good Condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A
Remarks:______________________________

4. Leachate Extraction Wells:
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A
Remarks:______________________________

5. Settlement Monuments: ☐ Located ☐ Routinely Surveyed ☒ N/A
Remarks:______________________________

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

F. Cover Drainage Layer ☐ **Applicable** ☒ **N/A**

G. Detention/Sedimentation Ponds ☐ **Applicable** ☒ **N/A**

H. Retaining Walls ☐ **Applicable** ☒ **N/A**

I. Perimeter Ditches/Offsite Discharge ☐ **Applicable** ☒ **N/A**

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

Attachment F-1. Five-Year Review Site Inspection Checklist – C-Area Burning/ Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) Operable Unit *(continued)*

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☒ N/A

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

C. Treatment System ☐ Applicable ☒ N/A

D. Monitoring Data ☒ Applicable ☐ N/A

1. Monitoring Data:
☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring Data:
☐ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

E. Monitored Natural Attenuation ☒Applicable ☐ N/A

1. Monitoring Wells *(natural attenuation remedy)***:**
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ All required wells located ☐ Needs maintenance ☐ N/A
Remarks:____

X. OTHER REMEDIES

If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

A. Soil Vapor Extraction System ☒ Applicable ☐ N/A

1. Blowers, Wellhead Plumbing, and Electrical:
☒ Good Condition ☒ All required wells located ☐ Needs maintenance ☐ N/A
Remarks:____

2. Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances:
☒ Good Condition ☐ Needs maintenance
Remarks:____

3. Spare Parts and Equipment:
☒ Readily Available ☒ Good Condition ☐ Requires Upgrade ☐ Needs to be provided
Remarks:____

Attachment F-1. Five-Year Review Site Inspection Checklist – C-Area Burning/ Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) Operable Unit *(continued/end)*

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

The remedy for the CBRP OU is maintaining the integrity of the soil cover system, operating the existing active MicroBlowers^{TM}, implementing institutional controls (i.e., LUCs), and MNA for groundwater. The remedy is fully established and functioning as designed.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The protectiveness of the remedy is maintained through effective containment source removal by soil vapor extraction and prevention of contaminant leachate by minimizing infiltration through the contaminants by a low permeability soil cover system. Institutional controls (i.e., LUCs) effectively prevent unauthorized access to the OU: physical access controls to SRS (fences, guards, security patrols, etc.); administrative controls (SRS is a secured government facility with land use restrictions); and warning signs and use controls (SRS Site Use/Site Clearance Program).

C. Early Indicators of Potential Remedy Failure

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

N/A

D-AREA OPERABLE UNIT

I. Introduction

This report is the second five-year review for the D-Area Operable Unit (DAOU). The review was conducted from August 2017 through November 2017. Contaminants have been left in place at the DAOU at levels that do not allow unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the DAOU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table G-1 lists the chronology of site events for the DAOU.

III. Background

The DAOU is listed as a Resource Conservation and Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) unit in Appendix C of the Federal Facility Agreement (FFA) for Savannah River Site (SRS) (FFA 1993). The media of concern is surface and vadose zone soil, sediment, surface water, and concrete. Groundwater is addressed separately by the D-Area Groundwater OU.

An area-based remedial strategy has been implemented in D Area. Remedial decisions for two surface units in D Area (i.e., the D-Area Rubble Pit [431-2D] and the D-Area Ash Basin [488-D]) are addressed by the D-Area Expanded OU Record of Decision (ROD). In 2010, South Carolina Department of Health and Environmental Control (SCDHEC) identified a problem with proceeding to a final ROD for the DAOU because the D-Area Powerhouse (484-D) would still be operational after approval of a final ROD. The U.S. Department of Energy (USDOE), U.S. Environmental Protection Agency (USEPA), and SCDHEC agreed to pursue an Early Action to allow the project to remain on track and achieve the targeted footprint reduction in DAOU. The scope of the EAROD (SRNS 2011a) was to implement land use controls (LUCs) for DAOU subunits and facilities where previous removal actions had been completed or no additional remedial actions beyond

LUCs was needed. The D-Area Powerhouse (484-D) was placed in standby mode for six months following startup of the replacement power plant. Due to its operational status at that time, the remedial decision for the D-Area Powerhouse (484-D) is not included in the DAOU EAROD (SRNS 2011a). In addition, the northern 25% of the 489-D D-Area Coal Pile Runoff Basin (489-D) (CPRB) was addressed by the DAOU EAROD while the southern 75% of the 489-D CPRB remained operational.

The remedial action for the remaining southern 75% of the 489-D CPRB, the 488-1D Ash Basin, 488-2D Ash Basin, and 488-4D Ash Landfill will be addressed by a Second EAROD scheduled for issuance in 2019. The remaining DAOU subunits and facilities associated with the D-Area Powerhouse (484-D) will be closed under the DAOU final ROD scheduled for issuance in 2046.

Physical Characteristics

D Area is located in the southwest quadrant of the SRS, approximately 900 m (3,000 ft) east of the nearest site boundary, the Savannah River (Figure G-1). The DAOU is approximately 85 hectares (210 acres) and is composed of surface units and source areas in D Area that are potentially responsible for contaminating groundwater (Figure G-2). The following subunits comprise the DAOU:

- Bubble Tower Subunit consisting of 717-D Maintenance Facility, D-Area Heavy Water Facility (DHWF), and Fire Fighting Training Facility (approximately 38.6 hectares [95 acres]);
- Moderator Processing Subunit consisting of 420-D Concentrator Building, 420-2D Rework Handling Facility, 421-2D Moderating Handling Storage Building, 421-D Finishing Building, 421-4D Drum Storage Building, and 772-D Control Laboratory/ Supervisor’s Office (approximately 6 hectares [15 acres]);
- Powerhouse Subunit consisting of the 489-D CPRB, D-Area Waste Oil Facility (484-10D) (WOF), D-Area Powerhouse (484-D), water treatment plant, and 483-D Combined Spills (approximately 40.6 hectares [100 acres]);

- Miscellaneous Units consisting of 904-50G Outfall and D-Area Asbestos Pit (080-20G);
- D-Area Inactive Process Sewer Lines (DIPSL), which is located in the Bubble Tower, the Moderator Processing, and the Powerhouse subunits (approximately 4,260 linear m [14,200 linear ft]);
- Electrical Transformers; and
- Miscellaneous Buildings.

The 488-1D Ash Basin, 488-2D Ash Basin, and 488-4D Ash Landfill were moved from FFA Appendix G.1, Areas to be Investigated, to FFA Appendix C, RCRA/CERCLA Units List, as subunits of the DAOU in April 2013 and will be addressed by a Second EAROD.

Land and Resource Use

According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The Land Use Control Assurance Plan for the SRS (WSRC 1999) designates the DAOU as being within an industrial area. The future land use for the DAOU is reasonably anticipated to remain industrial with the USDOE maintaining control of the land.

History of Contamination

SRS produced special nuclear materials for the U.S. Department of Defense between 1952 and 1988. The reactors that were used to produce the special nuclear materials required heavy water (deuterium oxide) as a neutron moderator. Historically, heavy water was produced at D Area at the DHWF (i.e., Bubble Tower Subunit). D Area also contained the Heavy Water Rework Facility that purified the SRS inventory of used reactor moderator. The inactive facilities within the DAOU that pose a potential risk to humans and/or the environment are summarized below.

Bubble Tower Subunit operated from the early 1950s until shutdown in January 1982 (Figure G-3). During its operation, the surrounding soil was contaminated by tetrachloroethylene (PCE). The nature and extent of contamination evaluation determined that PCE poses a contaminant migration (CM) problem. There is no risk to future industrial workers or ecological receptors. In addition, there is no principal threat source material (PTSM) associated with this subunit.

The Moderator Processing Subunit was shut down in the late 1990s (Figure G-3). The nature and extent of contamination evaluation determined tritium in concrete and/or soil poses a CM threat at the 420-D Concentrator Building, 420-2D Rework Handling Facility, and 421-2D Moderating Handling Storage Building locations.

The Powerhouse Subunit includes the 484-D Powerhouse, the D-Area WOF, the 489-D CPRB, water treatment plant, and the 483-D Combined Spills. The 484-D Powerhouse began operation in 1952, ceased operation in April 2012, and is occasionally used for military training exercises. The small water treatment plant provided feedwater for the Powerhouse building boilers. Caustic and acid systems were used to regenerate the ion exchange columns used to condition raw water for use in the Powerhouse boilers. The D-Area WOF, located outside of the Powerhouse on the south side of the building, stored used oil that was burned in the Powerhouse building boilers. The 489-D CPRB is an active facility, currently being used as a retention basin receiving stormwater runoff from the inactive coal pile area south of the D-Area Powerhouse (484-D). Previous operation of the 489-D CPRB has resulted in a metals plume due to low pH infiltration from the basin. Though the quantity of source material was reduced in 2000 (as discussed in Initial Response), the nature and extent of contamination evaluation indicated that arsenic in sediments pose a risk to human and ecological receptors; 2-methylnaphthalene, metals and low pH pose a risk to ecological receptors; and arsenic in surface soil poses a risk to human receptors. An evaluation of the soil at the 483-D Combined Spills area determined that there is no threat to industrial workers or ecological receptors, no contaminant migration threat, and no constituents that constitute PTSM.

The two Miscellaneous Units, 904-50G Outfall and D-Area Asbestos Pit (080-20G), were removed from operations in 1982 and 1975, respectively. The 904-50G Outfall received process discharges and river water during operation of the bubble towers. There are no refined constituents of concern (RCOCs) for human or ecological receptors at the 904-50G

Outfall. No problems were identified that would warrant a remedial action associated with the 904-50G Outfall. The D-Area Asbestos Pit (080-20G) operated between 1973 and 1975 as a disposal site for asbestos insulation and piping from the R Area steam lines. The pit also received asbestos, metal, scrap, and concrete from the bubble towers in 1974. The pit was estimated to contain 3,290 m^3 (4,300 ft^3) of buried waste and has been closed to disposal activities. The D-Area Asbestos Pit (080-20G) was characterized under the Site Evaluation program. The results of the investigation determined that the asbestos pit poses no threat to human health or the environment. However, should asbestos be brought to the surface, there would be potential for exposure.

The DIPSLs, composed of vitrified clay pipe and reinforced-concrete pipe, were constructed in 1952 to carry wastewater from various heavy water processing facilities associated with the OU to a drainage ditch south of the 489-D CPRB. Process sewer wastewater was contaminated principally with tritium and hydrogen sulfide. Samples were obtained from within the DIPSL manholes and from various locations beneath the DIPSLs. No constituents of concern (COCs) were identified. However, the manholes associated with the DIPSLs will be plugged and grouted as an engineering control to restrict access to impacted areas (i.e., residual contaminants in the DIPSLs) and for general safety.

Electrical transformer substations were located throughout D Area and were often included with facilities during decommissioning activities. In the 1980s, transformers were switched from polychlorinated biphenyl (PCB) oil to mineral oil, where feasible. In 1986, USEPA performed a detailed assessment of SRS compliance with the Toxic Substances Control Act and found records of analysis, storage, and disposal of PCB materials to be in compliance. As of 1996, SRS had replaced or rendered non-PCB all of the site’s transformers and large capacitors that were regulated due to PCB content. There are no records indicating a spill or release from the transformers while they were operated with PCB oil; therefore, no samples were collected during decommissioning. During pre-work plan characterization, visual inspections of the remaining concrete pads were performed with no evidence of spills on the pads. There are no problems warranting action for the electrical transformer substations.

The D-Area miscellaneous buildings were used for administrative purposes, general storage, etc. These buildings were classified through the Facility Decommissioning Evaluation process as Simple Model Decommissioning and have been deactivated and decommissioned with concurrence from USEPA and SCDHEC. Simple Model Decommissioning is performed for clean buildings with only normal safety risks associated with decommissioning. No sampling is required for the buildings decommissioned under the Simple Model and there are no problems warranting action.

Initial Response

In 1975, the D-Area Asbestos Pit (080-20G) was closed and backfilled with soil to cover the waste. A maintenance action was performed in 2011 to remove woody vegetation and to implement institutional controls (i.e., LUCs) at the D-Area Asbestos Pit (080-20G) to prevent the potential for an unacceptable exposure to asbestos if the cover is breached and asbestos containing material is brought to the surface.

In 2000, a maintenance action was performed at the 489-D CPRB to excavate 7,650 m^3 (10,000 yd^3) of coal fines from the 489-D CPRB sediments, significantly reducing the quantity of source material.

A treatability study to address the tritium in concrete and soil at the Moderator Processing Subunit was conducted in two stages during 2009 and 2010. After incorporating lessons learned, a removal action was conducted in the Moderator Processing Subunit to remove tritium in the concrete and soil with the operation of an On-Unit Thermal Treatment System from October 21, 2010 to September 8, 2011. The purpose of the removal action was to reduce the potential leaching of tritium in vadose zone soils and concrete slabs that could result in a maximum contaminant level (MCL) exceedance in the groundwater.

In 2010, a removal action was started in the Bubble Tower Subunit with the installation of a MicroBlower^{TM}-equipped soil vapor extraction (SVE) system to remove volatile organic compounds (VOCs). The purpose of the removal action was to reduce the potential leaching of PCE in vadose zone soils that could result in a MCL exceedance in the groundwater. The MicroBlower^{TM} system is anticipated to operate until remedial goals (RGs) are achieved.

In 2011, a removal action was taken in the Powerhouse Subunit with surface water management at the 489-D CPRB, consolidation of the contaminated sediment from the D-006 Outfall (Petroleum Release Site) and D-Area WOF into the northern 25% of the 489-D CPRB, and application of a soil cover.

Basis for Taking Action

The risks associated with the DAOU as summarized from the EAROD (SRNS 2011a) are provided below and are the basis for taking action at the DAOU.

- Human Health Risk: Arsenic associated with the 489-D CPRB poses a risk to the future industrial worker. Subsurface asbestos at the D-Area Asbestos Pit (080-20G) would present an exposure risk to human receptors if brought to the surface. PCE in the soil near the 717-D Maintenance Shop (Bubble Tower Subunit) and tritium in concrete (420-D/420-2D Facilities of the Moderator Processing Subunit) and soil (420-2D/ 421-2D Facilities of the Moderator Processing Subunit) pose contaminant migration risks.
- Ecological Risk: Arsenic and 2-methylnaphthalene associated with the 489-D CPRB pose a risk to benthic organisms. Metals (aluminum, beryllium, cobalt, copper, iron, manganese, and zinc) and low pH in surface water present a risk to aquatic ecological receptors.

IV. Remedial Actions

Remedy Selection

Regulatory decisions (i.e., early removal actions) were previously made for the Bubble Tower Subunit, the Moderator Processing Subunit, the Powerhouse Subunit, and Miscellaneous Units and documented in the Removal Site Evaluation Report (RSER) /Engineering Evaluation/Cost Analysis (EE/CA) documents (SRNS 2009a, SRNS 2009b, SRNS 2009c). Cleanup goals established for the DAOU subunits (including goals identified for the early removal actions) are based on industrial land use. Therefore, hazardous substances will remain at the DAOU at levels that pose a threat to human health and prevent unrestricted land use. The remedial action of LUCs selected in the EAROD (SRNS 2011a) for a portion of the DAOU will prevent land disturbance activities and protects against unrestricted (i.e., residential) use. This will facilitate protecting the public health or welfare of the environment from actual or threatened releases of hazardous substances into the environment.

In September 2010, SCDHEC identified a problem with proceeding with a final ROD for DAOU given that the D-Area Powerhouse (484-D) would still be operational after approval of the ROD. Therefore, USDOE, USEPA, and SCDHEC agreed to pursue an EAROD to allow the project to remain on track and achieve the targeted footprint reduction.

The RCOCs and RGs for the subunits, as identified in the EAROD (SRNS 2011a) are provided in Table G-2.

The remedial action objectives (RAOs) identified in the EAROD (SRNS 2011a) for the DAOU after completion of the removal actions are as follows:

- Protect industrial workers from exposure to asbestos-containing waste in subsurface soil at the D-Area Asbestos Pit; and
- Ensure protection against unrestricted (i.e., residential) land use at the DAOU.

The removal actions that have been accepted as final actions within the DAOU, and their associated RAOs, are as follows:

- Reduce the potential leaching of PCE in the Bubble Tower Subunit vadose zone soils that would result in an MCL exceedance in groundwater (SRNS 2009a);
- Reduce the potential leaching of tritium in the Moderator Processing subunit vadose zone soils and concrete slabs that would result in an MCL exceedance in groundwater (SRNS 2009b); and

- Prevent exposure of industrial workers to arsenic contaminated soil at D-Area WOF, D-Area Powerhouse (484-D) and ecological receptors to contaminated soil at the 489-D CPRB (SRNS 2009c);

The following removal actions have been completed.

- Treatment of the tritium contaminated soil at the Moderator Processing Subunit with an on-unit thermal detritiation system;
- Removal of arsenic contaminated soil at the D-Area WOF;
- Consolidation of contaminated soils from D-006 Outfall and D-Area WOF with 489-D CPRB contaminated soil and placement under a 0.6-m (2-ft) soil cover over the northern 25% of the 489-D CPRB.

The selected early action for the DAOU as stated in the EAROD (SRNS 2011a) is LUCs for the Bubble Tower Subunit, Moderator Processing Subunit, Northern 25% of the 489-D CPRB, Asbestos Pit, DIPSLs, electrical transformer pads, and miscellaneous building pads. The DAOU LUCs consist of the following:

- Physical access control into D Area. Access is controlled by a locked fence and is monitored by SRS security personnel. Only authorized personnel may enter.
- Signage and monuments will be located at the DAOU boundaries to alert onsite workers to the presence of hazardous substances and to prevent unknowing entry and unrestricted use.
- Administrative controls as managed through the SRS Site Use/Site Clearance Program to require authorization before beginning any excavation activity at the DAOU.
- Maintenance of the soil covers for the D Area Asbestos Pit, the northern section of the 489-D CPRB, and the Bubble Tower to ensure that there is no erosion damage and to prevent unauthorized excavation or construction activities.
- Plugging and grouting of the manholes associated with the DIPSLs as an engineering control to restrict access to impacted areas and for general safety.

- Site maintenance, such as inspections, general housekeeping, repair of erosion damage and other routine maintenance, is to be conducted as needed.

There is no threat to human health or ecological receptors at the 904-50G Outfall, the DIPSLs outside of the former industrial area, electrical transformer pads and miscellaneous building pads. Therefore, no LUCs are needed for these areas.

Remedy Implementation

Implementation of the remedial actions included the following activities for the specific subunits:

Bubble Tower Subunit

- Installed a SVE system consisting of eleven MicroBlowers^{TM}-equipped to treat a volume of 3,085 m^3 (4,033 yd^3) of PCE contaminated soil below a surface area of 990 m^2 (11,000 ft^2) (SRNS 2011c).
- Installed a 0.3-hectare (0.7-acre) cover system consisting of a common fill grading layer, low-permeability flexible membrane liner, geocomposite drainage layer, 20-cm (8-in) of common fill, 10-cm (4-in) of topsoil and establishment of vegetation over the soil contamination area to act as a barrier to prevent soil vapor from short-circuiting the shallow SVE well system.

Moderator Processing Subunit

- Excavated tritium contaminated soil and concrete associated with the 420-D Concentrator Building slab, 420-2D Rework Handling Facility Building slab and the 421-2D Moderator Handling and Storage Building and placing it into the On-Unit Thermal Detritiation Units. Four units were constructed and operated for a total of 17 heating campaigns to treat approximately 1,262 m^3 (1,650 yd^3) (SRNS 2011d) of tritium-contaminated soil and concrete to below CM thresholds. It is estimated that the total tritium removed was 472 Ci. Once materials met the criteria for completion, the unit was emptied and the treated material was backfilled into the excavated areas. The last unit was emptied on August 10, 2011.

- Disposed of 89 m^3 (116.7 yd^3) of waste offsite. This waste consisted of low-level radioactive CERCLA waste (i.e. plastic tarp, cast iron drain piping, tritium contaminated equipment, and cesium-137 waste from the 420-2D pad) and mixed waste (i.e. radiologically contaminated lead joints from the 420-D pad).

Powerhouse Subunit

- Reduced the existing coal storage area with a new berm and a new swale that redirects runoff to the 75% southern section of the 489-D CPRB;
- Removed visible coal from the coal storage area as a maintenance action;
- Improved surface water management at the 489-D CPRB;
- Dewatered the northern 25% section of the 489-D CPRB by pumping the runoff into the southern section. Consolidated the contaminated sediment from the D-006 Outfall (Petroleum Release Site) (4,208 m^3 [5,500 yd^3]) and D-Area WOF (168 m^3 [220 yd^3]) into the northern 25% of the 489-D CPRB;
- Installed a 1.9-hectare (4.8-acre) soil cover over the northern 25% of the 489-D CPRB consisting of 2 layers – 50 cm (20 in) minimum of compacted common fill topped by 10 cm (4 in) of topsoil;
- Dewatered the southern 75% section of the 489-D CPRB;
- Excavated and disposed of coal fines and contaminated soil from the base of the southern 75% section of the 489-D CPRB;
- Clean fill was added to the southern 75% section of the 489-D CPRB, contoured and re-graded to function as a storm water retention basin; and
- Installing four warning signs.

DIPSL

- Plugged and grouted 40 DIPSL manholes to abandon-in-place.

Asbestos Pit

- Established a maintenance program for the 1-hectare (2.5-acre) native soil cover; and
- Installed four warning signs.

Additionally, implementation of the remedial actions at the DAOU includes establishing LUCs for 67 hectares (165 acres) for the DAOU. Figures G-4 and G-5 provide current photographs of the DAOU.

System Operations/Operation and Maintenance

As of November 2017, the Bubble Tower Subunit SVE (i.e., MicroBlower^{TM} system) is in operation. Operation of SVE was started on November 9, 2010 and has removed 18 kg (39.6 lbs) of PCE through the end of 2016. The SVE is anticipated to operate until RGs are achieved.

After remediation activities are complete, only inspection and maintenance activities will be required at DAOU. LUCs include the following:

- Visual inspections for evidence of damage to the 489-D CPRB, Asbestos Pit and Bubble Tower Subunit cover systems due to erosion, settlement or intrusion by burrowing animals are being performed annually. The inspections also address upkeep of the vegetative cover and access control barriers (e.g., the warning signs);
- Necessary repairs (e.g., replacing eroded or disturbed soil, sign repair, etc.) and vegetation management (e.g., mowing, removal of larger vegetation, etc.) are being performed when required; and
- Institutional controls (i.e., LUCs) are being enforced to preclude access through the SRS Site Use/ Site Clearance program and SRS site security.

Table G-3 compares the actual operation and maintenance (O&M) costs for the five-year remedy review period to the estimated direct O&M costs from the EAROD (SRNS 2011a). The estimated cost for Fiscal Year (FY) 2012 to FY2017 is $63,000 for the SVE systems, soil cover, institutional controls i.e., (LUCs), and five-year remedy reviews. The actual

O&M cost for FY2012 to FY2017 is $956,062. The O&M costs from FY2012 to FY2017 are higher than estimated because O&M costs for the SVE system at the D-Area Bubble Tower Subunit costs were not included in the EAROD cost estimate.

V. Progress since Last Review

The remedy at DAOU is protective of human health and the environment.

Exposure pathways that could result in unacceptable risks are being controlled by institutional controls (i.e., LUCs) to prevent exposure to or ingestion of contaminated groundwater and soil media. Contamination at the DAOU is being addressed through removal of contaminated media, implementation of the soil cover, physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the DAOU for industrial use only, and warning signs and use restrictions via the SRS Site Use/Site Clearance Program.

VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII, Documents Reviewed;
- Confirmed the implementation of the remedial action;
- Reviewed the data associated with the SVE system for the Bubble Tower subunit and the detritiation for the Moderator Processing subunit (discussed below);
- Inspected the OU, interviewed maintenance personnel and documented the results on the Inspection Checklist provided in Attachment G-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance.

Data Review

DAOU Bubble Tower Subunit

The remedy for the PCE contaminated vadose zone soils of the Bubble Tower Subunit is operation of a network of MicroBlower™ SVE units. This network facilitates breaking of the transport pathway from the source to the groundwater. The approved Removal Action Report (RAR) for the DAOU Bubble Tower Subunit (SRNS 2011c) requires the monitoring results from the SVE system be reported in the five-year remedy review report. Attachment G-2 provides the detailed data associated with the operation of this system. The system has been operating near 100% for the last five years (2012 through 2016). The MicroBlower™ system has removed approximately 18 kg (39.6 lbs) of PCE, 3.8 kg (8.3 lbs) of trichloroethylene (TCE), and 118 kg (260 lbs) of other contaminants, mainly found in petroleum products. Most contaminants were removed between 2011 and 2013 with minimal removal amounts for the last few years.

Moderator Processing Subunit

The remedy for the tritium-contaminated soils of the Moderator Processing Subunit was treatment by on-site detritiation units. The RAR (SRNS 2011d) provides detail on the construction and operation of these units. The RGs for soil (120 pCi/g) and concrete (68,000 pCi/g) were achieved for tritium removal and the soil/concrete was returned to the excavated areas (Table G-4). Detailed data tables are available in the RAR.

Summary of Inspections and Interviews

Interviews were conducted with Richard Feagin, O&M staff member, on October 11, 2017 and George Joyner, O&M Site Manager, on October 12, 2017 at the O&M organization offices. No issues were identified as an outcome of these interviews.

The DAOU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) and USDOE personnel on December 15, 2017. No issues were identified for the DAOU during this inspection.

A site inspection will be conducted by USEPA and SCDHEC personnel, accompanied by USDOE and SRNS personnel, prior to submittal of the Revision 1 of this document. It is anticipated that no significant problems regarding this OU will be identified during the inspection.

Scheduled annual site inspections conducted from FY2012 through FY2017 identified the presence of ant mounds, pine samplings growing on the D-Area Asbestos Pit cover, and minor erosion on the D-Area Asbestos Pit cover. These findings were documented on the field inspection checklist and resolved soon after discovery.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The review of documents, applicable or relevant and appropriate requirements (ARARs), risk assumptions, and the results of the site inspection indicates that the remedy is functioning as intended by the EAROD (SRNS 2011a). There are several facets to the functioning of the remedy at the DAOU.

LUCs were the selected remedy in the EAROD with a requirement to complete the removal actions for subunits (Bubble Tower, Moderator Processing, and Powerhouse). The LUCs are functioning properly to protect industrial workers from exposure to asbestos-containing waste in the subsurface soils of the D-Area Asbestos Pit and to protect against unrestricted land use at the DAOU.

The operation of the detritiation units has been successful in meeting the RGs for tritium in the Moderator Processing subunit vadose zone soils and concrete slabs. The removal and consolidation of contaminated soils associated with the 489-D CPRB and D-Area WOF under a cover system have been successful in addressing the RAOs to prevent exposure to industrial workers and ecological receptors to contaminated soils.

The MicroBlower™ SVE system is removing VOCs, including PCE, from the vadose zone in support of the RAO of reducing potential leaching of PCE in the Bubble Tower Subunit vadose zone soils.

The Early Action Land Use Control Implementation Plan for DAOU governs LUC implementation, maintenance, monitoring, reporting, and enforcement (SRNS 2011b). LUCs that are in place include physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), use restrictions to prevent unauthorized contact, removal or excavation of contaminated soils, restrictions to prevent unauthorized access to or use of groundwater until cleanup levels are met, and restrictions to prevent disturbance of the soil covers for the D-Area Asbestos Pit, the northern section of the 489-D CPRB, and the Bubble Tower. Warning signs are in good condition, and no activities were observed that would have violated the LUCs. -All LUC objectives are being met.

Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still Valid?

The exposure assumptions, toxicity data, and cleanup levels used at the time of remedy selection are still valid. There have been no changes in standards or to-be-considered guidance identified in the EAROD that call into question the protectiveness of the remedy.

ARARs for this OU include those in the EAROD as well as those in the RSER/EE/CA documents for the three removal actions. All but one of the action-specific ARARs for the removal actions have been met. This includes the Toxic Air Pollutants standards (SC.R.61-62.5 Standard 8) (associated with the SVE system for the Bubble Tower subunit). Location-specific ARARs for all three removal actions have been met. The chemical-specific ARARs will be met and evaluated through the ongoing groundwater monitoring that is part of the D-Area Groundwater OU. For the LUCs in the EAROD, there are neither location-specific nor chemical-specific ARARs. The relevant ARARs are action-specific and are related to the closure and monitoring of landfills, both the cover systems and groundwater. For those ARARs that will remain applicable until RGs have been met, the requirements set forth by the associated regulations are currently being complied with.

The USEPA standards and toxicity values have been updated since the last five-year remedy review as shown in Appendix B. The changes to the values for COCs at the DAOU were not significant, and the RAOs continue to be met by the remedial action. No new standards or to-be-considered guidance have been identified that call into question the protectiveness of the remedy.

Fact sheets provided on the USEPA webpage regarding emerging contaminants were reviewed for applicability to this site. None of the listed emerging contaminants were identified as applicable to this OU.

Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No new information has come to light that could call into question the protectiveness of the remedy.

VIII. Issues

The following issue has been identified during this remedy review:

- The DAOU Bubble Tower MicroBlower™ SVE has been successful in treating VOC contamination. Contaminant removal from the DAOU Bubble Tower Microblower™ SVE wells has greatly diminished or ceased since 2012 and operation of the SVE system may no longer be needed for future protectiveness if the soil RG has been achieved.

IX. Recommendations and Follow-up Actions

Recommendations for the DAOU are provided in Table G-5.

X. Protectiveness Statement(s)

The remedy at the DAOU OU is protective of human health and the environment.

Exposure pathways that could result in unacceptable risks are being controlled with LUCs. All threats to contaminated media at the DAOU were addressed by early removal actions and implementation of LUCs through implementation of physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the DAOU for industrial use only, and warning signs and land use restrictions via the SRS Site Use/Site Clearance Program.

XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Operating Equipment is scheduled for January 2024.

XII. Documents Reviewed

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

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

SRNS, 2009a. *Removal Site Evaluation Report/Engineering Evaluation/Cost Analysis for the Volatile Organic Compound-Contaminated Soil at the Bubble Tower Subunit at the D Area Operable Unit (U),* SRNS-RP-2009-00544, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2009b. *Removal Site Evaluation Report/Engineering Evaluation/Cost Analysis for the Tritium-Contaminated Soil and Concrete at the Moderator Processing Subunit at the D Area Operable Unit (U),* SRNS-RP-2009-00542, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2009c. *Removal Site Evaluation Report/Engineering Evaluation/Cost Analysis for the 489-D Coal Pile Runoff Basin, D-006 Outfall, and 484-10D Waste Oil Facility at the D Area Operable Unit (U),* SRNS-RP-2009-00805, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2011a. *Early Action Record of Decision Remedial Alternative Selection for the D-Area Operable Unit (U),* SRNS-RP-2010-00162, Revision 1.2, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2011b. *Early Action Land Use Control Implementation Plan (EALUCIP) for the D-Area Operable Unit (DAOU) (U)*, SRNS-RP-2011-01166, Revision 0 (corrected), Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2011c. *Removal Action Report for Volatile Organic Compound-Contaminated Soil at the Bubble Tower Subunit of the D-Area Operable Unit (U)*, SRNS-RP-2010-01727, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2011d. *Removal Action Report for the Tritium-Contaminated Soil and Concrete at the Moderator Processing Subunit at the D-Area Operable Unit (U)*, SRNS-RP-2011-01485, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC, 1999. *Land Use Control Assurance Plan for the Savannah River Site*, WSRC-RP-98-4125, Revision 1.1, latest update, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

Various – Inspection Data Sheets - *Field Inspection Checklist for D-Area Operable Unit*, ER-IDS-019-072, Inspection period 2013 through 2017 (annually)

Various – Inspection Data Sheets - *Field Inspection Checklist for D-Area Coal Pile Runoff Basin*, ER-IDS-019-067, Inspection period 2013 through 2017 (annually)

Various – Inspection Data Sheets - *Field Inspection Checklist for D-Area Bubble Tower*, ER-IDS-019-068, Inspection period 2013 through 2017 (annually)

Various – Inspection Data Sheets - *Field Inspection Checklist for D-Area Asbestos Pit*, ER-IDS-019-069, Inspection period 2012 through 2017 (annually)

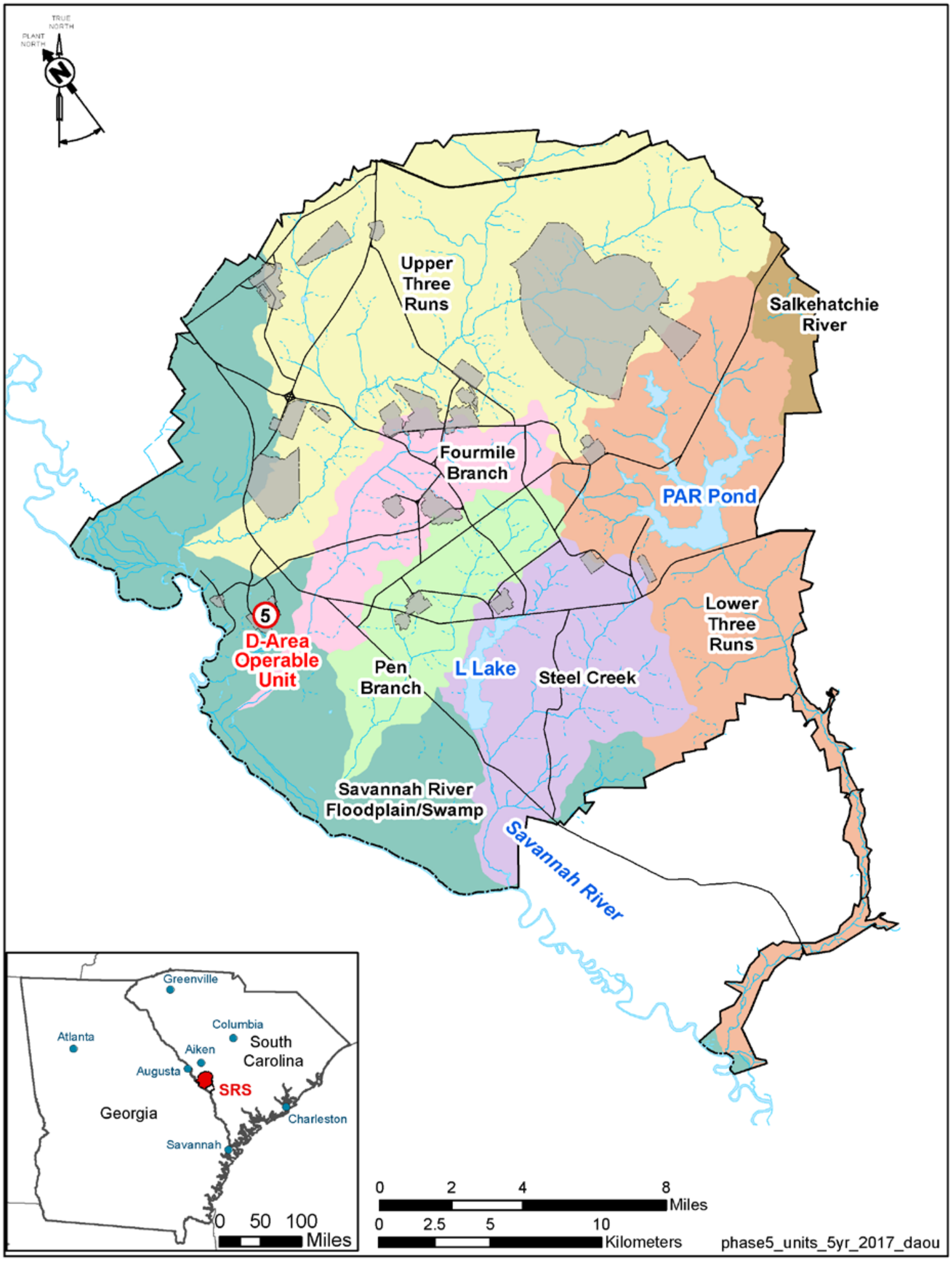

Figure G-1. Location of the DAOU within the Savannah River Site

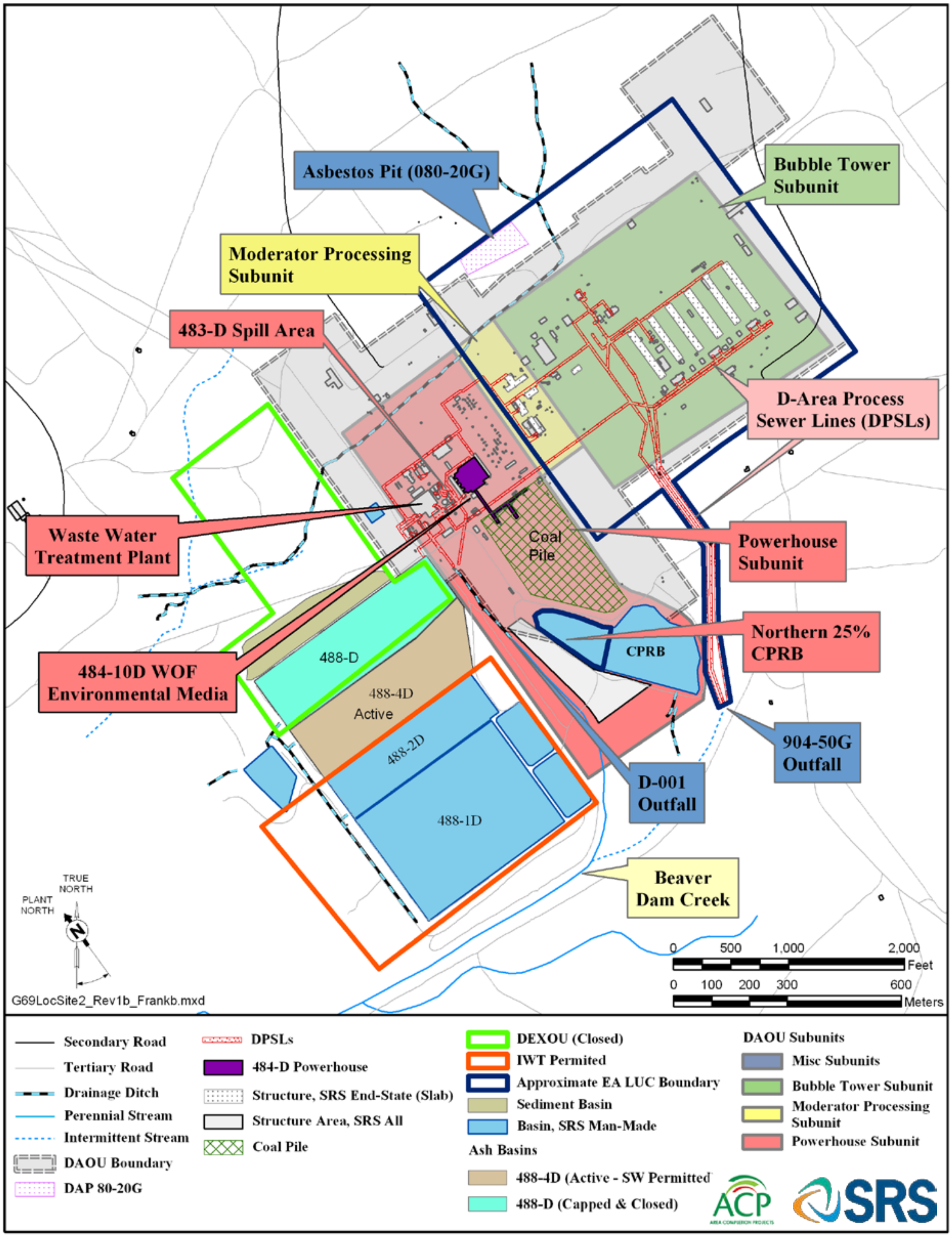

Figure G-2. Location of DAOU Subunits

1982 Aerial Photo

Moderator Sub-unit - 1995

Bubble Towers - 1995

Figure G-3. Early Photos of the DAOU

Figure G-4. 2015 Aerial Photo of DAOU

Bubble Tower Subunit

AsbestosPit

Coal Pile Runoff Basin

Waste Oil Facility

Figure G-5. Current Photographs of the Subunits of the D-Area Operable Unit (2017)

Table G-1. Chronology of OU Events

Event	Date
Bubble Tower Subunit Removal Action Start/Complete	July 6, 2010 / November 2, 2010
Bubble Tower Subunit SVE Operations Start/Complete	November 9, 2010 / on-going
Moderator Processing Subunit Thermal Detritiation Unit #1 Removal Action Start / Complete	October 20, 2010 / June 21, 2011
Moderator Processing Subunit Thermal Detritiation Unit #2, #3, and #4 Operations Start / Complete	November 3, 2010 / August 10, 2011
Powerhouse Subunit Removal Action Start / Complete	April 11, 2011 / September 8, 2011
Early Action Record of Decision (EAROD) Issuance	September 26, 2011
Previous Five-Year Reviews	February 4, 2014

Table G-2. RCOCs and RGs for Future Industrial Worker at DAOU

RCOC	Type RCOC	Final RG
Bubble Tower - Soil		
Tetrachloroethylene	CM	20 µg/kg
Moderator Processing		
Tritium concrete	CM	68,000 ρCi/g
Tritium soil	CM	120 ρCi/g
Powerhouse (489-D CPRB) - Sediments		
Sediments		
Arsenic	Human Health, Ecological	8.2 mg/kg
2-Methylnapthalene	Ecological	0.07 mg/kg
Powerhouse (489-D CPRB) – Surface Water		
Aluminum	Ecological	0.087 mg/L
Beryllium	Ecological	0.00053 mg/L
Cobalt	Ecological	0.023 mg/L
Copper	Ecological	0.00362 mg/L
Iron	Ecological	1.0 mg/L
Manganese	Ecological	0.12 mg/L
Zinc	Ecological	0.0327 mg/L
pH	Ecological	6.5-9.0

Table G-3. Actual versus Estimated O&M Costs

Project Cost	**FY2012**	**FY2013**	**FY2014**	**FY2015**	**FY2016**	**FY2017**	**5-Year Total**
Total Actual O&M Costs ($)	355,195	158,782	150,422	75,266	123,967	92,430	956,062[a]
Total Plug-In ROD Estimated Direct O&M Costs ($)	20,500	5,500	5,500	5,500	5,500	20,500	63,000

a The actual O&M cost is higher than expected due to the D-Area Bubble Tower Subunit costs not being included in the EAROD cost estimate.

Table G-4. Summary of Confirmatory Sampling for On-Site Thermal Detritiation Treatment of Soils and Concrete associated with the Moderator Processing Subunit (SRNS 2011d)

Event #	**Treatment Cell #**	**Media**	**# of Records**	**Maximum Concentration (pCi/g)**	**Minimum Concentration (pCi/g)**
DAOU-HR-TS	2	Soil	5	72.9	31.2
	3	Concrete	2	724	640
	4	Concrete	2	29.7	19.9
		Soil	2	39.2	35.1
	1	Concrete	11	17.4	ND
		Soil	4	38.4	9.88
DAOU-HR-TS10	4	Soil	5	104	77.2
DAOU-HR-TS11	1	Concrete	7	189	10.3
	1	Soil	5	55.1	17.5
	3	Soil	5	ND	ND
	2	Soil	5	15.9	7.79 (J)
	4	Soil	5	67.7	22.6
	1	Soil	5	64.3	21.9
	2	Soil	5	7.14 (J)	5.1 (J)
	3	Soil	4	5.48	4.4
DAOU-HR-TS2	1	Soil	4	54.4	12
DAOU-HR-TS3	1	Soil	5	29.3	15.2
DAOU-HR-TS4	2	Soil	5	133	68.3
DAOU-HR-TS5	1	Soil	5	40.2	19.7
DAOU-HR-TS9	3	Soil	3	69.8	45.3
		Concrete	2	48.9	40.7
	1	Concrete	2	541	119
	2	Soil	4	142	102

Note: Sampling events occurred over multiple dates. Thus, multiple listing of a treatment cell for a single media within a single event indicates separate sampling events.

Table G-5. Recommendations and Follow-up Actions for DAOU

Issue	**Recommendations/ Follow-up Actions**	**Party Responsible**	**Oversight Agency**	**Milestone Date**	**Affects Protectiveness? (Y/N)**	
					Current	**Future**
Contaminant removal from the DAOU Bubble Tower MicroBlower™ SVE wells has greatly diminished or ceased since 2012 and operation of the SVE system may no longer be needed for future protectiveness if the soil RG has been achieved.	Due to the DAOU Bubble Tower Subunit MicroBlower™ SVE system's minimal removals of contaminants for at least the last four years (Figure G-2-2, Attachment G-2), SRS proposes to shut down the MicroBlower™ SVE system and collect a confirmation soil sample to determine if the PCE soil RG has been met (20 µg/kg). If the RG has been achieved, the results will be submitted to the Core Team for consensus to justify discontinuing operation of the SVE and/or monitoring.	USDOE	SCDHEC/ USEPA	June 2018	N	N

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Attachment G-1. Five-Year Review Site Inspection Checklist – D-Area Operable Unit

I. SITE INFORMATION

Site Name:	**D-Area Operable Unit**	**Date of Inspection:**	**08/31/2017**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**CERCLIS #63**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**74 °F and Overcast**

Remedy Includes: *(Click all that apply)*

☒ Landfill Cover/Containment
☒ Access Controls
☒ Institutional Controls
☐ Groundwater Pump and Treatment
☐ Surface Water Pump and Treatment
☐ Monitored Natural Attenuation
☐ Groundwater Containment
☐ Vertical Barriers

☒ Other Soil Vapor Extraction

Attachments: ☐ Inspection team roster attached ☐ Inspection team roster attached

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 10/12/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

Problems/Suggestions: ☐ Report Attached

2. **O&M Staff:** Richard Feagin (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 10/11/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4416

Problems/Suggestions: ☐ Report Attached

Attachment G-1. Five-Year Review Site Inspection Checklist – D-Area Operable Unit *(continued)*

II. INTERVIEWS *(Click all that apply) (Continued)*

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

Agency: ____________________

Contact: ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

Agency: ____________________

Contact: ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

Agency: ____________________

Contact: ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

4. **Other Interviews** *(Optional):* ☐ Report Attached ____________________

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Click all that apply)*

1. **O&M Documents:**

☐ O&M Manual	☐ Readily Available	☐ Up to Date	☒ N/A
☒ As-Built Drawings	☒ Readily Available	☒ Up to Date	☐ N/A
☐ Maintenance Logs	☐ Readily Available	☐ Up to Date	☒ N/A

Remarks: See *Waste Unit Inspection and Maintenance*, ER-SOP-019 and *D-Area Coal Pile Runoff Basin Field Inspection Checklist*, ER-IDS-019-067, *D-Area Bubble Tower Field Inspection Checklist*, ER-IDS-019-068, *D-Area Asbestos Pit Field Inspection Checklist*, ER-IDS-019-069, *D-Area Operable Unit Field Inspection Checklist*, ER-IDS-019-072

Attachment G-1 Five-Year Review Site Inspection Checklist – D-Area Operable Unit *(continued)*

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)*

2. Health and Safety Plans (HASPs):

☐ Site-Specific Health and Safety Plans ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Contingency Plan/Emergency Response Plan ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.120.HAZWOPER. A SSHASP is prepared if needed.

3. O&M and OSHA Training Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix.

4. Permits and Service Agreements:

☒ Air Discharge Permit ☒ Readily Available ☒ Up to Date ☐ N/A
☒ Effluent Discharge ☒ Readily Available ☒ Up to Date ☐ N/A
☐ Waste Disposal; POTW ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Other Permits ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks: SCDHEC Air Quality Permit, NPDES Permit SC 0000175

5. Gas Generation Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

6. Settlement Monument Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

7. Groundwater Monitoring Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks:

8. Leachate Extraction Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

9. Discharge Compliance Records:

☒ Air ☒ Readily Available ☒ Up to Date ☐ N/A
☒ Water (Effluent) ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks:

10. Daily Access/Security Logs: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Daily Operational Log

Attachment G-1. Five-Year Review Site Inspection Checklist – D-Area Operable Unit *(continued)*

IV. O&M COSTS

1. O&M Organization:

☐ State In-House
☐ PRP In-House
☒ Other: SRS
☐ Contractor for State
☐ Contractor for PRP

2. O&M Cost Records:

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review

Total annual cost by year for review period, if available

From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached

3. Unanticipated or Unusually High O&M Costs During Review Period

Describe costs and reasons: ______

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing Damage: ☒ Location shown on site map ☒ Gates secured ☐ N/A

Remarks: OU-specific perimeter fencing is not required by the remedial action. However, access to D-Area is controlled by a locked gate and is monitored by SRS security personnel.

B. Signs

1. Signs and Other Security Measures: ☐ Location shown on site map ☐ N/A

Remarks: Signs are in good condition

Attachment G-1. Five-Year Review Site Inspection Checklist – D-Area Operable Unit *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Once in 5 years
Responsible Party/Agent: USDOE Savannah River Field Office
Contact: Karen Adams (Name) Federal Project Director (Title) 12/15/17 (Date) 803-952-7871 (Phone No.)

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

2. Adequacy: ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks:

D. General

1. Vandalism/Trespassing: ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

2. Land use changes onsite: ☒ N/A
Remarks:

3. Land use changes offsite: ☒ N/A
Remarks:

Attachment G-1. Five-Year Review Site Inspection Checklist – D-Area Operable Unit *(continued)*

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. Roads damaged: ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks:

B. Other Site Conditions

Remarks: Vegetation mowed routinely. Annual site inspections performed during the period FY2012 through FY2017 identified the presence of ant mounds, pine samplings growing on the D-Area Asbestos Pit cover, and minor erosion of the D-Area Asbestos Pit cover. These findings were resolved soon after discovery.

VII. LANDFILL COVER/CONTAINMENT ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. Pumps, Wellhead Plumbing, and Electrical:
☒ Good Condition ☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks:

2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances:
☒ Good Condition ☐ Needs Maintenance
Remarks:

3. Spare Parts and Equipment:
☒ Readily Available ☒ Good Condition ☐ Requires Upgrade ☐ Needs to be provided
Remarks:

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

Attachment G-1. Five-Year Review Site Inspection Checklist – D-Area Operable Unit *(continued)*

IX. GROUNDWATER/SURFACE WATER REMEDIES *(Continued)*

C. Treatment System ☒ Applicable ☐ N/A

1. Treatment Train (Check components that apply)**:**

☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☐ Carbon adsorbers
☐ Filters________________
☐ Additive (e.g., chelation agent, flocculent)________________
☐ Others________________
☐ Good Condition ☐ Needs maintenance
☐ Sampling ports properly marked and function
☐ Sampling/maintenance log displayed and up-to-date
☐ Equipment properly identified
☐ Sampling ports properly marked and function
☐ Quantity of groundwater treatment annually________________
☐ Quantity of surface water treatment annually________________
Remarks:________________

2. Electrical Enclosures and Panels *(properly rated and function)***:**

☒ N/A ☐ Good Condition ☐ Needs maintenance
Remarks:________________

3. Tanks, Vaults, Storage Vessels:

☒ N/A ☐ Good Condition ☐ Proper secondary containment ☐ Needs maintenance
Remarks:________________

4. Discharge Structure Appurtenances:

☒ N/A ☐ Good Condition ☐ Needs maintenance
Remarks:________________

5. Treatment Building(s):

☒ N/A ☐ Good Condition (especially roof and doorways ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks:________________

Attachment G-1. Five-Year Review Site Inspection Checklist – D-Area Operable Unit *(continued)*

IX. GROUNDWATER/SURFACE WATER REMEDIES *(Continued)*

6. Monitoring Wells *(pump and treatment remedy)***:**

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs maintenance ☐ N/A

Remarks:

D. Monitoring Data ☒ Applicable ☐ N/A

1. Monitoring Data:

☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring Data:

☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

E. Monitored Natural Attenuation ☐ Applicable ☒ N/A

X. OTHER REMEDIES

If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

A. Soil Vapor Extraction System ☒ Applicable ☐ N/A

1. Blowers, Wellhead Plumbing, and Electrical:

☒ Good Condition ☒ All required wells located ☐ Needs maintenance ☐ N/A

Remarks: SVE systems at the Bubble Tower Subunit

2. Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances:

☒ Good Condition ☐ Needs maintenance

Remarks:

3. Spare Parts and Equipment:

☒ Readily Available ☒ Good Condition ☐ Requires Upgrade ☐ Needs to be provided

Remarks:

Attachment G-1. Five-Year Review Site Inspection Checklist – D-Area Operable Unit *(continued/end)*

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

The remedial action for the DAOU is SVE with MicroBlowers^{TM} to prevent the migration of VOCs from the contaminated soils to groundwater above the MCLs, a 1-foot soil cover to protect remedial workers and future industrial workers from unacceptable exposure to VOCs and institutional controls (i.e., LUCs). The SVE system is operating at the Bubble Tower Subunit and is functioning as expected.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The O&M procedures are adequately maintaining the integrity of the Bubble Tower Subunit SVE system. The O&M procedures consisting of annual site inspections and site maintenance (cover system and warning signs) and site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the OU) have been implemented. There are no issues requiring corrective actions

C. Early Indicators of Potential Remedy Failure

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Recommendations provided in the OU-specific review report (Table G-5).

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Attachment G-2. D-Area Bubble Tower Subunit SVE Monitoring Report

Introduction

MicroBlower™-equipped soil vapor extraction (SVE) wells are installed and operating at eleven locations associated with the D-Area Bubble Tower Subunit of the D-Area Operable Unit (DAOU). The SVE system is located within the areal extent of the vadose zone contaminated with tetrachloroethylene (PCE) (Figure G-2-1). Construction was completed on November 8, 2010 with operation of the SVE system beginning November 9, 2010.

The Bubble Tower Subunit is approximately 38.6 hectares (95 acres) in area and includes the bubble towers, firefighting training facility, and the 717-D Maintenance Facility. These facilities have undergone deactivation and demolition and only the concrete building slabs and residual soil contamination remain. An area east of the 717-D Maintenance Facility was identified as a source zone for PCE contamination and the focus of the SVE operations. In general, there is a vertical trend of increasing concentration with depth in the soil column to the water table. It is estimated the area requiring treatment is approximately 980 m^2 (10,890 ft^2) with a total depth of 3 m (10 ft).

Based on the contaminant fate and transport evaluation, PCE was identified as a contaminant migration refined constituents of concern (CM RCOC) exceeding the CM threshold of 20 µg/kg in soil (SRNS 2011a). The remedial action objective (RAO) is to prevent migration of PCE from vadose zone soil to groundwater at concentrations exceeding MCLs.

The SVE wells are constructed of 0.6-m (2-in) schedule 40 polyvinyl chloride pipe with 1.5 m (5 ft) screens placed 1.5 to 3 m (5 to 10 ft) below ground surface (bgs) for each well. The depth to water is approximately 3 to 3.6 m (10 to 12 ft) bgs (SRNS 2009). The MicroBlower™ system likely removed the bulk of the PCE within the vadose zone early in the operation period. At the time the representatives from U.S. Department of Energy, U.S. Environmental Protection Agency, and South Carolina Department of Health and Environmental Control determined that degradation to groundwater has been halted and/or the threat to groundwater has been eliminated, SRS will collect confirmatory soil samples to ensure the PCE RG of 20 µg/kg of soil has been met.

Data Summary

Calculations based on flow rates, run times, and contaminant concentrations have determined that approximately 18 (39.6 lbs) of PCE have been removed from the soils at the Bubble Tower Subunit over the period 2010 through 2016 (Table G-2-1). Additionally, trichloroethylene (TCE) (3.8 kg [8.3 lbs]) (Table G-2-2) and 118 kg (260 lbs) of other contaminants have also been removed (Table G-2-3), which are mainly compounds typically found in petroleum products and are associated with the 717-D Maintenance Facility. The wells were sampled semiannually and flow measurements were also collected. Although flow measurements are variable based on time of year, the time of day sampled, and weather conditions, an overall average of 2 ft^3/min is used to calculate the total mass removed for all the wells. It is also assumed that the MicroBlowers™ operate for approximately 12 hours/day.

As shown in the contaminant tables, the majority of the contaminants were removed during 2010, 2011, and 2012. Afterward, contaminant removal has greatly diminished or ceased. The average concentration of PCE for the eleven SVE wells during 2011 was 4.13 ppmv and the average during 2016 was 0.0071 ppmv, showing a near 600 times decrease in PCE concentrations. The average concentration of TCE for the eleven SVE wells during 2010 was 4.37 ppmv and the average during 2016 was 0.00089 ppmv, showing a near 5,000 times decrease in TCE concentrations. Figure G-2-2 displays the cumulative mass removal of PCE and TCE from 2010 through 2016 and demonstrates how the majority of the contaminants have been removed in the first few years of operation. The petroleum related chemicals also display similar contaminant trends.

Summary of Operation

The DAOU Bubble Tower Subunit remediation by SVE via eleven 0.6-m (2-in) SVE wells with MicroBlower™ was initiated on November 9, 2010. An internal exemption from air permitting based upon calculations of potential to emit (PTE) of TCE and PCE was obtained prior to startup. The MicroBlower™ wells ran without incident from November 9, 2010 until December 17, 2010. A reevaluation of the PTE for air emission was conducted in this time frame considering the possible impact of petroleum products known to have been in the area. All eleven SVE wells were sampled on December 15, 2010 and the vapor samples analyzed. On December 18, 2010, all eleven MicroBlower™ wells were shut down to evaluate the results of the vapor sampling and the reconsideration of possible air emissions. An additional sampling event occurred on March 3, 2011 when the MicroBlower™ wells were temporarily restarted for the sampling of vapors from each of the SVE wells. The internal exemption was revised May 24, 2011 to account for additional constituents from the co-located petroleum products. The MicroBlower™ wells remained down until May 26, 2011 when all eleven MicroBlower™ wells were brought back on-line.

The MicroBlower™ wells have operated since May 26, 2011 through the duration of this reporting of December 31, 2016. Individual MicroBlower™ wells have gone down on occasion due to a variety of causes, but all eleven MicroBlower™ wells have operated from approximately 28,000 to 29,500 hours since starting on November 9, 2010. During 2012 through 2016, the MicroBlower™ wells have been operating between 95% to near 100% of the time.

References

SRNS, 2009. *RCRA Facility Investigation/Remedial Investigation (RFI/RI) Work Plan and RFI/RI Report with Baseline Risk Assessment for the D-Area Operable Unit (U),* WSRC-RP-2007-4079, Revision 1.1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2011. *Early Action Record of Decision Remedial Alternative Selection for the D-Area Operable Unit (U),* SRNS-RP-2010-00162, Revision 1.2, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

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Figure G-2-1. Layout of SVE wells for the DAOU Bubble Tower Subunit MicroBlower™ System

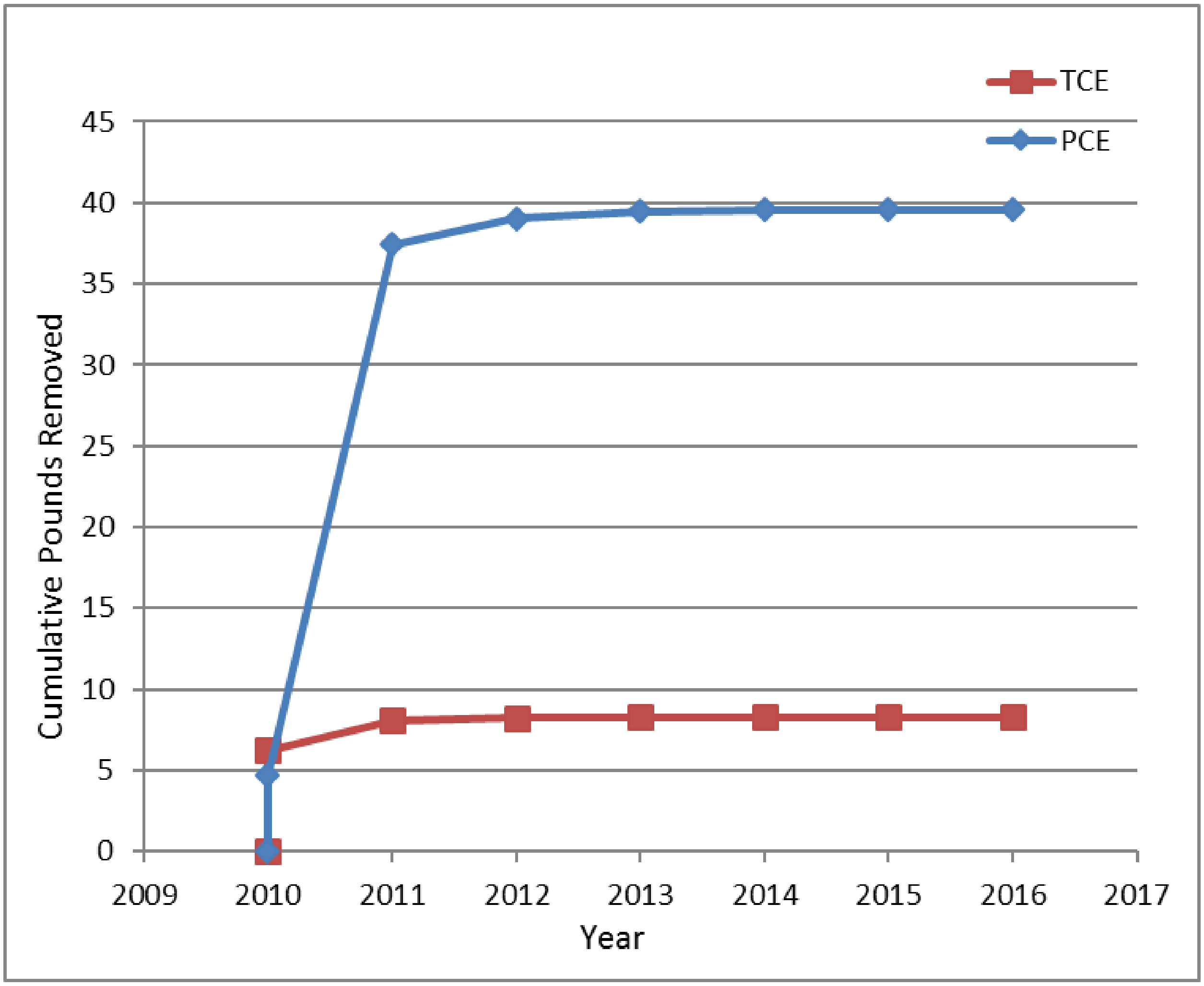

Figure G-2-2. Cumulative PCE and TCE Mass Removed by Year

Table G-2-1. Average PCE Concentrations and Mass Removed (lbs) in the Off-Gas for the DAOU Bubble Tower Subunit SVE wells per Well per Year

	2010		2011		2012		2013		2014		2015		2016		Well Totals
	Concentration (ppmv)	Pounds Removed	Concentration (ppmv)	Pounds Removed	Concentration (ppmv)	Pounds Removed	Concentration (ppmv)	Pounds Removed	Concentration (ppmv)	Pounds Removed	Concentration (ppmv)	Pounds Removed	Concentration (ppmv)	Pounds Removed	
DSVE001	0.057	0.013	0.0062	0.001	0.013	0.003	0.013	0.003	0.007	0.001	0	0	0.0039	0.001	**0.022**
DSVE002	0.048	0.011	0.0078	0.002	0.0047	0.001	0	0	0.003	0.001	0	0	0.0026	0.001	**0.015**
DSVE003	0.434	0.096	0.008	0.002	0.2885	0.064	0.027	0.006	0.0165	0.004	0	0	0.0225	0.005	**0.176**
DSVE004	0.059	0.013	0.0038	0.001	0.0051	0.001	0.0016	0.000	0.0015	0.000	0	0	0.0135	0.003	**0.019**
DSVE005	0.056	0.012	0.0044	0.001	0.0061	0.001	0.001	0.000	0	0	0	0	0.0055	0.001	**0.016**
DSVE006	0.189	0.042	0.0702	0.016	4.7745	1.060	0.24	0.051	0.0153	0.003	0	0	0.0026	0.001	**1.173**
DSVE007	0.426	0.095	0.0232	0.005	0.0061	0.001	0.0172	0.004	0	0	0	0	0.005	0.001	**0.106**
DSVE008	NS	NS	44.195	9.815	1.87	0.415	1.75	0.367	0.25	0.053	0.001	0.000	0.0042	0.001	**10.651**
DSVE009	30.251	6.718	0.2112	0.047	0.3025	0.067	0.0245	0.005	0.0089	0.002	0.0018	0.000	0.006	0.001	**6.841**
DSVE010	4.286	0.952	0.5798	0.129	0.0055	0.001	0	0	0	0	0	0	0.0085	0.002	**1.084**
DSVE011	8.038	1.785	0.2996	0.067	0.0167	0.004	0	0	0.0011	0.000	0	0	0.0039	0.001	**1.856**
Yearly Totals		**4.660**		**32.760**		**1.620**		**0.436**		**0.064**		**0.001**		**0.017**	**39.558**

NS – Not sampled; 0 Concentration – Not Detected.

Table G-2-2. Average TCE Concentrations and Mass Removed (lbs) in the Off-Gas for the DAOU Bubble Tower Subunit SVE wells per Well per Year

	2010		2011		2012		2013		2014		2015		2016		Well Totals
	Concentration (ppmv)	Pounds Removed	Concentration (ppmv)	Pounds Removed	Concentration (ppmv)	Pounds Removed	Concentration (ppmv)	Pounds Removed	Concentration (ppmv)	Pounds Removed	Concentration (ppmv)	Pounds Removed	Concentration (ppmv)	Pounds Removed	
DSVE001	0.0028	0.001	0.0028	0.001	0.0012	0.004	0	0	0	0	0	0	0	0	**0.005**
DSVE002	0.0012	0.000	0.0022	0.000	0	0	0	0	0	0	0	0	0	0	**0.001**
DSVE003	0.434	0.096	0.0024	0.001	0.0145	0.003	0	0	0	0	0.001	0.000	0.0014	0.000	**0.101**
DSVE004	0.059	0.013	0.0026	0.001	0	0	0	0	0	0	0	0	0.0015	0.000	**0.014**
DSVE005	0.056	0.012	0.0022	0.000	0	0	0	0	0	0	0.0015	0.000	0.0013	0.000	**0.014**
DSVE006	0.189	0.042	0.0112	0.002	0.1123	0.025	0	0	0.0038	0.001	0.0013	0.000	0	0	**0.071**
DSVE007	0.426	0.095	0.0148	0.003	0.0014	0.000	0.0185	0.004	0.0013	0.000	0.001	0.000	0.0055	0.001	**0.104**
DSVE008	NS	NS	3.091	0.686	0.35	0.078	0.15	0.031	0.0395	0.008	0	0	0	0	**0.804**
DSVE009	30.251	6.718	0.0284	0.006	0.057	0.013	0	0	0.0021	0.000	0.0013	0.000	0	0	**6.738**
DSVE010	4.286	0.952	0.04	0.009	0	0	0	0	0	0	0	0	0	0	**0.961**
DSVE011	8.038	1.785	0.0184	0.004	0.0019	0.000	0	0	0	0	0	0	0	0	**1.790**
Yearly Totals		**6.260**		**1.840**		**0.123**		**0.036**		**0.010**		**0.001**		**0.002**	**8.272**

NS – Not sampled; 0 Concentration – Not Detected.

Table G-2-3. Petroleum Products Mass Removed (lbs) in the Off-Gas for the DAOU Bubble Tower Subunit SVE wells per Year

	2010	2011	2012	2013	2014	2015	2016	Total
BTEX	NS	41.43	57.76	88.20	NS	0.78	0.16	**188.33**
Hexane	NS	37.9	10.64	7.15	NS	0	0.01	**55.70**
Methyl Isobutyl Keton	NS	5.51	0.79	1.26	NS	0	0	**7.56**
Methyl Ethyl Ketone	NS	0.17	6.09	1.87	NS	0.01	0	**8.14**
Isopropyl Benzene	NS	0.28	0.09	0.10	NS	0	0	**0.47**
								260.20

NS – Not sampled; 0 – No contaminants removed.

F-AREA GROUNDWATER OPERABLE UNIT

I. Introduction

This is the fifth five-year review for the F-Area Groundwater Operable Unit (OU). This review was conducted from August 2017 through November 2017. The review for this unit is conducted under the Savannah River Site (SRS) Resource Conservation and Recovery Act (RCRA) program. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) review requirements are met by the RCRA program; therefore, a separate review of the RCRA Corrective Action is not duplicated in this document. Contaminants remaining at the F-Area Groundwater OU are at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the F-Area Groundwater OU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table H-1 lists the chronology of site events for the F-Area Groundwater OU.

III. Background

F-Area Groundwater OU, a media-specific OU, is listed as a RCRA unit in Appendix C of the Federal Facility Agreement for the SRS (FFA 1993). The media associated with the F-Area Groundwater OU is groundwater.

The F-Area Groundwater OU is the groundwater associated with the F-Area Hazardous Waste Management Facility (HWMF) OU.

Physical Characteristics

The F-Area Groundwater OU lies in the central portion of SRS; approximately 8 km (5 mi) from the nearest site boundary (Figure H-1). The groundwater contamination plume associated with the three earthen unlined F-Area HWMF basins is called the F-Area Groundwater OU and is observed in a zone, which extends from the water table surface to approximately 15 m (50 ft) below ground surface and covers an area of approximately 81 hectares (200 acres).

Land and Resource Use

According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The *Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999) designates the F-Area Groundwater OU as being within an industrial area. The future land use for the F-Area Groundwater OU is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

The F-Area HWMF operated from 1955 until 1988. During that time, the facility received approximately 1.8 billion gallons of low-level waste effluents from F-Area chemical separations facilities such as the nitric acid recovery unit, waste storage system evaporator overheads, and general-purpose evaporator overheads. The effluents were acidic (wastewater with nitric acid) and low-activity waste solution containing a wide variety of radionuclides and dissolved metals. Tritium was the primary radionuclide released to the basins.

Initial Response

A groundwater monitoring network was installed in the 1950s. In 1986, the determination was made that the basins should be regulated under RCRA as hazardous waste disposal facilities, and closure plans were initiated. The basins were closed by dewatering, physically and chemically stabilizing the remaining sludge, and covering them with a protective multi-layer system to reduce rainwater infiltration. The basin closures were completed in 1991.

In 1992, South Carolina Department of Health and Environmental Control (SCDHEC) issued to SRS a RCRA Permit Renewal that specified ongoing groundwater monitoring requirements and a Corrective Action Plan to remediate the contaminated portions of the uppermost groundwater aquifer. Several of the contaminants exceeded regulatory limits and were targeted for remediation.

Basis for Taking Action

The maximum detected levels of several contaminants (e.g., tritium, iodine-129, and strontium-90) in the F-Area groundwater currently exceed the National Primary Drinking Water Standards and state standards (i.e., maximum contaminant levels [MCLs]). However, potential exposures to the general public are minimized by the distance from the OU to the site boundary, natural attenuation and radionuclide decay, institutional controls (i.e., land use controls [LUCs]), and dilution in receiving streams. The remediation of the F-Area Groundwater OU was designed to meet, as far as practicable, the groundwater protection standards (GWPS) outlined in the 1992 SRS RCRA Permit Renewal.

The constituents for which monitoring is required are shown in Table H-2. These constituents are identified in the current SRS RCRA Permit Renewal (SCDHEC 2017) and listed in the Interim Action Record of Decision (IROD) (WSRC 1995). These constituents are monitored because they were detected at concentrations above the GWPS established in the 1992 SRS RCRA Permit Renewal.

IV. Remedial Actions

Remedy Selection

An IROD for the F-Area Groundwater OU was issued in April 1995 (WSRC 1995). A final Record of Decision (ROD) for the F-Area Groundwater OU has not been issued. The final action for this media-specific OU will be documented by modifications to the RCRA permit renewal.

The selected interim action under CERCLA is no further action beyond that required by the corrective action as identified in the SRS RCRA Permit Renewal. As specified in the SRS RCRA Permit Renewal, the goal of remediation of the F-Area Groundwater Operable Unit is to lower contaminant concentrations in the groundwater associated with the F-Area HWMF to levels specified in the RCRA permit renewal and to minimize the discharge of contaminants to the adjacent stream. Under RCRA, the corrective action for the F-Area HWMF commenced in 1989, was certified closed in February 1991, and certification of closure was approved by SCDHEC in April 1991 (WSRC 1995). The remedial action objectives (RAOs) of the interim remedial action are to address the potential ecological impacts at the seeplines along Fourmile Branch and to address the ambient water quality standards in Fourmile Branch by remediating this OU (WSRC 1995).

The SRS RCRA Permit Renewal set forth a phased approach to remediating the groundwater that required documented evaluations of the performance of the system to determine effectiveness toward meeting the RAOs. The Phase 1 remedy involved groundwater recovery and hydraulic control with treatment of mobile hazardous constituents and radionuclides (except tritium and nitrates) and injection of treated water into the shallow aquifer at the upgradient extent of the plume. The evaluation of this remedy (WSRC 2001) facilitated the following phased success measures to reach the RAOs that are in the current SRS RCRA Permit Renewal (SCDHEC 2017):

- Phase 1: Implement a groundwater extraction and injection system to capture and remediate those portions of the contaminant plume delineated by the 10,000 pCi/mL tritium isoconcentration contour;
- Phase 2A-1: Before October 31, 2012, reduce the mass flux (Curies/year) of tritium discharging from the F-Area plume to Fourmile Branch by 70%;
- Phase 2A-2: Before October 31, 2017, reduce the concentration of the remaining Appendix IVB-A (SCDHEC 2017) constituents in Fourmile Branch (except tritium and iodine-129) to levels that are less than GWPS as measured at Surface Water Sampling Stations FMC-002F and FMA-7U;
- Phase 2A-3: Before October 31, 2025, reduce the concentration of iodine-129 in Fourmile Branch to levels that are less than the GWPS;
- Phase 2A-4: Develop and test practicable technologies to be employed for the 2B goals (except tritium);

- Phase 2B-1: Before July 31, 2020, reduce the discharge from the F-Area plume of all Appendix IVB-A (SCDHEC 2017) constituents in the surface water at the seepline to concentrations less than the GWPS (except tritium and iodine-129);
- Phase 2B-2: Before October 31, 2030, reduce the discharge from the F-Area plume of iodine-129 in the surface water at the seepline to a concentration less than the GWPS as measured at Wetland Seepline Surface Water Sampling Locations FAS-91, FAS-92, FAS-93, FAS-96, and FAS-103;
- Phase 2B-3: Give consideration to technical and economic feasibility of performing these remedial actions successfully; and
- Phase 3: Capture and remediate the entire contaminant plume above those concentrations listed in the GWPS (SCDHEC 2017) and/or evaluate the applicability of Alternate Concentration Limits and/or a Mixing Zone.

Remedy Implementation

Consistent with the phased approach of the RCRA permit renewal, the implementation of the remedy was structured to prevent the plumes from further migration and discharge to Fourmile Branch, treat and/or attenuate the contaminant plumes at and approaching the OU boundary (Fourmile Branch), and treat and/or attenuate all contaminants within the OU. Except for the initial treatment (pump-treat-reinjection), the permit identifies that development work would be needed to select and implement technologies to address the unique conditions presented at this OU. While the treatments that are and have been part of the remedy for this OU are presented chronologically in the following paragraphs, they work synergistically to address the permit requirements and RAOs.

Active Treatment with Pump – Treat - Reinjection

In 1997, SRS designed and built a pump-and-treat system using a water treatment unit (WTU) with a network of injection and extraction wells. The remediation system extracted groundwater downgradient of the seepage basins, passed it through the WTU to remove metals and radionuclides, and re-injected the treated water upgradient to maintain the recirculation loop. To reduce the migration of tritium to Fourmile Branch, the system lengthened the tritium pathway in the extraction/reinjection loop, which allowed more time for tritium decay prior to discharging to Fourmile Branch. Over the course of pump-and-treat operations, due to increased water volume and gradient from injection of treated water, the effectiveness of the system on reducing tritium flux to Fourmile Branch had diminished. This prompted termination of operations and implementation of new corrective actions (subsurface barriers and gates, and base injection). Operation of the pump and treat system was suspended October 2003 upon receipt of conditional approval by SCDHEC.

Passive Control of Water Table Gradients and pH Treatment

After successful completion of a small-scale pilot study to demonstrate that raising the pH value of the F-Area groundwater will immobilize metals, a subsurface barrier and gate system and base (alkaline) solution injection system were constructed, replacing the ineffective groundwater pump-and-treat unit. In June 2005, the operation of the base injection system commenced. Base injection operations are currently ongoing. During June 2008, the base injection system was expanded to treat groundwater beneath the wetlands by injecting base through a series of injection wells. The engineered groundwater barriers were expanded in 2010 to add an additional gate and footage of wall. Operations in the new gate commenced in 2011.

The barriers were constructed across the preferential groundwater flow paths leading to the wetlands adjacent to Fourmile Branch. The subsurface barrier and gate system reduces the groundwater flow velocity (allowing more time for radioactive decay) and controls the flux of contaminants to Fourmile Branch. Within the gates, base injection is operated to immobilize metals and metallic radionuclides. With the expansion of the system, the barrier, composed of low permeability amendments, consists of four walls totaling 750 m (2,500 ft) in length and three gates/funnels. Construction utilized an in-situ soil mixing technique to blend acid resistant pozzolan cement and attapulgite clay with native soils. A small percentage of caustic was also added to the cement to facilitate curing. Upon hardening, the resulting soil/cement mixture formed a low permeability (less than

1E-06 cm/s) subsurface barrier approximately 0.75 m (2.5 ft) thick on average. Vertically the wall was installed from just below ground surface to the base of the upper aquifer zone. The location of the original barrier, the extension, and the injection wells are shown in Figure H-2.

A silver chloride injection field pilot study began in March 2009 to test the potential to capture iodine-129 and form stable, insoluble silver iodide. The pilot study was effective, and a field scale demonstration was implemented in the small central gate. SCDHEC approved a permit modification allowing full-scale operation effective July 20, 2011. SRS injected half of the permitted and purchased quantity in 2011 and injected the remaining quantity on hand in 2015. SRS is proposing to inject additional silver chloride at the central gate in fiscal year (FY) 2018.

System Operations/Operation and Maintenance

Remedial activities are still in progress that require operations and maintenance (O&M).

Since 2005, the base injection system that stabilizes the pH in the target zone has operated with periodic injections of base to maintain pH downgradient of the barrier to support sorption of the metals and metallic radionuclides. Since 2005, 234.7 million L (62.0 million gal) of base solution were injected through the barrier wall gates. Beginning in 2008, 151 million L (39.9 million gal) of base solution have been injected through individual injection ports in the wetlands. Additionally, a total of 385.7 million L (101.9 million gal) of base solution have been injected into the subsurface.

The injection of silver chloride into the plume at the central gate to stabilize iodine-129 as silver iodide occurred in 2011 and was continued in 2015. Approximately 655,000 L (173,000 gal) of the ultra-fine ground silver chloride suspension (water + silver chloride amendment) was placed into the subsurface during the two deployments. Based on the pilot test and the two rounds of injection at the central gate, silver chloride has been demonstrated effective at sequestering iodine-129 in situ. Variations in the degree of reduction have been observed during each deployment. Monitoring points closest to the injection show the greatest reduction in concentration and wells further away show less of an impact. Achieving an adequate treatment zone for iodine-129 within the central gate will require additional deployments of silver chloride. SRS is proposing to inject additional silver chloride at the central gate in FY2018. An Underground Injection Control permit application will be developed and submitted for approval (SRNS 2016a).

Costs associated with the selected interim remedy for F-Area Groundwater include O&M costs of the WTU, base injection, and institutional controls (i.e., LUCs). The actual O&M cost during FY2012 to FY2017 is $3,582,920. RCRA documentation does not require estimated project costs to be prepared. Therefore, none are included in this remedy review.

V. Progress since Last Review

The previous protectiveness statement concluded that the interim remedial actions at the F-Area Groundwater OU are expected to be protective, and in the interim, exposure pathways that could result in unacceptable risks are being maintained by engineered subsurface barriers and a base injection treatment system and are monitored by the groundwater monitoring network, which have all been functioning properly.

Recommendations and follow-up actions from the last five-year review included opportunities to optimize the monitoring system. Implementation of the optimization opportunities is discussed in Section VII. Technical Assessment.

The following actions have been completed:

- Silver chloride injection - Conducted two deployments at the central gate and concluded that the silver chloride effectively sequesters iodine-129 and the silver chloride particles do not migrate a significant distance away from the treatment zone.
- Proposed to inject additional silver chloride at the central gate in FY2018.
- Added silver chloride as a corrective action for iodine-129 at the F-Area HWMF (Revision 2 to the 2000 RCRA Permit Renewal Application, WSRC-IM-98-30, Volume IV).
- Implemented recommendations for optimization of the monitoring system.

Base injection continues – Modifications were made to several of the base injection wells to better direct the base solution to areas of the acid impacted portions of the aquifer that were likely not receiving sufficient base. A silver chloride injection campaign has been scheduled for FY2018.

VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII. Documents Reviewed;
- Confirmed the implemented remedial actions are ongoing. Figure H-3 provides current photographs of the remedial actions;
- Reviewed all process and performance monitoring data provided by the annual groundwater monitoring and corrective action reports and provided a technical assessment of whether the treatment systems are functioning as intended by the IROD and whether the shutdown criteria have been achieved;
- Inspected the OU, interviewed maintenance personnel and documented the results on the Inspection Checklist provided in Attachment H-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls and provided current photos of the treatment system (Figure H-3);
- Ensured that all actions required under the RCRA Permit Renewal were implemented; and
- Reviewed changes in standards and to-be-considered guidance.

Data Review

This OU has a unique set of subsurface conditions, facilitated in part by the carrier fluid for the process waste that was discharged to the seepage basins (groundwater contaminant source). This low pH liquid (acid) leached to the subsurface over a 30-plus year period creating a groundwater plume of low pH that has impacted the geochemistry of the subsurface soils, leaching natural metals and minerals, and minimizing the retardation of contaminants. As recognized by SRS, the pH must be addressed to have success in reaching the RAOs and RCRA permit renewal requirements. Because of the properties of the individual metal and radionuclide contaminants, one remedy will not address all the contaminants. In addition, the only viable approach to tritium, a main contaminant at this site, is increased travel time to receptors to allow for radioactive decay. Thus, the remedial approach implemented at SRS attempts to address all these facets. This technical assessment was conducted to assess progress in addressing the RAOs as per the IROD (WSRC 1995).

Ecological Studies

Ecological studies associated with the F-Area Groundwater OU are conducted as part of the Fourmile Branch Integrator Operable Unit (IOU). These studies include ecological benchmark comparisons that compare ecological screening values (ESVs) to sediment, sediment/soil, and surface water media constituent concentrations. The ESVs are derived from ecologically relevant criteria and standards such as National Ambient Water Quality Criteria. Review of the fifth periodic report for the Fourmile Branch IOU indicates that in terms of community level effects there is no evidence that metals discharged from F Area have degraded fish or macroinvertebrate communities in Fourmile Branch. Aluminum, barium, and mercury may pose a potential threat to wildlife. Aluminum and barium showed a potential threat to wildlife upgradient of SRS operations. Only mercury is a potential issue in lower and middle Fourmile Branch, but there is little evidence that this is associated with discharges from SRS operational areas (i.e., F-Area, H-Area) (SRNS 2016b).

The decrease in pH of the groundwater due to the introduction of the low pH fluid became evident in the wetland areas in the form of a tree-kill zone. The ongoing base injection operations appear to be positively impacting this area. From a visual survey, the tree-kill zone appears to be recovering.

Groundwater and Surface Water Data

As a condition of the RCRA permit renewal for the F-Area HWMF groundwater, SRS annually calculates and reports the tritium flux to Fourmile Branch. As shown in Table H-3, tritium flux discharges have been reduced by 70%.

A review of surface water data from stations FMC002H, FMC002HD, FM2BD, and FMC002F from 1997 to 2016 (was conducted to assess the effect of the F-Area Groundwater OU treatment systems on Fourmile Branch. Table H-4 presents the contaminants that at any time during the review period were detected above the GWPS or MCL. The base injection went into operation in 2005. The data in Table H-4 provides evidence that the base injection operations are having a positive influence on the concentrations of all constituents except for iodine-129. The concentrations of the constituents are decreasing or are below the GWPS and/or MCL. SRS recognizes that iodine-129 will not be treated by the base injection system and thus is investigating and implementing other approaches to remediate the iodine (as discussed below). The data provides evidence that the remedial activities are having a positive impact on the groundwater and Fourmile Branch surface water (Tables H-3 and H-4, respectively). Because all constituents have not reached acceptable levels in the surface water, correction action activities will continue.

A review of the seepline groundwater data from initial sampling in 2001 to 2016 was conducted to assess the effect of the F-Area Groundwater OU treatment systems on the seeplines. Table H-5 provides a summary of constituents from the seepline sampling locations that have exceeded the GWPS or MCL at any time during the period beginning in 2001 and ending December 31, 2016. Review of the seepline data indicates a downward trend in contaminant levels for the majority of constituents. Of the three constituents identified in the ecological studies as potential threats to wildlife, only mercury was detected above standard with concentrations decreasing after the barrier and gate system with base injection became operational.

Summary of Inspections and Interviews

Interviews were conducted with Richard Feagin, O&M staff member, on October 11, 2017 and George Joyner, O&M Site Manager, on October 12, 2017 at the O&M organization offices. No issues were identified for the F-Area Groundwater OU during this interview.

The F-Area Groundwater OU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) and USDOE personnel on November 29, 2017. No issues were identified for the F-Area Groundwater OU during this inspection.

A site inspection will be conducted by U.S. Environmental Protection Agency (USEPA) and SCDHEC personnel, accompanied by USDOE and SRNS personnel, prior to submittal of the Revision 1 of this document. It is anticipated that no significant problems regarding this OU will be identified during the inspection.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The review of documents, Applicable or Relevant and Appropriate Requirements (ARARs), risk assumptions, and results of the site inspection indicate that the remedy is functioning as intended by the IROD. The IROD identifies no further action beyond that required by the SRS RCRA Permit Renewal but stipulates the corrective action will address the potential ecological impacts at the seeplines along Fourmile Branch and will also serve to address the ambient water quality standards in Fourmile Branch by remediating this OU. The implemented treatment strategy is addressing the goal of the remediation, as described in the SRS RCRA Permit Renewal by lowering contaminant concentrations in the groundwater associated with the F-Area HWMF to levels specified in the RCRA permit renewal and to minimizing the discharge of contaminants to the adjacent stream. SRS has met the Phase 1, 2A-1 and 2A-2 goals outlined in the SRS RCRA Permit Renewal and are actively implementing corrective actions to meet the remaining goals.

Ecological assessment of Fourmile Branch indicates no impact from the F-Area HWMF. Of the three constituents (i.e., aluminum, barium, and mercury) identified in the ecological studies as potential threats to wildlife, only mercury was detected above the groundwater standard at the seepline. Review of available data from ecological studies indicate that mercury is a regional problem attributed to atmospheric deposition and upgradient mercury discharges from offsite sources. As part of the Fourmile Branch IOU program, studies of ecological impacts to the Fourmile Branch are ongoing and show that the RAOs of the IROD are being met. The groundwater requirements of the RCRA permit renewal, which the IROD identified must also be satisfied, have not been met. However, the treatment approach is making positive progress towards those requirements. The effective implementation of institutional controls (i.e., LUCs) has prevented exposure to, or ingestion of, contaminated groundwater.

According to the data reviewed, the site inspections, and the interviews, the remedy is functioning as intended by the IROD. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

On February 11, 2014, the SCDHEC originally issued the 2014 RCRA Permit Renewal for the SRS (SCDHEC 2014). The SCDHEC modified the 2014 RCRA Permit Renewal on August 17, 2017, which became effective on September 2, 2017 (SCDHEC 2017). Included in the changes to the permit was an optimization effort associated with this OU. The optimizations for the F Area Groundwater OU included the removal of wells (FSB 115C/D and FSB 116C/D) that were installed in 1990 and have had no discernible contaminant trends since then. These wells were also identified as candidates to reduce sampling for full suite and well pairs providing redundant data. Cyanide and bis(2-ethylhexyl)phthalate were also removed from the permitted constituents list due to sporadic detection, both temporally and spatially, from 2000 through March 2017 (SRNS 2012).

The LUC requirements are discussed and approved as part of the closure/post-closure/permit application process and are governed by the RCRA Permit Renewal for the SRS (SCDHEC 2017). Therefore, a Land Use Control Implementation Plan is not required for this OU. The institutional controls (i.e., LUCs) that are in place to prevent exposure to or ingestion of contaminated groundwater include physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the F-Area Groundwater OU for industrial use only (SRS is a secured government facility with land use restrictions), and use restrictions via the SRS Site Use/Site Clearance Program. No activities were observed that would have violated the institutional controls (i.e., LUCs).

Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Still Valid?

The exposure assumptions, toxicity data, and cleanup levels used at the time of remedy selection are still valid. There have been no changes in standards or to-be-considered guidance identified in the IROD that call into questions the protectiveness of the remedy.

The action specific ARARs have been met with the shutting down and dismantling of the groundwater pump and treat system. The chemical specific ARARs focusing on radiological exposure of the public and personnel and location specific ARARs associated with groundwater remediation must still be met and have been evaluated.

The GWPS set forth in the SRS RCRA Permit Renewal (SCDHEC 2017) for the monitored constituents were compared against MCLs, where available. The comparison found one constituent (arsenic) where the GWPS differed from the MCL, as shown in Table H-6. The GWPS for arsenic is less stringent than the MCL. Review of groundwater arsenic data for the F-Area wells monitored as per the RCRA permit renewal for the period January 2000 through December 2016 found 91 unqualified detects out of 2,963 records. The average detected arsenic concentration is 7.7 µg/L. Of the 91 detects, 16 records were at or above the MCL of 10 µg/L with a maximum value of 90.7 µg/L. These 16 exceedances of the MCL occurred during the time period 2000 through 2006 and are found in five wells. The arsenic groundwater data provide no evidence of an arsenic groundwater issue. Thus, the GWPS being greater than the MCL does not affect the protectiveness of the remedy. The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection are still valid.

Fact sheets provided on the USEPA webpage regarding emerging contaminants were reviewed for applicability to this OU. Due to the widespread usage of chlorinated solvents at SRS and the use of 1,4-dioxane as a stabilizer in chlorinated solvents, paint strippers, greases, and waxes, SRS began sampling for this constituent at selected wells within the F-Area Groundwater OU in 2007. Of the 32 records reviewed from ten wells, all were non-detects, providing evidence that 1,4-dioxane is not a constituent of concern for the F-Area Groundwater OU.

There have been no changes in MCLs (versus GWPS) that would impact the remedy. The remedy is progressing as expected.

Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No new information has come to light that could call into question the protectiveness of the remedy.

VIII. Issues

There are no issues related to current operations, site conditions or activities that currently prevent the remedy from being protective.

IX. Recommendations and Follow-up Actions

There are no recommendations or follow-up actions for F-Area Groundwater OU.

X. Protectiveness Statement(s)

The remedy at the F-Area Groundwater OU is currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled by the barrier wall and base injection treatment systems, groundwater monitoring, and implementation of LUCs including physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), and administrative controls that restrict site use to industrial use only (via the SRS Site Use/Site Clearance Program). Protectiveness of the remedial action will be verified by continued groundwater monitoring.

XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Operating Equipment is scheduled for January 2024.

XII. Documents Reviewed

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

SCDHEC, 2014. *South Carolina Department of Health and Environmental Control Hazardous and Mixed Waste Permit, Permit Number SC1 898 008 989, 2014 RCRA Permit Renewal for the Savannah River Site, issued on February 11, 2014, Module III - Postclosure Care and Module IV – Groundwater Requirements, Section B, F-Area Hazardous Waste Management Facility,* South Carolina Department of Health and Environmental Control, Office of Environmental Quality Control, Bureau of Land and Waste Management, Columbia, SC

SCDHEC, 2017. *South Carolina Department of Health and Environmental Control Hazardous and Mixed Waste Permit, Permit Number SC1 898 008 989, 2014 RCRA Permit Renewal for the Savannah River Site, issued on February 11, 2014, modified on August 17, 2017 and modification effective on September 2, 2017, Module IV – Groundwater Requirements, Section C, H-Area Hazardous Waste Management Facility*, South Carolina Department of Health and Environmental Control, Office of Environmental Quality Control, Bureau of Land and Waste Management, Columbia, SC

SRNS, 2012. *EC&ACP Groundwater Monitoring Optimization Report: A Comprehensive, Technical Approach for the Evaluation and Optimization of Groundwater Monitoring and Reporting (U),* SRNS-RP-2012-0196, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC.

SRNS, 2016a. *2015 Annual Corrective Action Report for the F-Area Hazardous Waste Management Facility, the H-Area Hazardous Waste Management Facility, and the Mixed*

Waste Management Facility (U) Volume I, SRNS-RP-2016-00106, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2016b. *Periodic Report 5 for the Fourmile Branch Integrator Operable Unit (IOU) (U)*, SRNS-RP-2016-00224, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC.

SRNS, 2017. *2016 Annual Corrective Action Report for the F-Area Hazardous Waste Management Facility, the H-Area Hazardous Waste Management Facility, and the Mixed Waste Management Facility (U) Volume I*, SRNS-RP-2017-00134, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 1993. *Final Record of Decision Remedial Alternative Selection for F-Area Hazardous Waste Management Facility (U),* WSRC-RP-93-1042, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1995. *Interim Action Record of Decision Remedial Alternative Selection for F-Area Groundwater Operable Unit (U)*, WSRC-RP-94-1162, Revision 1, Westinghouse Savannah River Company, Aiken, SC

WSRC, 1999. *Land Use Control Assurance Plan for the Savannah River Site*, WSRC-RP-98-4125, Revision 1.1, latest update, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC, 2001. *F-Area HWMF Corrective Action Phase 1 Evaluation*, WSRC-RP-2001-4014, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

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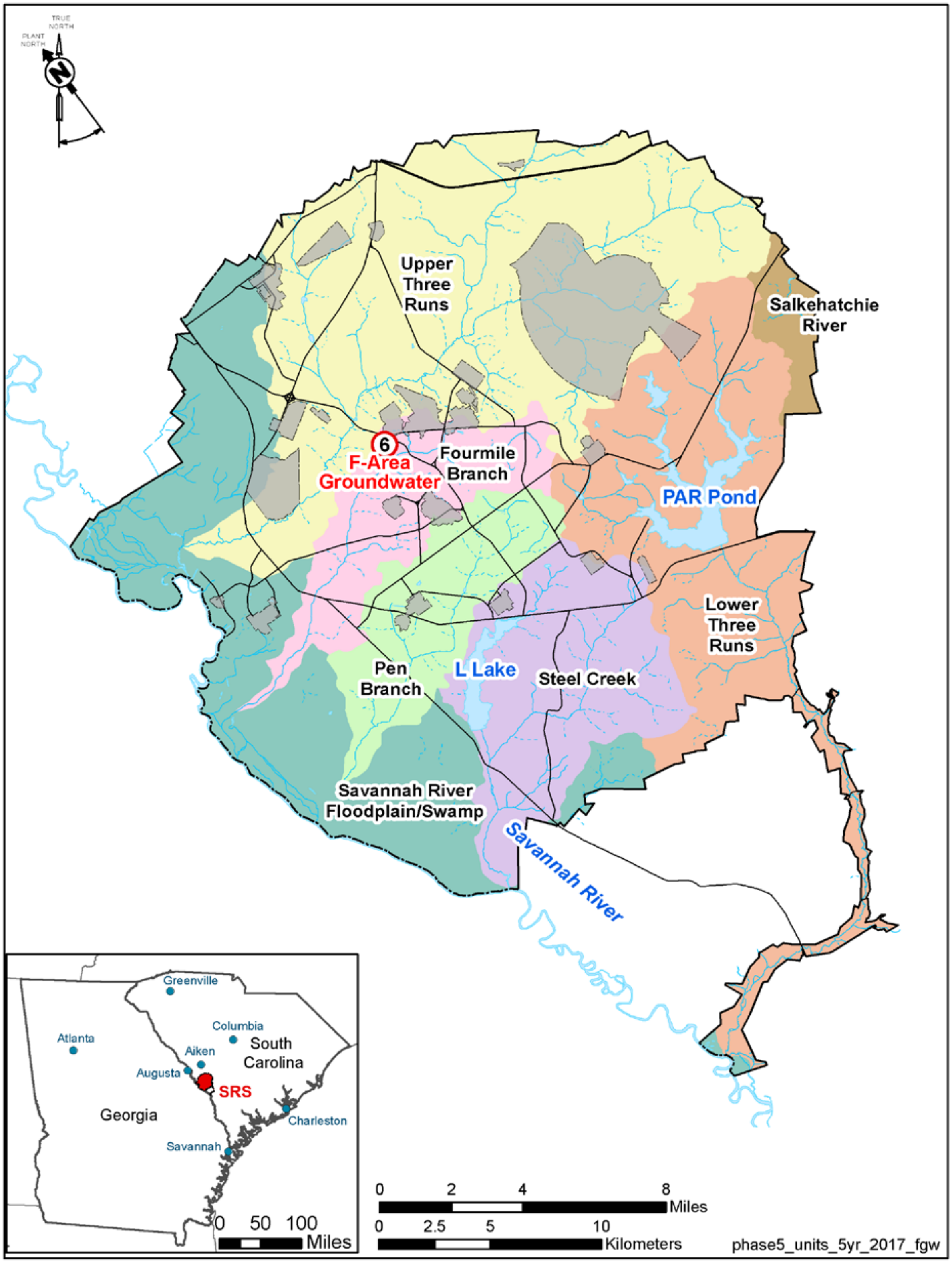

Figure H-1. Location of F-Area Groundwater OU at Savannah River Site

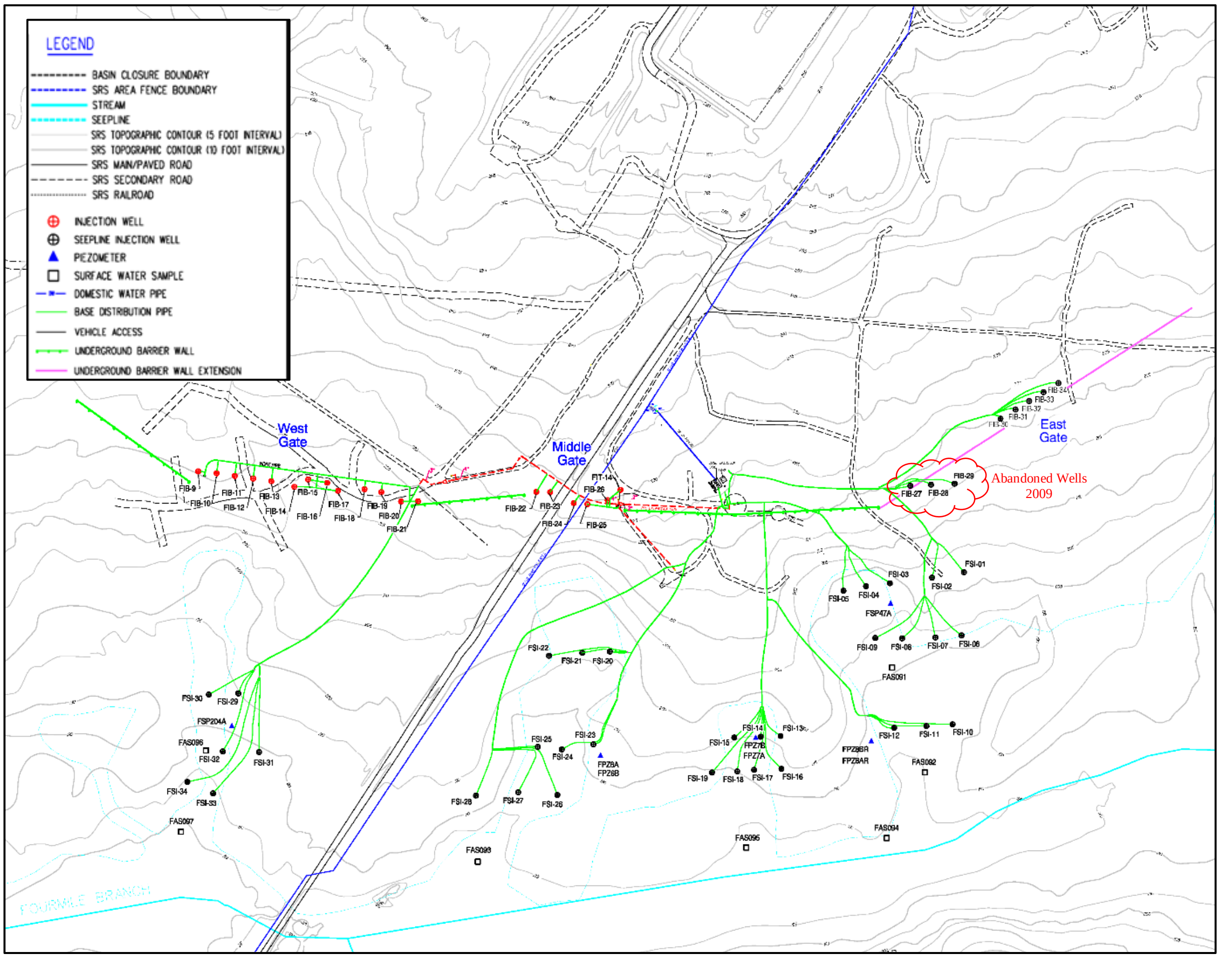

Figure H-2. F-Area Groundwater OU Treatment Systems Locations

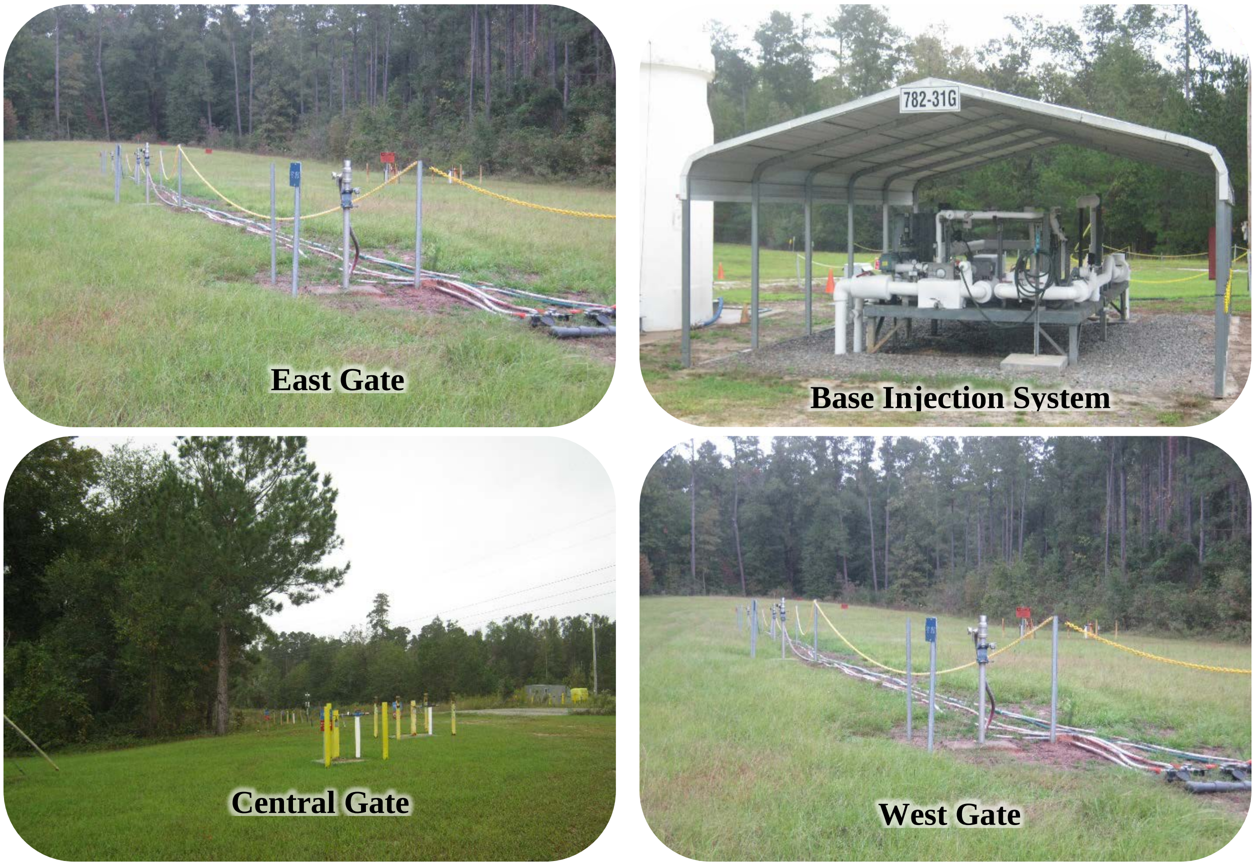

Figure H-3. 2017 Photographs of the F-Area Groundwater Treatment System

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Table H-1. Chronology of OU Events

Event	Date
RCRA Closure Plan Approved	June 1989
Corrective Action start	1989
RCRA Closure Certified	February 1991
IROD Issuance	April 13, 1995
Revised Corrective Action Plan submitted for Alternative Treatment	March 2003
Previous Five-Year Reviews Issuance	June 30, 1997 / February 12, 2004 / February 4, 2009 / February 4, 2014

Table H-2. F-Area Groundwater OU/HWMF Monitored Hazardous Constituents

Inorganics
Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Lead Mercury, Nickel, Nitrate, Selenium, Silver, Thallium, Vanadium, Zinc
Organics
Benzene, Chloroform, Methylene Chloride, Phenols, Tetrachloroethylene, Trichloroethylene, Trichlorofluoromethane
Radionuclides
Gross alpha, Gross (nonvolatile) beta, Total radium, Americium-241, Carbon-14, Cesium-137, Curium-242, Curium-243/244, Curium-246, Cobalt-60, Iodine-129, Plutonium-238, Plutonium-239/240, Radium-226, Radium-228, Strontium-90, Technetium-99, Thorium-228, Thorium-230, Thorium-232, Tritium, Uranium-233/234, Uranium-235, Uranium-238

Per the SRS RCRA Permit Renewal (SCDHEC 2017)

* As listed in Final ROD for F-Area HWMF (WSRC 1993) and IROD for F-Area Groundwater (WSRC 1995), these constituents would not necessarily be identified as final or refined constituents of concern under current protocols. These constituents have not necessarily exceeded their respective MCLs or even been detected in local groundwater.

Table H-3. Summary of Calculated Tritium Flux to Fourmile Branch Associated with the F-Area Groundwater OU

Year	Calculated Tritium Flux (Curies/year)	% Tritium Reduction (Baseline year of 2000)
2000	660[a]	NA
2003	352[a]	46
2004	352[a]	46
2005	254[a]	61
2006	177[a]	73
2007	173[a]	73
2008	168[a]	74
2009	115[a]	82
2010	240[a]	63[b]
2011	117[a]	80
2012	141[a]	79
2013	243[a]	63[c]
2014	256[a]	61[c]
2015	195[a]	70
2016	187[a]	72

a - As reported in the Annual Corrective Action Report (SRNS 2017)

b - Extensive base injection in the wetlands during 2009 and 2010 led to a temporary increase in tritium flux to Fourmile Branch

c - Base injection in the wetlands along with significantly more precipitation than the 30-year average during 2013 led to a temporary increase in tritium flux to Fourmile Branch

Table H-4. Summary of Constituents from the F-Area Groundwater OU Surface Waters of Fourmile Branch Detected Above Standards

Constituent	Unit	GWPS or MCL[1]	Maximum Concentration (µg/L) [# of samples]			
			2nd Remedy Review (1997-2001)	3rd Remedy Review (2002–2006)	4th Remedy Review (2007–2011)	5th Remedy Review (2012–2016)
Cesium-137	pCi/L	50	110 [12]	12.7 [27]	16.1 (J) [40]	11.2 (J) [10]
Cobalt	µg/L	3	4.71 (J) [14]	1.3 [27]	1.22 [21]	4.07 (J) [36][3]
Gross alpha	pCi/L	15	155 [19]	2.71 [51]	2.3 [53]	4.72 (J) [50]
Iodine-129	pCi/L	1	0.642 [10]	5.88 [22]	14.5 [53]	10.1 [58]
Nitrate	µg/L	10,000	665 [23]	4,260 [55]	7,480 [51]	1,120 [44]
Nonvolatile beta	pCi/L	50	207 [19]	26.2 [51]	23.6 [53]	14.8 [50]
Phenols	µg/L	2	ND [10]	ND [21]	58 (J) [11][2]	ND [10]
Radium, total	pCi/L	5	30.3 [15]	0.66 [30]	0.59 [31]	1.35 [22]
Radium-226	pCi/L	5	28.7 [15]	0.64 [38]	0.49 [31]	1.12 [28]
Radium-228	pCi/L	5	22.1 [16]	4.93 [34]	4.08 [24]	1.3 (J) [13]
Strontium-90	pCi/L	8	13.2 [17]	5.5 [18]	5.6 [41]	4.66 (J) [31]
Tritium	pCi/L	20,000	506,000 [25]	625,000 [261]	337,000 [298]	340,000 [335][4]

[1] The more conservative of the MCL or GWPS was used for comparison.

[2] Of the 11 records, 7 were non-detects and 4 were estimated values.

[3] All other records were below the MCL.

[4] FMC-002H had two anomalous results with concentrations of 2,160,000 pCi/L and 1,220,000 pCi/L. The average concentration for the 5th Remedy Review period was 64,000 pCi/L.

ND – Non-detect

J – Estimated Value

Table H-5. Summary of Constituents from the F-Area Groundwater OU Seepline Groundwater Detected Above Standards

Constituent	**Unit**	**GWPS or MCL[1]**	**Maximum Concentration (µg/L) [# of samples]**			
			2nd Remedy Review (1997-2001)	**3rd Remedy Review (2002–2006)**	**4th Remedy Review (2007–2011)**	**5th Remedy Review (2012–2016)**
Beryllium	µg/L	4	21.9 [7]	22.3 [254]	10.8 [283]	3.02 [94]
Cadmium	µg/L	5	14.2 [7]	26.8 [268]	22 [355]	10.8 [367]
Cobalt	µg/L	3	36.7 [7]	373 [264]	294 [337]	96.8 [275]
Gross alpha	pCi/L	15	543 [5]	143 [371]	90.1 [369]	89.9 [379]
Iodine-129	pCi/L	1	1620 [7]	926 [302]	392 [397]	227 [404]
Mercury	µg/L	2	ND [7]	5.89 [272]	2.3 [357]	4.47 [363]
Nitrate	µg/L	10,000	173,000 [6]	259,000 [351]	201,000 [385]	170,000 [370]
Nonvolatile beta	pCi/L	50	1070 [5]	1730 [371]	1870 [369]	613 [379]
Radium, total	pCi/L	5	83.8 [6]	98.4 [254]	90.2 [194]	47.6 [377]
Radium-226	pCi/L	5	77.9 [5]	100.2 [298]	56.3 [370]	39.4 [406]
Radium-228	pCi/L	5	28.3 [6]	417 [294]	279 [369]	181 [402]
Strontium-90	pCi/L	8	393 [6]	802 [174]	392 [380]	256 [378]
Technetium-99	pCi/L	50	791 [5]	403 [308]	146 [266]	123 [369]
Tritium	pCi/L	20,000	5,190,000 [7]	6,530,000 [501]	3,650,000 [564]	1,940,000 [532]
Uranium-233/234	pCi/L	15	238 [6]	113 [307]	48.2 [380]	34.2 [365]
Uranium-238	pCi/L	15	430 [6]	201 [307]	66.4 [380]	45.1 [384]

Note: Analytical data reporting began in 2001.

[1] The more conservative of the GWPS or MCL was used for comparison purposes

Table H-6. Comparison of Permitted GWPS for the F-Area Groundwater versus MCLs

Constituent	**GWPS[1] (µg/L)**	**MCL[2] (µg/L)**
Arsenic	50	10

[1] GWPS as set forth in the SRS RCRA Permit Renewal (SCDHEC 2017)

[2] EPA MCLs

Attachment H-1. Five-Year Review Site Inspection Checklist – F-Area Groundwater Operable Unit

I. SITE INFORMATION

Site Name:	**F-Area Groundwater Operable Unit**	**Date of Inspection:**	**08/30/2017**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**CERCLIS #8**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**75°F and Cloudy**

Remedy Includes: *(Click all that apply)*

☐ Landfill Cover / Containment
☒ Access Controls
☒ Institutional Controls
☒ Groundwater Pump and Treatment
☐ Surface Water Pump and Treatment
☐ Monitored Natural Attenuation
☐ Groundwater Containment
☒ Vertical Barriers

☒ Other Base injection

Attachments: ☐ Inspection team roster attached ☐ Inspection team roster attached

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 10/12/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

Problems/Suggestions: ☐ Report Attached

2. **O&M Staff:** Richard Feagin (Name) EC&ACP Post Closure Waste Site Operations Engineering (Title) 10/11/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.:803-952-4416

Problems/Suggestions: ☐ Report Attached

Attachment H-1. Five-Year Review Site Inspection Checklist – F-Area Groundwater Operable Unit *(continued)*

II. INTERVIEWS *(Click all that apply) (Continued)*

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

Agency: ______________________________

Contact: ____________ ____________ ________ ________
(Name) (Title) (Date) (Phone No.)

Problems/Suggestions: ☐ Report Attached ______________________________

Agency: ______________________________

Contact: ____________ ____________ ________ ________
(Name) (Title) (Date) (Phone No.)

Problems/Suggestions: ☐ Report Attached ______________________________

Agency: ______________________________

Contact: ____________ ____________ ________ ________
(Name) (Title) (Date) (Phone No.)

Problems/Suggestions: ☐ Report Attached ______________________________

4. **Other Interviews** *(Optional):* ☐ Report Attached ______________________________

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Click all that apply)*

1. **O&M Documents:**

☐ O&M Manual	☐ Readily Available	☐ Up to Date	☒ N/A
☒ As-Built Drawings	☒ Readily Available	☒ Up to Date	☐ N/A
☐ Maintenance Logs	☐ Readily Available	☐ Up to Date	☒ N/A

Remarks: ______________________________

Attachment H-1. Five-Year Review Site Inspection Checklist – F-Area Groundwater Operable Unit *(continued)*

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)*

2. Health and Safety Plans (HASPs):

☐ Site-Specific Health and Safety Plans	☐ Readily Available	☐ Up to Date	☒ N/A
☐ Contingency Plan/Emergency Response Plan	☐ Readily Available	☐ Up to Date	☒ N/A

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.120.HAZWOPER. A SSHASP is prepared if needed.

3. O&M and OSHA Training Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix

4. Permits and Service Agreements:

☐ Air Discharge Permit	☐ Readily Available	☐ Up to Date	☒ N/A
☐ Effluent Discharge	☐ Readily Available	☐ Up to Date	☒ N/A
☐ Waste Disposal; POTW	☐ Readily Available	☐ Up to Date	☒ N/A
☒ Other Permits	☒ Readily Available	☒ Up to Date	☐ N/A

Remarks: RCRA Permit Renewal for SRS, Underground Injection Control Permits

5. Gas Generation Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

6. Settlement Monument Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

7. Groundwater Monitoring Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks:

8. Leachate Extraction Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

9. Discharge Compliance Records:

☐ Air	☐ Readily Available	☐ Up to Date	☒ N/A
☐ Water (Effluent)	☐ Readily Available	☐ Up to Date	☒ N/A

Remarks:

10. Daily Access/Security Logs: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

Attachment H-1. Five-Year Review Site Inspection Checklist – F-Area Groundwater Operable Unit *(continued)*

IV. O&M COSTS

1. O&M Organization:

☐ State In-House
☐ PRP In-House
☒ Other: SRS
☐ Contractor for State
☐ Contractor for PRP

2. O&M Cost Records:

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place

☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

Total annual cost by year for review period, if available

From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached

3. Unanticipated or Unusually High O&M Costs During Review Period

Describe costs and reasons: ______

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing Damage: ☐ Location shown on site map ☐ Gates secured ☒ N/A

Remarks: OU-specific perimeter fencing is not required by the remedial action.

B. Fencing

1. Signs and Other Security Measures: ☐ Location shown on site map ☒ N/A

Remarks: ______

Attachment H-1. Five-Year Review Site Inspection Checklist – F-Area Groundwater Operable Unit *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Once in 5 years
Responsible Party/Agent: USDOE Savannah River Field Office

Contact:	Phil Prater	IACD Program Manager	11/29/17	803-952-9333
	(Name)	(Title)	(Date)	(Phone No.)

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

2. Adequacy: ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks:

D. General

1. Vandalism/Trespassing: ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

2. Land use changes onsite: ☒ N/A
Remarks:

3. Land use changes offsite: ☒ N/A
Remarks:

Attachment H-1. Five-Year Review Site Inspection Checklist – F-Area Groundwater Operable Unit *(continued)*

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. Roads damaged: ☐ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks:______________________________

B. Other Site Conditions

Remarks:______________________________

VII. LANDFILL COVER / CONTAINMENT ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☒ Applicable ☐ N/A

1. Settlement: ☐ Location shown on site map ☒ Settlement not evident

Areal extent__________ Depth__________

Remarks:______________________________

2. Performance Monitoring:

Type of Monitoring: Potentiometric head________ ☐ Performance not monitored

Frequency Quarterly ☐ Evidence of breaching Head Differential 10.3 Feet

Remarks:______________________________

Attachment H-1. Five-Year Review Site Inspection Checklist – F-Area Groundwater Operable Unit *(continued)*

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ **Applicable** ☐ **N/A**

A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☒ N/A

1. Pumps, Wellhead Plumbing, and Electrical:
☐ Good Condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks: The groundwater extraction system has been removed from service

2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances:
☐ Good Condition ☐ Needs Maintenance
Remarks:

3. Spare Parts and Equipment:
☐ Readily Available ☐ Good Condition ☐ Requires Upgrade ☐ Needs to be provided
Remarks:

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

C. Treatment System ☐ Applicable ☒ N/A

D. Monitoring Data

1. Monitoring Data:
☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring Data:
☐ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

E. Monitored Natural Attenuation

1. Monitoring Wells *(natural attenuation remedy)*:
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs maintenance ☒ N/A
Remarks:

X. OTHER REMEDIES

If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

A. Groundwater Injection Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. Pumps, Wellhead Plumbing, and Electrical:
☐ Good Condition ☐ All required wells located ☐ Needs maintenance ☒ N/A
Remarks: The base injection system and silver chloride injection are operated as needed to maintain desired groundwater parameters.

Attachment H-1. Five-Year Review Site Inspection Checklist – F-Area Groundwater Operable Unit *(continued)*

X. OTHER REMEDIES *(Continued)*

2. Injection System Pipelines, Valves, Valve Boxes and Other Appurtenances:

☒ Good Condition ☐ Needs maintenance

Remarks:______________________________

3. Spare Parts and Equipment:

☒ Readily Available ☒ Good Condition ☐ Requires Upgrade ☐ Needs to be provided

Remarks:______________________________

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

The groundwater extraction/treat/reinjection remedial system functioned as designed from 1999 to 2003. The engineered subsurface barriers with base injection in the gates replaced the groundwater pump and treat system, is the current remedy, and is operating as designed. A treatment for iodine-129 has been implemented and added as a remedy in the RCRA permit renewal. The combination of treatments is expected to meet the RAOs and RGs for this OU. The remedies deployed address the potential ecological impacts at the seeplines along Fourmile Branch and the ambient water quality standards in Fourmile Branch by remediating this OU.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

Operating and Maintenance programs are well established and functioning to ensure that remedial systems remain in effective service. There are no issues requiring corrective actions.

C. Implementation of the Remedy

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

Attachment H-1. Five-Year Review Site Inspection Checklist – F-Area Groundwater Operable Unit *(continued/end)*

XI. OVERALL OBSERVATIONS *(Continued)*

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Optimizations recently implemented are discussed in Section VII of this OU specific review.

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H-AREA GROUNDWATER OPERABLE UNIT

I. Introduction

This is the fifth five-year review for the H-Area Groundwater Operable Unit (OU). This review was conducted from August 2017 through November 2017. The review for this unit is conducted under the Savannah River Site (SRS) Resource Conservation and Recovery Act (RCRA) program. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) review requirements are met by the RCRA program; therefore, a separate review of the RCRA Corrective Action is not duplicated in this document. Contaminants remaining at the H-Area Groundwater OU are at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the H-Area Groundwater OU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table I-1 lists the chronology of site events for the H-Area Groundwater OU.

III. Background

H-Area Groundwater OU, a media-specific OU, is listed as a RCRA Unit in Appendix C of the Federal Facility Agreement for the SRS (FFA 1993). The media associated with the H-Area Groundwater OU is groundwater.

The H-Area Groundwater OU is the groundwater associated with the H-Area Hazardous Waste Management Facility (HWMF) OU.

Physical Characteristics

The H-Area Groundwater OU lies in the central portion of SRS; approximately 9.6 km (6 mi) from the nearest site boundary (see Figure I-1). The groundwater contamination plume associated with the four earthen unlined H-Area HWMF basins is the H-Area Groundwater OU and is observed in a zone which extends from the water table surface to approximately 15 m (50 ft) below ground surface and covers an area of approximately 81.2 hectares (200 acres).

Land and Resource Use

According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The *Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999) designates the H-Area Groundwater OU as being within an industrial area. The future land use for the H-Area Groundwater OU is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

The major source of the H-Area Groundwater OU contamination was the H-Area HWMF.

The H-Area HWMF, shown in Figure I-2, operated from 1955 until 1988. During that time, the facility received approximately 6.1 billion L (1.6 billion gal) of low-level waste effluents from H-Area chemical separation facilities such as the nitric acid recovery unit, waste storage system evaporator overheads, and general-purpose evaporator overheads. The effluents were acidic (wastewater with nitric acid) and low-activity waste solution containing a wide variety of radionuclides and dissolved metals. Significant amounts of nitrate and caustic were received. Tritium was the primary radionuclide released to the basins.

Initial Response

A groundwater monitoring network was installed in the 1950s. In 1986, the determination was made that the basins should be regulated under RCRA as hazardous waste disposal facilities, and closure plans were initiated. The basins were closed by dewatering, physically and chemically stabilizing the remaining sludge, and covering them with a protective multi-layer system to reduce rainwater infiltration. The basin closures were completed in 1991.

In 1992, South Carolina Department of Health and Environmental Control (SCDHEC) issued to SRS a RCRA Permit Renewal that specified ongoing groundwater monitoring requirements and a Corrective Action Plan to remediate the contaminated portions of the uppermost groundwater aquifer. Several contaminants exceeded regulatory limits and were targeted for remediation.

Basis for Taking Action

The maximum detected levels of several contaminants (e.g., tritium, mercury, and strontium-90) in the H-Area groundwater currently exceed the National Primary Drinking Water Standards and state standards (i.e., maximum contaminant levels [MCLs]). However, potential exposures to the general public are minimized by the distance from the OU to the site boundary, natural attenuation and radionuclide decay, institutional controls (i.e. land use controls [LUCs]), and dilution in receiving streams. The remediation of the H-Area Groundwater OU was designed to meet, as far as practicable, the Groundwater Protection Standards (GWPS) outlined in the 1992 SRS RCRA Permit Renewal.

The contaminants requiring monitoring are shown in Table I-2. These contaminants are identified in the current SRS RCRA Permit Renewal (SCDHEC 2017) and listed in the Interim Action Record of Decision (IROD) (WSRC 1995). These contaminants are monitored because they were detected at concentrations above the GWPS established in the 1992 SRS RCRA Permit Renewal.

IV. Remedial Actions

Remedy Selection

An IROD for the H-Area Groundwater OU was issued in April 1995 (WSRC 1995). A Final ROD has not been issued. The final action for this media-specific OU will be documented by modifications to the RCRA permit renewal.

The selected interim action under CERCLA is no further action beyond that required by the corrective action as identified in the SRS RCRA Permit. As described in the SRS RCRA Permit Renewal, the goal of remediation of the H-Area Groundwater OU is to lower contaminant concentrations in the groundwater associated with the H-Area HWMF to levels specified in the RCRA permit renewal and to minimize the discharge of contaminants to the adjacent stream (WSRC 1995). The remedial action objectives (RAOs) of the interim remedial action are to address the potential ecological impacts at the seeplines along Fourmile Branch and to address the ambient water quality standards in Fourmile Branch by remediating this OU (WSRC 1995).

The SRS RCRA Permit Renewal set forth a phased approach to remediating the groundwater that required documented evaluations of the performance of the system to determine effectiveness toward meeting the RAOs. The Phase 1 remedy was groundwater recovery and hydraulic control with treatment of mobile hazardous constituents and radionuclides (except tritium and nitrates) and injection of treated water into the shallow aquifer at the upgradient extent of the plume. The evaluation of this remedy (WSRC 2001) facilitated the following phased success measures to reach the RAOs that are in the current SRS RCRA Permit Renewal (SCDHEC 2017):

- Phase 1: Implement a groundwater extraction and injection system to capture and remediate those portions of the contaminant plume delineated by the 10,000 pCi/mL tritium isoconcentration contour. Also capture the mercury plume emanating from Basin H-3;
- Phase 2a: Reduce mass flux (curies/year) of tritium discharging from the H-Area plume to Fourmile Branch by 70% and reduce the concentration of the remaining Appendix IVC-A (SCDHEC 2017) constituents in Fourmile Branch to levels that are less than the GWPS as measured at Surface Water Sampling Stations FFM-H2, FM-2, FM-2A, and FM-2D, and develop and test practicable technologies to be employed for the 2b goals (except tritium);
- Phase 2b: Reduce the discharge from the H-Area plume of all Appendix IVC-A (SCDHEC 2017) constituents in the surface water at the seepline to concentrations less than the GWPS as measured at Wetland Seepline Surface Water Sampling Locations HAS-102, HAS-103, HAS-106, HAS-107, and HAS-113 (except tritium); and

- Phase 3: Capture and remediate the entire contaminant plume above those concentrations listed in the GWPS (SCDHEC 2017) and/or evaluate the applicability of Alternate Concentration Limits and/or a Mixing Zone.

Remedy Implementation

Consistent with the phased approach of the RCRA permit renewal, the implementation of the remedy was structured to prevent the plumes from further migration and discharge to Fourmile Branch, treat and/or attenuate the contaminant plumes at and approaching the OU boundary (Fourmile Branch), and finally to treat and/or attenuate all contaminants within the OU. Except for the initial treatment (pump-treat-reinjection), the permit identifies that development work would be needed to select and implement technologies to address the unique conditions presented at this OU. While the treatments that are and have been part of the remedy are presented chronologically in the following paragraphs, they work synergistically to address the permit requirements and RAOs.

Active Treatment with Pump - Treat - Reinjection

In 1997, SRS designed and built a pump-and-treat system using a water treatment unit (WTU) with a network of injection and extraction wells. The remediation system extracted groundwater downgradient of the seepage basins, passed it through a WTU to remove metals and radionuclides, and re-injected the treated water upgradient to maintain the recirculation loop. To reduce the migration of tritium to Fourmile Branch, the system lengthened the tritium pathway in the extraction/reinjection loop. This was expected to provide more time for decay prior to discharge to Fourmile Branch. The length of the tritium pathway between injection and extraction was not sufficient to support decay and significant breakthrough (due to increased water volume and gradient), which prompted the termination of operations. Operation of the pump-and-treat system was suspended October 2003 upon receipt of conditional approval by SCDHEC.

Passive Treatment with Subsurface Barrier System

In 2004, two groundwater barriers were installed. One barrier was placed upgradient of Basin H-4 and a second barrier was placed downgradient of the basin for a total length of

948 m (3,160 ft). The subsurface barrier and gate system reduces the groundwater flow velocity (allowing more time for radioactive decay) and controls the flux of contaminants to Fourmile Branch. Construction utilized an in-situ soil mixing technique to blend acid resistant pozzolan cement and attapulgite clay with native soils. A small percentage of caustic was also added to the cement to facilitate curing. Upon hardening, the resulting soil/cement mixture formed a low permeability (less than 1E-06 cm/s) subsurface barrier approximately 0.75 m (2.5 ft) thick on average. Vertically the wall was installed from just below ground surface to the base of the upper aquifer zone. Placement of the barrier walls altered groundwater levels near the walls (groundwater gradient), thus altering groundwater flow paths and increasing groundwater travel times to surface water and seeplines.

In June 2010, a base injection system, comprised of injection wells, pumping station, and chemical metering system, was constructed to inject an alkaline solution approximately at a pH of 10 into the aquifer to immobilize metals. Figure I-3 shows the locations of the injectors that are placed downgradient of the barrier walls and upgradient of the seepline. The operation of the base injection system has not been required since 2011, except for the injection of a limited quantity in 2015 to empty and flush the base concentrate supply tank. SRS is observing the effects of previous base injection at H Area, prior to potentially injecting additional base.

System Operations/Operation and Maintenance

Remedial activities are still in progress that require operations and maintenance (O&M).

- Since operation of the base injection system began in 2010, the pH in the target zone has stabilized. Periodic injections are ongoing to maintain pH in the target zone of the plume. Through the end of 2016, 71.5 million L (18.9 million gal) of base solution have been injected (Table I-3).

In 2011, enhancements were made to the cover system over the H-Area HWMF basins. Specifically, the drainage system, consisting of concrete-lined swales, was re-graded and new concrete was installed. Also, modifications to tie the drainage layer from the cap to the swales were completed.

Costs associated with the selected interim remedy for H-Area Groundwater OU include O&M costs of WTU, base injection, and institutional controls. The actual O&M cost during fiscal year (FY) 2012 to FY2017 is $3,611,856. RCRA documentation does not require estimated project costs to be prepared. Therefore, none are included in this remedy review.

V. Progress since Last Review

The previous protectiveness statement concluded that the interim remedial actions at the H-Area Groundwater OU are expected to be protective, and in the interim, exposure pathways that could result in unacceptable risks are being maintained by the barrier walls and base injection treatment system which have been functioning properly based on groundwater monitoring data.

Recommendations and follow-up actions from the last five-year review included opportunities to optimize the monitoring system. Implementation of the optimization opportunities is discussed in Section VII. Technical Assessment.

Base injection operations are continuing as needed.

VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII. Documents Reviewed;
- Confirmed the implementation of the remedial action. Figure I-4 provides current photographs of the remedial actions;
- Reviewed all process and performance monitoring data provided by the annual groundwater monitoring and corrective action reports and provided a technical assessment of whether the treatment systems are functioning as intended by the IROD and whether the shutdown criteria have been achieved;

- Inspected the OU, interviewed maintenance personnel and documented the results on the Inspection Checklist provided in Attachment I-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls;
- Ensured that all actions required under the RCRA Permit Renewal were implemented; and
- Reviewed changes in standards and to-be-considered guidance.

Data Review

The H-Area Groundwater OU and underlying geology have been impacted by the volumes of acidic waste discharged to the basins. The carrier fluid for the process waste to the seepage basins (groundwater contaminant source) was low pH acid that leached to the subsurface over a 30-plus year period creating a groundwater plume of low pH that has impacted the geochemistry of the subsurface soils, leached natural metals and minerals, and minimized the retardation of contaminants. As recognized by SRS, the pH must be addressed to have success in reaching the RAOs and RCRA permit requirements. Because of the properties of the individual metal and radionuclide contaminants, one remedy will not address all the contaminants. The only viable approach to tritium, a main contaminant at this site, is to decrease the rate of release from sources and slow the migration rates through the water table to the receptors. Thus, the remedial approach implemented at SRS attempts to address these facets. This technical review was conducted to assess progress in addressing the RAOs as per the IROD (WSRC 1995).

Ecological Studies

Ecological studies associated with the H-Area Groundwater OU are conducted as part of the Fourmile Branch Integrator Operable Unit (IOU). These studies include ecological benchmark comparisons that compare ecological screening values (ESVs) to sediment, sediment/soil, and surface water media constituent concentrations. The ESVs are derived from ecologically relevant criteria and standards such as National Ambient Water Quality Criteria. Review of the fifth periodic report for the Fourmile Branch IOU indicates that in terms of community level effects there is no evidence that metals discharged from H Area have degraded fish or macroinvertebrate communities in Fourmile Branch (SRNS 2016b). Aluminum, barium, and mercury may pose a potential threat to wildlife. Aluminum and barium showed a potential threat to wildlife upgradient of SRS operations. Only mercury is a potential issue in lower and middle Fourmile Branch, but there is little evidence that this is associated with discharges from SRS operational areas (i.e., F Area, H Area) (SRNS 2016b).

Groundwater and Surface Water Data

This data review encompassed a review of concentration data, contaminant plume maps (SRNS 2012, SRNS 2013, SRNS 2014, SRNS 2015, SRNS 2016a), and time trend data for sampling locations within the H-Area Groundwater OU.

As a condition of the RCRA permit renewal for the H-Area HWMF groundwater, SRS annually calculates and reports the tritium flux to Fourmile Branch. As shown in Table I-4, tritium flux discharges have been reduced by > 70 %.

A review of the surface water data from stations FM-2U, FM-H1, FM-H2, FM-2, FM-2A, FM-2D, FM-2B, FM-3A, FMC-002H and FMC-002HD was conducted to evaluate the impact of the H-Area Groundwater OU on Fourmile Branch. Table I-5 presents the contaminants that at any time during the review period were detected above the GWPS or MCL. The data in Table I-5 provides evidence that the subsurface barriers and base injection operations are having a positive influence on the concentrations of all constituents. The concentrations of the constituents are decreasing or are below the GWPS and/or MCL.

A review of the seepline groundwater data from initial sampling in 2001 to 2016 was conducted to assess the effect of the H-Areas Groundwater OU treatment systems on the seeplines. Table I-6 provides a summary of constituents from the seepline sampling locations that have exceeded the GWPS or MCL at any time during the period beginning in 2001 (initial sampling) and ending December 2016. Review of the seepline data indicates decreasing concentrations over time for all constituents except iodine-129. Carbon-14 appears to be increasing, but the unusually high concentrations of carbon-14 are most likely due to interference during analysis caused by high tritium concentrations. SRS recognizes that iodine-129 will not be treated by the base injection system and thus is investigating other approaches to remediate the iodine.

While showing decreasing concentrations over time, there are several contaminants that remain above their standards. These contaminants are associated with existing plumes and are located downgradient of these plumes. Of the three constituents identified in the ecological studies as potential threats to wildlife, only mercury was detected above standard with concentrations decreasing to below the GWPS during this five-year review cycle.

Summary of Inspections and Interviews

Interviews were conducted with Richard Feagin, O&M staff member, on October 11, 2017 and George Joyner, O&M Site Manager, on October 12, 2017 at the O&M organization offices. No issues were identified for the H-Area Groundwater OU during these interviews.

The H-Area Groundwater OU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) and USDOE personnel on November 29, 2017. No issues were identified for the H-Area Groundwater OU during this inspection

A site inspection will be conducted by U.S. Environmental Protection Agency (USEPA) and SCDHEC personnel, accompanied by USDOE and SRNS personnel, prior to submittal of the Revision 1 of this document. It is anticipated that no significant problems regarding this OU will be identified during the inspection.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The review of documents, Applicable or Relevant and Appropriate Requirements (ARARs), risk assumptions, and the results of site inspections indicate that the remedy is functioning as intended by the IROD. The IROD identifies no further action beyond that required by the SRS RCRA Permit Renewal, but stipulates the corrective action will address the potential ecological impacts at the seeplines along Fourmile Branch and will also serve to address the ambient water quality standards in Fourmile Branch by remediating this OU. The implemented treatment strategy is addressing the goal of the remediation, as described in the SRS RCRA Permit Renewal by lowering contaminant concentrations in the groundwater associated with the H-Area HWMF to levels specified in the RCRA permit renewal and to minimizing the discharge of contaminants to the adjacent stream. Ecological assessment of Fourmile Branch indicates no impact from the H-Area HWMF. However, aluminum, barium, and mercury are potential threats to wildlife in Fourmile Branch in the area impacted by H-Area operations. As part of the Fourmile Branch IOU program, studies of ecological impacts to the branch will be ongoing. Based on the results of the ecological studies to date, the RAOs of the IROD are being met. The groundwater requirements of the RCRA permit renewal, which the IROD identified must also be satisfied, have not been met. However, the treatment approach is making positive progress towards those requirements. The effective implementation of institutional controls has prevented exposure to, or ingestion of, contaminated groundwater.

According to the data reviewed, the site inspections, and the interviews, the remedy is functioning as intended by the IROD. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

On February 11, 2014, the SCDHEC originally issued the 2014 RCRA Permit Renewal for the SRS (SCDHEC 2014). The SCDHEC modified the 2014 RCRA Permit Renewal on August 17, 2017, which became effective on September 2, 2017 (SCDHEC 2017). Included in the changes to the permit was an optimization effort associated with this OU. The optimizations for the H Area Groundwater OU included the removal of twelve wells (HSB 130C/D, HSB 132C/D, HSB 140C/D, HSB 141C/D, HSB 146C/D, HSB 148C/D) located on the opposite side of Fourmile Branch that were installed in 1990, have concentrations below GWPS, and have had no discernible contaminant trends. Bis(2-ethylhexyl)phthalate was also removed from the permitted constituents due to its sporadic detection, both temporally and spatially, from 2000 through March 2017 (SRNS 2012).

The LUC requirements are discussed and approved as part of the closure/post-closure/permit application process and are governed by the RCRA Permit Renewal for the SRS (SCDHEC 2017). Therefore, a Land Use Control Implementation Plan is not required for this OU. The institutional controls (i.e., LUCs) that are in place to prevent exposure to or ingestion of contaminated groundwater include physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the A/M-Area Groundwater OU for industrial use only (SRS is a secured government facility with land use restrictions), and use restrictions via the SRS Site Use/Site Clearance Program. No activities were observed that would have violated the institutional controls (i.e., LUCs).

Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Still Valid?

The exposure assumptions, toxicity data, and cleanup levels used at the time of remedy selection are still valid. There have been no changes in standards or to-be-considered guidance identified in the IROD that call into questions the protectiveness of the remedy.

The action specific ARARs have been met with the shutting down and dismantling of the groundwater pump-and-treat system. The chemical specific ARARs and location specific ARARs associated with groundwater remediation must still be met and have been evaluated.

The GWPS set forth in the SRS RCRA Permit Renewal (SCDHEC 2017) for the constituents that were identified as present above those standards were compared against MCLs, where available. The comparison found four constituents where the GWPS differed from the MCL (Table I-7). The GWPS is more protective than the MCL for carbon-14, cobalt-60, and technetium-99; thus, SRS is adhering to a more stringent standard. The groundwater data for the H-Area wells that are monitored as per the RCRA permit renewal were evaluated for the period January 2000 through August 2016 for arsenic. Two thousand nine hundred and eighty-seven arsenic records were reviewed from the period 2000 through 2016. There were 73 unqualified detected results from 39 wells during the period 2000 through 2008 with an average value of 7.4 µg/L. Zero records were above the

GWPS of 50 µg/L and twelve records from two wells were above the MCL of 10 µg/L with a maximum value of 43.1 µg/L and an average value of 19 µg/L. Eleven of twelve records were from one well, a point of compliance well, located at the downgradient edge of Basin H-1. Since 2008, there have been no unqualified detected results. The data indicate the likelihood of a localized presence of arsenic. All wells associated with the H-Area Groundwater OU are monitored semiannually for arsenic.

Fact sheets provided on the USEPA webpage regarding emerging contaminants were reviewed for applicability to this site. 1,4-dioxane is a potential contaminant at this unit as it is found at sites where chlorinated solvents are present. The groundwater data for the H-Area wells that are monitored as per the RCRA permit renewal were evaluated for the period January 2000 through December 2016 for 1,4-dioxane. Three hundred and forty-four 1,4-dioxane records were reviewed from this period. There were 13 detected results from 4 wells (HSB-85A, 85B, 111D and 120C) with a maximum of 20 µg/L and an average value of 7.6 µg/L. SRS will continue to monitor for 1,4-dioxane as a potential contaminant for the H-Area Groundwater OU.

There have been no changes in MCLs (versus GWPS) that would impact the remedy. The remedy is progressing as expected.

Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No other information has come to light that could call into question the protectiveness of the remedy.

VIII. Issues

There are no issues related to current site operations, conditions or activities that currently prevent the remedy from being protective

IX. Recommendations and Follow-up Actions

There are no recommendations or follow-up actions for H-Area Groundwater OU.

X. Protectiveness Statement(s)

The remedy at the H-Area Groundwater OU is protective of human health and the environment.

Exposure pathways that could result in unacceptable risks are being controlled by the engineered subsurface barriers and base injection, groundwater monitoring, and implementation of physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the H-Area Groundwater OU for industrial use only, and use restrictions via the SRS Site Use/Site Clearance Program. Protectiveness of the remedial action will be verified by continued groundwater monitoring.

XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Operating Equipment is scheduled for January 2024.

XII. Documents Reviewed

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

SCDHEC, 2014. *South Carolina Department of Health and Environmental Control Hazardous and Mixed Waste Permit, Permit Number SC1 898 008 989, 2014 RCRA Permit Renewal for the Savannah River Site, issued on February 11, 2014, Module III - Postclosure Care and Module IV – Groundwater Requirements, Section C, H-Area Hazardous Waste Management Facility,* South Carolina Department of Health and

Environmental Control, Office of Environmental Quality Control, Bureau of Land and Waste Management, Columbia, SC

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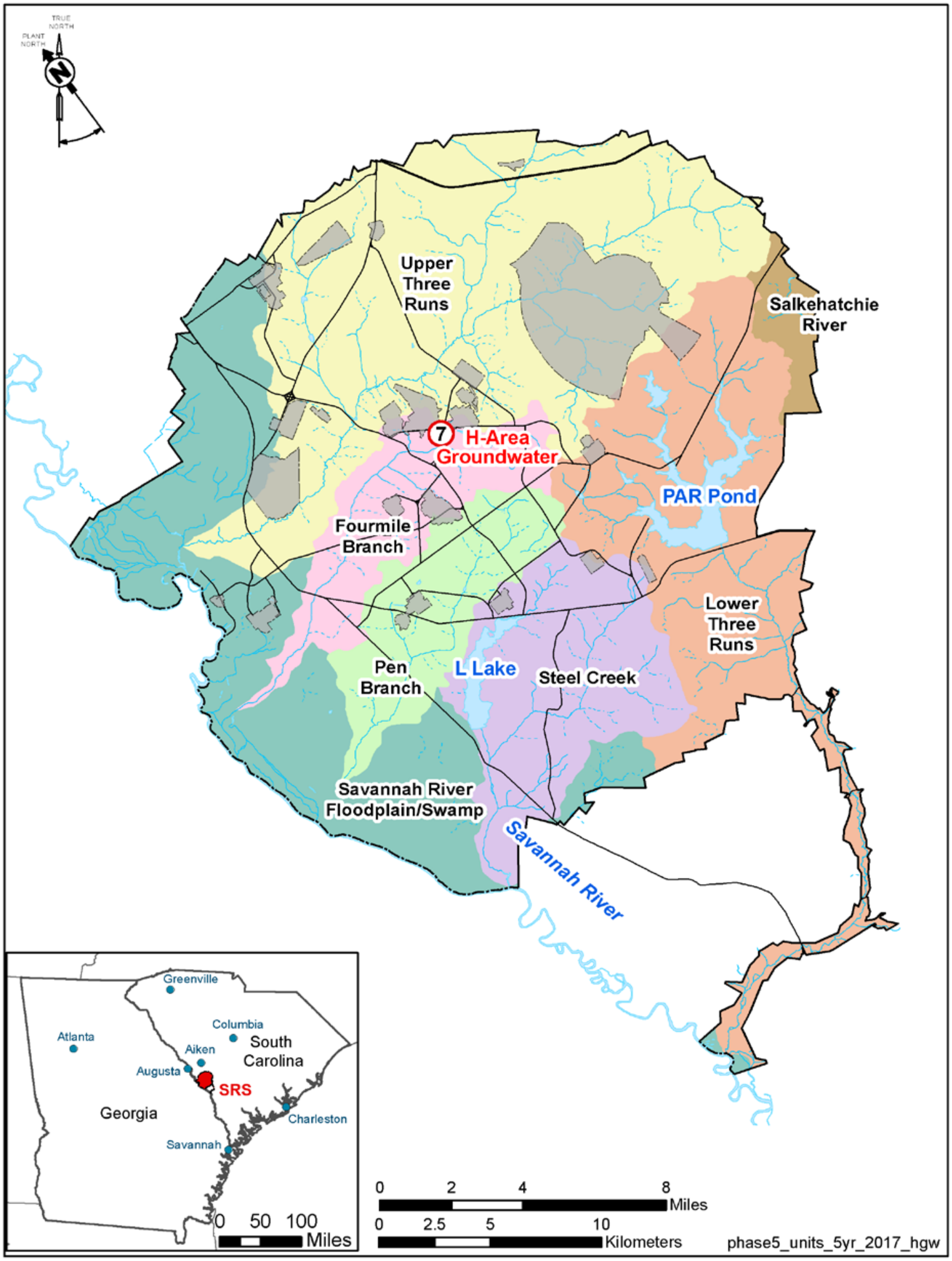

Figure I-1. Location of the H-Area Groundwater OU at the SRS

Figure I-2. H-Area HWMF Basins Prior to Closure (1989)

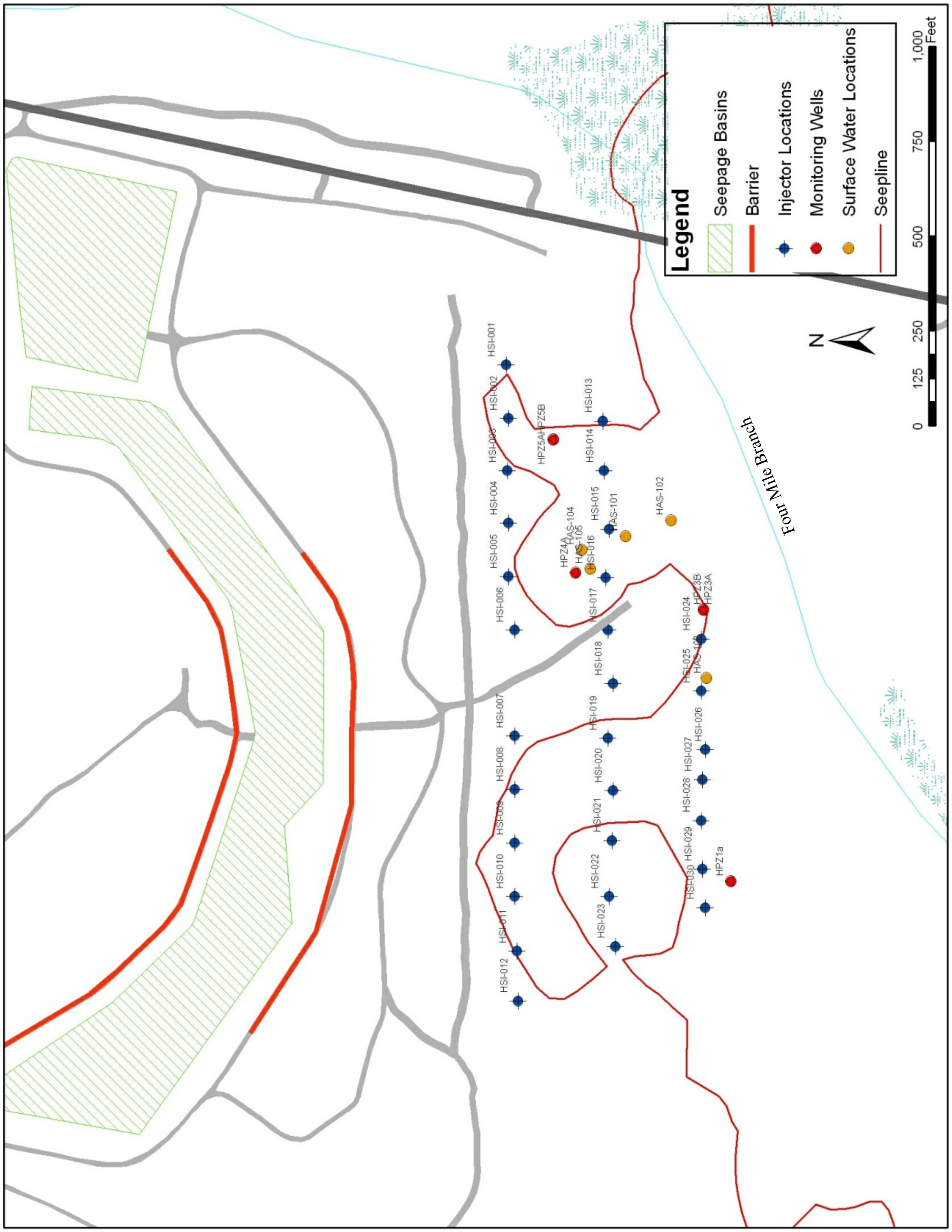

Figure I-3. **Treatment Systems for the H-Area Groundwater OU**

Figure I-4. **Current Photo of H-Area Groundwater (2017)**

Table I-1. Chronology of OU Events

Event	Date
RCRA Closure Plan Approved	1989
Corrective Action Start	1989
RCRA Closure Certified	1991
IROD Issuance	April 13, 1995
Previous Five-Year Reviews Issuance	June 30, 1997, February 12, 2004, February 4, 2009 / February 4, 2014

Table I-2. H-Area Groundwater OU / HWMF Monitored Hazardous Constituents

Inorganics
Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Cyanide, Lead, Mercury, Nickel, Nitrate-Nitrite as Nitrogen, Selenium, Silver, Thallium, Tin, Vanadium, Zinc
Organics
Benzene, Methylene chloride (Dichloromethane), Tetrachloroethylene (PCE), Trichloroethylene (TCE), Trichlorofluoromethane,
Radionuclides
Gross alpha, Gross (nonvolatile) beta, Total radium, Americium-241, Carbon-14, Cobalt-60, Curium-242, Curium-243/244, Curium-246, Iodine-129, Nickel-63, Plutonium-238, Plutonium-239/240, Radium-226, Radium-228, Strontium-90, Technetium-99, Thorium-228, Thorium-230, Thorium-232, Tritium, Uranium-233/234, Uranium-234, Uranium-235, Uranium-238

Per the SRS RCRA Permit Renewal (SCDHEC 2017)

* As listed in Final ROD for H-Area HWMF (WSRC 1993) and IROD for H-Area Groundwater (WSRC 1995), these constituents would not necessarily be identified as final or refined constituents of concern under current protocols. These constituents have not necessarily exceeded their respective MCLs or even been detected in local groundwater.

Table I-3. **H-Area HWMF Base Injection Volumes Injected**

Year	Total Volume (million gallons)
2010[a]	1.8[b]
2011	8.1 [b c]
2012	4.7 [b]
2013	4.1 [b]
2014	0 [b]
2015	0.2 [b]
2016	0 [b]

a - Operation of system began in September 2010
b - SRNS 2016a

Table I-4. **Summary of Calculated Tritium Flux to Fourmile Branch associated with the H-Area Groundwater OU (SRNS 2017)**

Year	Calculated Tritium Flux (Curies/year)	% Tritium Reduction from Baseline Year of 2000
2000	240	NA
2003	221	8
2004	147	39
2005	114	52
2006	116	52
2007	81	66
2008	90	62
2009	67	72
2010	50	79
2011	56	77
2012	44	82
2013	50	79
2014	52	78
2015	54	77
2016	42	82

Table I-5. Summary of Constituents from the H-Area Groundwater OU Surface Waters of Fourmile Branch Detected Above Standards

			Maximum Concentration [# of Samples]			
Constituent	**Unit**	**GWPS /MCL**[1]	**2nd Remedy Review (1997-2001)**	**3rd Remedy Review (2002-2006)**	**4th Remedy Review (2007-2011)**	**5th Remedy Review (2012-2016)**
Antimony	µg/L	6	10 [49]	2.7 [93]	0.21 [65]	All ND [38]
Arsenic	µg/L	10	6 [55]	3.12 [105]	27.1 [65]	8.54 (J) [38]
Beryllium	µg/L	4	5 [52]	0.22 [93]	0.23 [65]	0.41 (J) [38]
Cadmium	µg/L	5	5 [64]	0.65 [117]	1.15 [46]	0.13 (J) [32]
Carbon-14	pCi/L	50	11.2 [66]	162 [142]	1140 [88]	59.7 (J) [72]
Cobalt	µg/L	3	6.27 [52]	15.7 [93]	5.69 [65]	8.25 [77]
Gross alpha	pCi/L	15	46.8 [68]	7.06 [174]	128 [207]	12.5 [129]
Iodine-129	pCi/L	1	All ND [59]	4.69 [70]	9 [206]	3.44 (J) [134]
Non-volatile Beta	pCi/L	50	192 [68]	142 [174]	268 [207]	42 [129]
Total radium	pCi/L	5	13.5 [64]	4.16 [94]	7.44 [82]	4.95 [38]
Radium-226	pCi/L	5	12 [65]	2.68 [134]	5.55 [85]	4.97 (J) [58]
Radium-228	pCi/L	5	3.22 [66]	6.05 [113]	8.4 [69]	1.74 (J) [29]
Strontium-90	pCi/L	8	9.54 [67]	7.96 [57]	18.1 [135]	9.45 (J) [53]
Thallium	µg/L	2	10 [43]	7.95 [93]	2.52 [65]	0.2 (J) [38]
Tin	µg/L	2.6	10 [57]	8.37 [87]	0.62 [65]	All ND [31]
Tritium	pCi/L	20,000	312,000 [66]	4,810,000 [455]	2,760,000 [585]	179,000 [266]
Vanadium	µg/L	4	10.8 [52]	4.09 [93]	30.9 [65]	14.6 (J) [38]

ND = Non-detect
J = Estimated value

Table I-6. Summary of Constituents from the H-Area Groundwater OU Seepline Detected Above Standards

Constituent	**Unit**	**GWPS / MCL[1]**	**Maximum Concentration [# of Samples]**			
			2nd Remedy Review (1997-2001)	**3rd Remedy Review (2002-2006)**	**4th Remedy Review (2007-2011)**	**5th Remedy Review (2012-2016)**
Arsenic	µg/L	10	ND [8]	59.8 [117]	20.6 (J) [48]	ND [51]
Beryllium	µg/L	4	1.55 (J) [8]	9.87 [177]	0.63 [101]	2.74 [51]
Carbon-14	pCi/L	50	221 [8]	798.4 [197]	268 [195]	665 [173]
Chromium	µg/L	100	73.5 [8]	659 [172]	40.9 [48]	66.7 (J) [51]
Cobalt	µg/L	3	9.8 [8]	36.2 [181]	4.4 [132]	3.46 (J) [107]
Methylene Chloride	µg/L	5	8.31 [9]	16 [65]	ND [38]	4.02 (J) [49]
Gross Alpha	pCi/L	15	48.5 [7]	188 [199]	40.1 [236]	7.78 [212]
Iodine-129	pCi/L	1	39.6 [9]	50.7 [180]	22.1 [241]	77.4 [233]
Lead	µg/L	15	1920 [8]	460 [173]	9.01 [48]	29.6 [62]
Mercury	µg/L	2	ND [8]	2.33 [180]	1.1 [231]	1.22 [210]
Nickel	µg/L	100	29.7 [8]	267 [184]	62 [68]	16.2 [51]
Nickel-63	pCi/L	50	ND [8]	63.3 [70]	21.4 [70]	7.72 (J) [56]
Nitrate-Nitrite as N	mg/L	10	8.45 [8]	60.2 [207]	80.2 [234]	35 [215]
Non-Volatile Beta	pCi/L	50	86.1 [7]	302 [199]	107 [236]	100 [212]
Total Radium	pCi/L	5	8.04 [7]	133 [167]	7.51 [102]	2.73 [53]
Radium-226	pCi/L	5	13.3 [7]	11.3 [198]	1.98 [133]	3.95 [52]
Radium-228	pCi/L	5	18.1 [7]	3.2 [198]	6.74 [133]	2.21 [55]
Technetium-99	pCi/L	50	34.7 [7]	1080 [202]	196 [162]	159 [208]
Tin	µg/L	2.6	1340 [8]	49.8 [118]	ND	3.37 (J) [73]
Tritium	pCi/L	20,000	5,900,000 [9]	5,470,000 [204]	2,930,000 [235]	2,330,000 [218]
Uranium-233/234	pCi/L	15	5.76 [7]	16.8 [199]	0.87 [135]	0.383 [57]
Uranium-238	pCi/L	15	2.77 [7]	20.5 [199]	0.87 [135]	0.326 [57]
Vanadium	µg/L	4	81.1 [8]	733 [146]	10.5 [48]	72.5 [146]

J = Estimated value

Table I-7. Comparison of Permitted GWPS for the H-Area Groundwater OU versus MCLs

Contaminant	Unit	GWPS	MCL
Arsenic	µg/L	50	10
Carbon-14	pCi/L	50	2000
Cobalt-60	pCi/L	50	100
Technetium-99	pCi/L	50	900

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Attachment I-1. Five-Year Review Site Inspection Checklist – H-Area Groundwater Operable Unit

I. SITE INFORMATION

Site Name:	**H-Area Groundwater Operable Unit**	**Date of Inspection:**	**08/30/2017**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**CERCLIS #9**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**75°F and Cloudy**

Remedy Includes: *(Click all that apply)*

☐ Landfill Cover / Containment
☒ Access Controls
☒ Institutional Controls
☒ Groundwater Pump and Treatment
☐ Surface Water Pump and Treatment
☐ Monitored Natural Attenuation
☐ Groundwater Containment
☒ Vertical Barriers

☒ Other Base Injection

Attachments: ☐ Inspection team roster attached ☐ Inspection team roster attached

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 10/12/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

Problems/Suggestions: ☐ Report Attached

2. **O&M Staff:** Richard Feagin (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 10/11/2017 (Date)

Interviewed: ☐ At Site ☐ At Office ☒ By Phone Phone No.: 803-952-4416

Problems/Suggestions: ☐ Report Attached

Attachment I-1. Five-Year Review Site Inspection Checklist – H-Area Groundwater Operable Unit *(continued)*

II. INTERVIEWS *(Click all that apply) (Continued)*

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

Agency: ____________________

Contact: __________ (Name) __________ (Title) __________ (Date) __________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

____

Agency: ____________________

Contact: __________ (Name) __________ (Title) __________ (Date) __________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

____

Agency: ____________________

Contact: __________ (Name) __________ (Title) __________ (Date) __________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

____

4. **Other Interviews** *(Optional):* ☐ Report Attached ____________________

____

____

____

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Click all that apply)*

1. **O&M Documents:**

☐ O&M Manual	☐ Readily Available	☐ Up to Date	☐ N/A
☒ As-Built Drawings	☒ Readily Available	☒ Up to Date	☐ N/A
☐ Maintenance Logs	☐ Readily Available	☐ Up to Date	☐ N/A

Remarks: ____________________

____

Attachment I-1. Five-Year Review Site Inspection Checklist – H-Area Groundwater Operable Unit *(continued)*

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)*

2. Health and Safety Plans (HASPs):

☐ Site-Specific Health and Safety Plans ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Contingency Plan/Emergency Response Plan ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.120 HAZWOPER. A SSHASP is prepared if needed.

3. O&M and OSHA Training Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix.

4. Permits and Service Agreements:

☐ Air Discharge Permit ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Effluent Discharge ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Waste Disposal; POTW ☐ Readily Available ☐ Up to Date ☒ N/A
☒ Other Permits ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: RCRA Permit Renewal for the SRS

5. Gas Generation Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

6. Settlement Monument Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

7. Groundwater Monitoring Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks:

8. Leachate Extraction Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

9. Discharge Compliance Records:

☐ Air ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Water (Effluent) ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

10. Daily Access/Security Logs: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

Attachment I-1. Five-Year Review Site Inspection Checklist – H-Area Groundwater Operable Unit *(continued)*

IV. O&M COSTS

1. O&M Organization:

☐ State In-House ☐ Contractor for State
☐ PRP In-House ☐ Contractor for PRP
☒ Other: SRS

2. O&M Cost Records:

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

Total annual cost by year for review period, if available

From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached

3. Unanticipated or Unusually High O&M Costs During Review Period

Describe costs and reasons: ______

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing Damage: ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks: OU-specific perimeter fencing is not required by the remedial action.

B. Signs

1. Signs and Other Security Measures: ☐ Location shown on site map ☒ N/A
Remarks:______

Attachment I-1. Five-Year Review Site Inspection Checklist – H-Area Groundwater Operable Unit *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Once in five years
Responsible Party/Agent: USDOE Savannah River Field Office
Contact: Phil Prater (Name) IACD Program Manager (Title) 11/29/17 (Date) 803-952-9333 (Phone No.)

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

2. Adequacy: ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks:

D. General

1. Vandalism/Trespassing: ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

2. Land use changes onsite: ☒ N/A
Remarks:

3. Land use changes offsite: ☒ N/A
Remarks:

Attachment I-1. Five-Year Review Site Inspection Checklist – H-Area Groundwater Operable Unit *(continued)*

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. Roads damaged: ☐ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks:

B. Other Site Conditions

Remarks:

VII. LANDFILL COVER/CONTAIMENT SYSTEMS ☐Applicable ☒N/A

VIII. VERTICAL BARRIER WALLS ☒ Applicable ☐ N/A

1. Settlement: ☐ Location shown on site map ☒ Settlement not evident

Areal extent________ Depth________

Remarks:

2. Performance Monitoring:

Type of Monitoring: Potentiometric Head ☐ Performance not monitored

Frequency Quarterly ☐ Evidence of breaching Head Differential 10.5 Feet

Remarks:

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☒ N/A

1. Pumps, Wellhead Plumbing, and Electrical:

☐ Good Condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A

Remarks: The groundwater extraction system has been removed from service.

2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances:

☐ Good Condition ☐ Needs Maintenance

Remarks:

3. Spare Parts and Equipment:

☐ Readily Available ☐ Good Condition ☐ Requires Upgrade ☐ Needs to be provided

Remarks:

Attachment I-1. Five-Year Review Site Inspection Checklist – H-Area Groundwater Operable Unit *(continued)*

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ **Applicable** ☐ **N/A**

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

C. Treatment System ☐ Applicable ☒ N/A

D. Monitoring Data ☒ **Applicable** ☐ **N/A**

1. Monitoring Data:
☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring Data:
☐ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

E. Monitored Natural Attenuation ☐Applicable ☒ N/A

X. OTHER REMEDIES

If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

A. Groundwater Injection Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. Pumps, Wellhead Plumbing, and Electrical:
☐ Good Condition ☐ All required wells located ☐ Needs maintenance ☒ N/A
Remarks: The base injection system is operated as needed to maintain desired groundwater parameters.

2. Injection System Pipelines, Valves, Valve Boxes and Other Appurtenances:
☒ Good Condition ☐ Needs maintenance
Remarks:

3. Spare Parts and Equipment:
☒ Readily Available ☒ Good Condition ☐ Requires Upgrade ☐ Needs to be provided
Remarks:

Attachment I-1. Five-Year Review Site Inspection Checklist – H-Area Groundwater Operable Unit *(continued/end)*

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

The groundwater extraction/treat/reinjection remedial system functioned as designed from 1999 to 2003. The engineered subsurface barriers with base injection replaced the groundwater pump and treat system, is the current remedy, and is operating as designed. The remedy will facilitate achieving the RAOs and RGs for this OU.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The O&M programs are well established and functioning to ensure that remedial systems remain in effective service. There are no issues requiring corrective actions.

C. Early Indicators of Potential Remedy Failure

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Optimizations recently implemented are discussed in Section VII of this OU specific review.

M-AREA OPERABLE UNIT

I. Introduction

This report is the second five-year review for the M-Area Operable Unit (MAOU). The review was conducted from August 2017 through November 2017. Contaminants have been left in place at the MAOU at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the MAOU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table J-1 lists the chronology of site events for the MAOU.

III. Background

The MAOU is listed as a Resource Conservation and Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) unit in Appendix C of the Federal Facility Agreement (FFA) for Savannah River Site (SRS) (FFA 1993). The media of concern is subsurface vadose zone soil.

An area-based remedial strategy has been implemented in M Area; remedial decisions for the M-Area waste units and facilities addressed by the M-Area Settling Basin Inactive Process Sewer Lines to Manhole 1 (081-M) (MIPSL) Record of Decision (ROD) will continue as planned (Appendix K). All other remedial actions are addressed by the MAOU ROD.

Groundwater contamination from the MAOU is regulated by the South Carolina Department of Health and Environmental Control (SCDHEC) RCRA Permit Renewal for the SRS (Hazardous and Mixed Waste Permit SC1 890 008 989) and addressed by the requirements of the M Area and Metallurgical Laboratory Hazardous Waste Management Facilities Groundwater Monitoring and Corrective Action Agreements.

Physical Characteristics

MAOU is located in the northwest portion of SRS, and comprises approximately 29.4 hectares (72.6 acres) (Figure J-1). The MAOU was divided into four distinct areas based on the historical operations at the unit (Figure J-2). These areas are:

- Production Area (313-M, 320-M, 321-M [including Component and Tube Cleaning sump, referred to as Underground Sump #001, and Extrusion Press Pit, referred to as Underground Sump #002], 322-M, 340-M, and 324-M [including the northern portions of the MIPSL and associated feeder lines]) - This area also includes two warehouses: 330-M and 331-M. The Production Area is where fuel and target assemblies were produced between 1952 and 1988. Slugs of depleted uranium were stored in the warehouses.
- Liquid Effluent Treatment Facility (341-M, 341-1M and 341-8M) - This facility was built in 1988 to treat all the liquid effluent from the production area.
- Test Reactor Facilities (305-A and 777-10A) - These two test reactor facilities were used to determine the appropriate properties for the fuel elements and the target assemblies before a new model was placed into production.
- Salvage Area (740-A, 743-A and 741-A) - This area stored excess materials and equipment, contained support facilities for the personnel involved in the management of excess material and reconditioned non-nuclear material. Reconditioning involved painting and cleaning with solvents.

Land and Resource Use

According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The *Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999) designates the MAOU as being within an industrial area. The future land use for the MAOU is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

The manufacturing processes in M Area consumed a large quantity of industrial cleaning solvents and water, and early practices were to discharge the spent solvents and water directly into the environment. Of the reported 1.6 million kg (3.5-million lbs) of solvents discarded, approximately 900,000 kg (2-million lbs) was discarded to the M-Area Settling Basin, located south of M Area, via a process sewer line. This resulted in volatile organic compound (VOC) and radionuclide contamination at the M-Area Settling Basin and process sewer lines within the MAOU. The basin was closed with the installation of a protective cap in 1991.

All of the major facilities in M Area used industrial cleaning processes and products (trichloroethylene [TCE], tetrachloroethylene [PCE], and trichloroethane) that were discarded to the M-Area Settling Basin via process sewer lines. The M-Area Settling Basin is part of the M-Area HWMF. The contaminated sewer lines were managed under the MIPSL OU and its ROD (WSRC 2006a).

Many of the buildings and facilities were dismantled to their slab foundations by the mid-2000s. However as a result of the RCRA Facility Investigation/Remedial Investigation (RFI/RI) work plan characterization (WSRC 2007a), areas of VOC, polychlorinated biphenyl (PCB), polyaromatic hydrocarbons (PAHs), inorganic (metal), and radiological contamination still existed in and around the concrete slabs of buildings, in or near process sewer lines, and/or in soils surrounding these features and at the 741-A Salvage Yard (Figure J-3).

Initial Response

Removal actions were performed in 2007 through 2008 at various buildings in the Production Area (WSRC 2007b) and at the 741-A Salvage Yard (WSRC 2006b) to prevent exposure of the future industrial worker to the maximum levels of contamination at M Area and to reduce the potential leaching of contaminants from the soils to groundwater. The key elements of each area are discussed below.

313-M

- Removal of concrete (sumps/pits) with uranium-238 activity exceeding 1,900 ρCi/g (principal threat source material [PTSM] criteria);
- Removal of concrete and soils containing PCE at concentrations greater than 50 mg/kg; and
- Collection of samples from the base of each excavation to verify the goals of the removal action were met.

320-M

- Removal of concrete, brick, and soils containing PCE or TCE concentrations greater than 50 mg/kg; and
- Collection of samples from the base of the Tube Cleaning excavation and from the base of each of the auger (excavation) holes at the west side of the building slab to verify the goals of the removal action were met.

321-M

- Removal of concrete where uranium-235 activity exceeded the PTSM level of 402 ρCi/g;
- Removal of concrete, brick, pipe and soil (to a depth of 12.6 m [42 ft]) containing PCE concentrations greater than 50 mg/kg and stockpiled on unit and backfilled with sandy soil;
- Radiological survey of ground surface after slab removal; and
- Collection of samples from the base of each of the auger (excavation) holes to verify the goals of the removal action were met.

322-M

- Removal of sumps, pipe (containing sludge), and soils contaminated with PTSM levels of uranium-238. The sumps with activity levels greater than 1,900 ρCi/g uranium-238 in the concrete, and the pipe containing sludge with activities greater than 1790 ρCi/g uranium-238 or 394 ρCi/g uranium-235 were removed.

- Collection of soil samples from the base of the exaction to verify the goals of the removal action were met.

741-A Salvage Yard

- Soil to a depth of 0.61 m (2 ft) was removed in 2008 to protect the future industrial worker from soil contaminated with arsenic, PAHs (i.e., benzo(a)anthracene, benzo(a) pyrene, and benzo(a)fluoranthene), and PCBs (i.e., Aroclor 1254 and Aroclor 1260) greater than 1E-06 risk. Figure J-4 shows the area of soil removal from the 741-A Salvage Yard.

The Removal Action Reports for the Production Area (WSRC 2008b) and the 741-A Salvage Yard (WSRC 2008c) summarize the remediation and confirmatory sample results.

Figures J-5 and J-6 show historical and current photos of MAOU.

Basis for Taking Action

The potential exposure to or ingestion of contaminated soil, exposure to other contaminated media (i.e., concrete) and its potential to contaminate groundwater poses a potential increased risk of cancer to human receptors and is the basis for taking action at the MAOU.

Concrete slabs, below grade concrete barriers and structures, soils surrounding and underneath buildings, process sewer lines, sumps, trenches, and process feeder pipelines were sampled and summarized in the RFI/RI combined document (WSRC 2007a). VOCs (i.e., PCE and TCE) were found to be contaminant migration (CM) constituents of concern (COCs) in the vadose zone soil. Additionally, PCE was found at PTSM levels in deep soils at 321-M. Figure J-3 shows the areas of contamination before the removal actions.

Following completion of the removal actions, only vadose zone soils contaminated with PCE and TCE remained as the contamination requiring remedial action other than land use controls (LUCs). These areas are shown on Figure J-3. All concrete slabs and the 741-A Salvage Yard were effectively remediated to allow for industrial land use. PCE and TCE remained as CM COCs at the Production Area (i.e., 313-M, 320-M, and 321-M facilities) in soils. Approximately 30% of the PCE contaminated soil at PTSM levels remained in deep soil (>3 m [>10 ft] below ground surface) after the removal action below the 321-M slab. This is the contaminated soil that was left in-between the auger excavations completed during the removal action.

IV. Remedial Actions

Remedy Selection

As stated in the ROD (WSRC 2008a), the remedial action objectives (RAOs) for the MAOU after completion of the removal actions are as follows:

- Prevent human exposure to contaminants that present a risk of greater than 1E-06 to a future resident. This RAO applies to all subunits/building remnants in the MAOU.
- Prevent migration of VOCs in building slabs, sumps, or vadose zone to groundwater above MCLs. This RAO applies to the following facilities in the Production Area and their associated inactive process sewer line:
    - Buildings 313-M and 321-M (PCE in soil media)
    - Building 320-M (TCE in soil media)

Following the removal actions, VOC contamination that poses a CM threat remains in the vadose zone soils at 313-M, 320-M, and 321-M. As stated in the ROD (WSRC 2008a), the remedial action selected to meet the RAOs for the MAOU is as follows:

- Passive Soil Vapor Extraction (SVE) and Institutional Controls (i.e., LUCs)

An Explanation of Significant Difference (ESD) to the Revision 1 ROD for the M-Area Operable Unit was issued on July 9, 2009 to expand the selected remedy to include an additional treatment cell (i.e., the Passive SVE Cell) for contaminated soils that were excavated from 321-M during the removal action (SRNS 2009a). As described in the ESD, an infiltration control barrier made of flexible membrane liner (FML) would be placed over the soils/concrete media at the 321-M and Passive SVE Cell and sealed at the BaroBall^{TM}

wells, followed by 0.3 m (1 ft) of clean seeded common fill (i.e., vegetative cover) over the FML.

Remedy Implementation

The selected remedies met the RAOs at MAOU by implementing the following activities:

- Grouting of manholes to prevent access to the inactive process sewer lines.
- Installing four passive SVE wells at 313-M, 320-M, and Manhole 4A with depths between 10.7 and 15.2 m (35 and 50 ft).
- Constructing two VOC treatment cells (i.e., the 321-M Cell and the Passive SVE Cell) with a passive SVE treatment system using BaroBall^{TM} wells to treat 841 m^3 (1,100 yd^3) (321-M) and 2,500 m^3 (3,250 yd^3) (passive SVE) of VOC contaminated soils. Average PCE soil concentrations were 6.6 µg/kg. Placement of an FML infiltration control barrier over the soils/concrete media at the 321-M and Passive SVE Cell followed by 0.3 m (1 ft) of clean seeded common fill (i.e., vegetative cover). The configurations of two cells can be seen in the Post Construction Report (PCR) (SRNS 2011) and/or in Figures J-2-8 through J-2-11 (Attachment J-2).
- Established LUCs (including restricting worker access to contaminated media, manholes, and pipelines, prohibiting public and residential development and use of the property, maintaining the integrity of any SVE systems or monitoring wells, and preventing access to or use of the groundwater until cleanup levels are met) for approximately 28.7 hectares (70.9 acres). This area excludes the MIPSL OU LUC area of 0.69 hectares (1.7 acres) (SRNS 2009b).

System Operations/Operation and Maintenance

The following system operations are ongoing:

As of November 14, 2017, the passive SVE wells are still in operation. Operation of passive SVE wells started on June 16, 2010. The BaroBall^{TM} system is anticipated to operate until RGs are achieved (Table J-2).

Only LUCs including inspection and maintenance activities are required at MAOU as follows:

- Visual inspections for evidence of damage to the vegetative cover at the 321-M and Passive SVE due to erosion, settlement, or intrusion by burrowing animals are performed annually. The inspections also address upkeep of the passive SVE units, and access control barriers (e.g., the warning signs).
- Necessary repairs (e.g., replacing eroded or disturbed soil, sign repair, etc.) and vegetation management (e.g., mowing, removal of larger vegetation, etc.) are performed when required.
- Access controls and use restrictions are enforced to preclude access through the SRS Site Use/Site Clearance program and SRS site security.

Table J-3 compares the actual operation and maintenance (O&M) costs for the five-year remedy review period to the estimated direct O&M costs from the ROD (WSRC 2008a). The estimated O&M cost for Fiscal Year (FY) 2012 to FY2017 is $372,000 for the soil cover, passive SVE units, institutional controls (i.e., LUCs), and five-year remedy reviews. The actual cost for FY2012 to FY2017 is $673,572. The O&M costs from FY2012 to FY2017 are higher than estimated because the ROD estimate did not include the maintenance of the entire MAOU (e.g., mowing, etc.).

V. Progress Since Last Review

The previous protectiveness statement satisfies the current conditions at the MAOU.

VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII, Documents Reviewed;
- Confirmed the implementation of the remedial action;

- Evaluated passive SVE well sampling data to determine if shutdown criteria have been achieved (Attachment J-2);
- Inspected the OU, interviewed maintenance personnel, and documented the results on the Inspection Checklist provided in Attachment J-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance.

Data Review

This is the second monitoring report for the passive SVE activities at the MAOU and includes all data collected since the last review in 2012. Included are diagrams of each passive SVE operation (Figures J-2-7 through J-2-11), data tables of each stations results (Tables J-2-1 through J-2-5), and narrative evaluations of each unit's remediation progress (Attachment J-2).

Summary of Inspections and Interviews

Interviews were conducted with Richard Feagin, O&M staff member, on October 11, 2017, and with George Joyner, O&M Site Manager, on October 12, 2017 at the O&M organization offices. No issues were identified for the MAOU during these interviews.

The MAOU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) and USDOE personnel on December 15, 2017. No issues were identified for the MAOU during this inspection.

A site inspection will be conducted by U.S. Environmental Protection Agency (USEPA) and SCDHEC personnel, accompanied by USDOE and SRNS personnel, prior to submittal of the Revision 1 of this document. It is anticipated that no significant problems regarding this OU will be identified during the inspection.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The remedy is functioning as intended as demonstrated below:

- The selected remedy of LUCs is continuing to prevent human exposure to contaminated soils and concrete slabs. The Land Use Control Implementation Plan for MAOU governs LUC implementation, maintenance, monitoring, reporting, and enforcement of LUCs (SRNS 2009b). The LUCs that are in place include physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), use restrictions to prevent unauthorized contact, removal or excavation of contaminated media (i.e., soils, concrete slabs), restrictions to prevent unauthorized access to or use of groundwater until cleanup levels are met, and restrictions to prevent disturbance of the vegetative cover system. Warning signs are in good condition, and no activities were observed that would have violated the LUCs. All LUC objectives are being met. The annual inspections indicate that there are no intrusive activities and the soil covers over the passive SVE systems are intact.
- The selected remedy of a passive SVE treatment system is effective in preventing the migration of VOCs to the groundwater above MCLs. Per the MAOU PCR and Corrective Measures Implementation/Remedial Action Implementation Plan (SRNS 2009c) requirements, the passive SVE well sampling data at the treatment cells and passive SVE wells, and their evaluation are reported via the Five-Year Reviews. Semiannual monitoring was done for the first year, followed by annually sampling.

Attachment J-2 provides the details, data summary, and evaluation of the past five years of passive SVE monitoring data. In summary, all the passive SVE systems in MAOU appear to be operating as designed. The Manhole 4A (at 321-M) produced the highest concentration of PCE of all the MAOU systems with a maximum concentration of approximately 105.6 ppmv (2014). The Manhole 4A (at 321-M) only consists of one passive SVE well. The 321-M cell consistently produced relatively high concentrations of PCE in multiple wells, which in turn produces more mass removed. This is due to the higher soil VOC concentrations associated with the 321-M unit. The 320-M unit produced the highest TCE concentration of 14.8 ppmv (2012). This is due to the higher TCE concentration in the 320-M soil. The other systems were of lower concentrations of PCE and TCE results. A summary of the data at each system is provided in Table J-4. The wells at 313-M, the Passive SVE Cell, 321-M, and Manhole 4A were not sampled during the 2015 sampling event due to no flow conditions. The passive SVE systems are effectively removing VOCs, at much lower levels than the previous report. However, these concentrations are not low enough to achieve RGs; therefore, operation and monitoring of these systems is proposed to continue. No confirmatory soil samples are proposed to be collected to compare to RGs at this time.

Are Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still valid?

The exposure assumptions, toxicity data, and cleanup levels used at the time of remedy selection are still valid. There have been no changes in standards or to-be-considered guidance identified in the ROD that call into question the protectiveness of the remedy.

The USEPA standards and toxicity values have been updated since the last five-year remedy review as shown in Appendix B. The changes to the values for COCs at the MAOU were not significant, and the RAOs continue to be met by the remedial action. No new standards or to-be-considered guidance have been identified that call into question the protectiveness of the remedy.

Fact sheets provided on the USEPA webpage regarding emerging contaminants were reviewed for applicability to this site. None of the listed emerging contaminants were identified as applicable to this OU.

Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No new information has come to light that could call into question the protectiveness of the remedy.

VIII. Issues

There are no issues related to current site conditions or activities that currently prevent the remedy from being protective.

IX. Recommendations and Follow-up Actions

There are no recommendations or follow-up actions for this OU.

X. Protectiveness Statement(s)

The remedy at MAOU is protective of human health and the environment.

Exposure pathways that could result in unacceptable risks are being controlled by LUCs to prevent exposure to or ingestion of contaminated soil and concrete media. The passive SVE treatment systems are effective in preventing the migration of VOCs to the groundwater above MCLs. All threats to contaminated media at the MAOU are being addressed through physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the MAOU for industrial use only, and warning signs and use restrictions via the SRS Site Use/Site Clearance Program.

XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Operating Equipment is scheduled for January 2024.

XII. Documents Reviewed

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

SRNS, 2009a. *Explanation of Significant Difference to the Revision 1 Record of Decision for the M Area Operable Unit (MAOU) (U),* SRNS-RP-2009-00406, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2009b. *Land Use Control Implementation Plan (LUCIP) for the M-Area Operable Unit (U)*, WSRC-RP-2008-4067, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2009c. *Corrective Measures Implementation/Remedial Action Implementation Plan (CMI/RAIP) for the M-Area Operable Unit (MAOU) (U)*, WSRC-RP-2008-4063, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2011. *Post-Construction Report for the M-Area Operable Unit (U)*, Revision 1, February 2011, SRNS-RP-2010-00991, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 1999. *Land Use Control Assurance Plan for the Savannah River Site*, WSRC-RP-98-4125, Revision 1.1, latest revision, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC, 2006a. *Record of Decision Remedial Alternative Selection for the M Area Inactive Process Sewer Lines Operable Unit (081-M) (U)*, WSRC-RP-2006-4001, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken SC

WSRC, 2006b. *Removal Site Evaluation Report/Engineering Evaluation/Cost Analysis for the Contaminated Surficial Soils in the 741-A Salvage Yard at the M Area Operable Unit (U)*, WSRC-RP-2006-4053, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken SC

WSRC, 2007a. *RCRA Facility Investigation/Remedial Investigation (RFI/RI) Work Plan, RFI/RI Report with Baseline Risk Assessment (BRA) and Corrective Measures Study/Feasibility Study (CMS/FS) for M Area Operable Unit (U)*, WSRC-RP-2006-4060, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken SC

WSRC, 2007b. *Removal Site Evaluation Report/Engineering Evaluation/Cost Analysis at the Production Area of M Area Operable Unit (U)*, WSRC-RP-2006-4059, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken SC

WSRC, 2008a. *Record of Decision Remedial Alternative Selection for the M-Area Operable Unit (U)*, WSRC-RP-2008-4030, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC, 2008b. *Removal Action Report for the Production Area of M-Area Operable Unit (U)*, WSRC-RP-2008-4055, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC, 2008c. *Removal Action Report for the Contaminated Surficial Soil in the 741-A Salvage Yard at the M-Area Operable Unit (U)*, WSRC-RP-2008-4027, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

Various - Inspection Data Sheets – *Field Inspection Checklist, M-Area Operable Unit (U)*, ER-IDS-019-057, Inspection period 2012 through 2017 (annually)

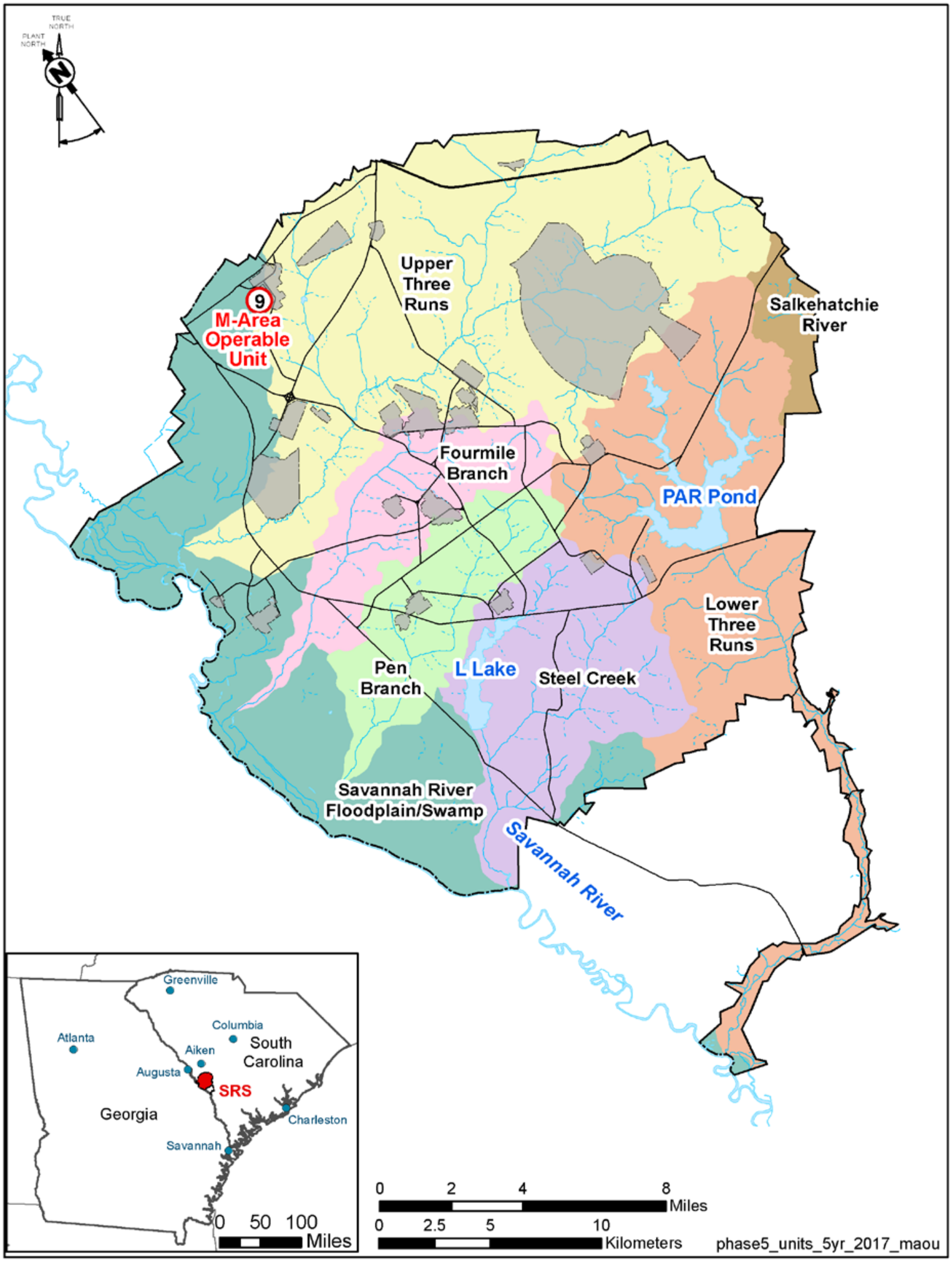

Figure J-1. Location of MAOU at Savannah River Site

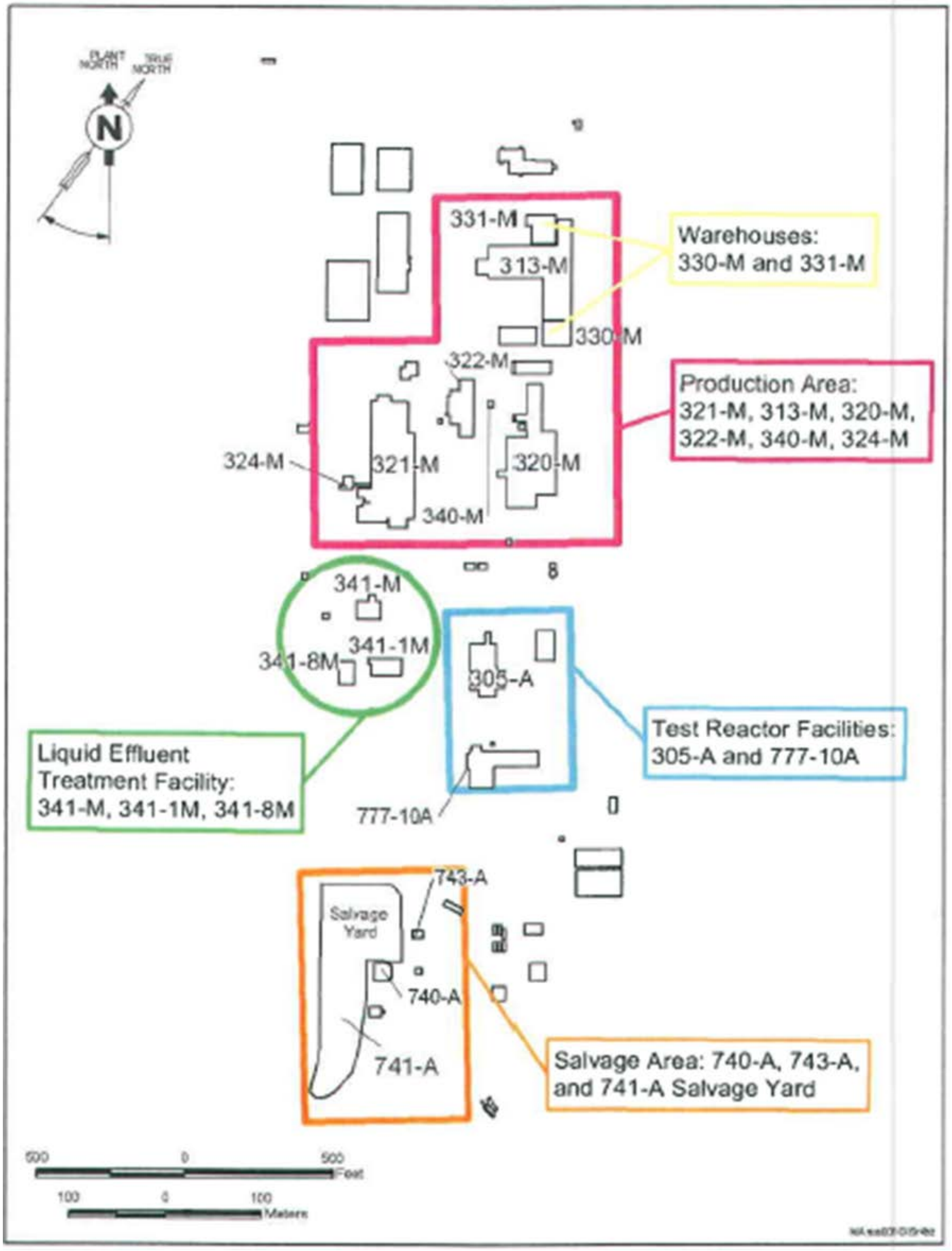

Figure J-2. Location of MAOU Subunits

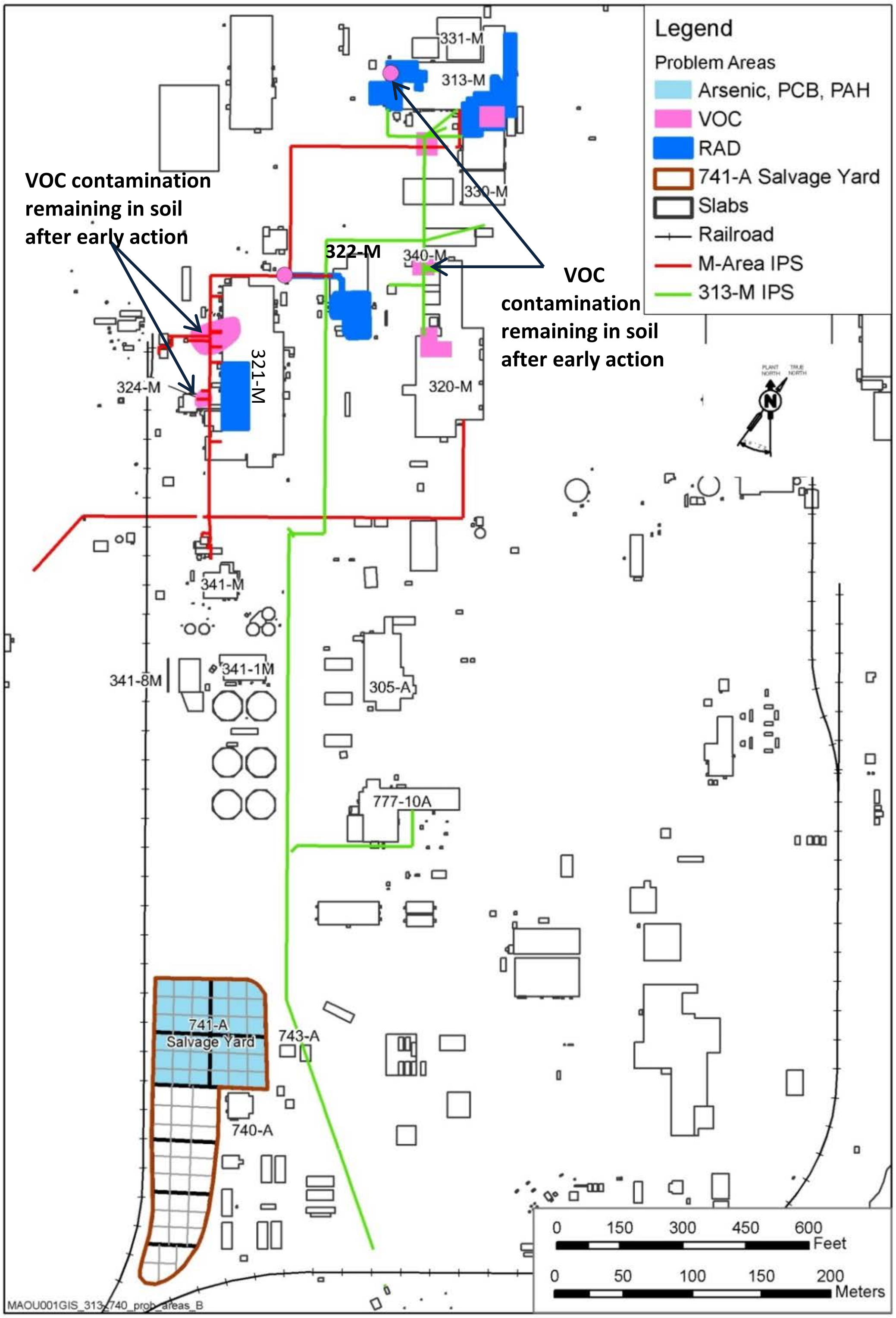

Figure J-3. Previous Areas of Contamination at the MAOU Before Removal Actions

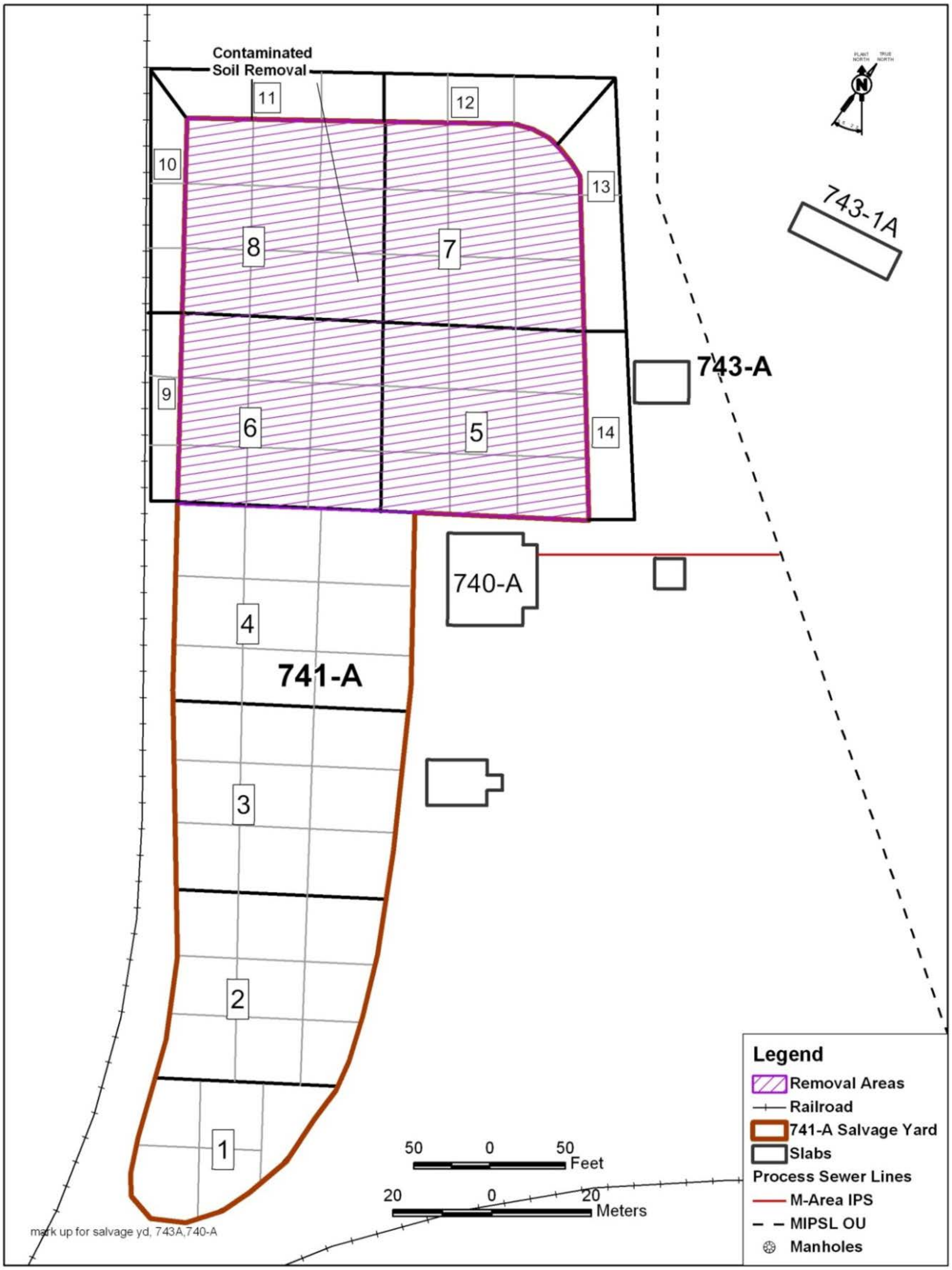

Figure J-4. Area of Contaminated Soil Removal at the 741-A Salvage Yard

Figure J-5. Aerial Photo of MAOU (Production Area) Before Deconstruction (Prior to 2003)

Figure J-6. Current (2017) Photos of MAOU

Table J-1. Chronology of OU Events

Event	Date
Removal Action Start / Complete	February 21, 2007 / April 10, 2008
ROD Issuance	February 5, 2009
ESD to the ROD Issuance	July 9, 2009
Remedial Action Construction Start / Finish	August 10, 2009 / July 21, 2010
Remedial Action Operations Start / Finish	June 16, 2010 / On-going
Previous Five-Year Reviews Issuance	February 4, 2014

Table J-2. Final RCOC RGs

RCOC	Type RCOC	RG
PCE at 313-M	CM	1.80 mg/kg
PCE at 321-M	CM	3.00 mg/kg
TCE at 320-M MIPSL Tie-in	CM	15.00 mg/kg

Table J-3. Actual versus Estimated O&M Costs

	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	5-Year Total
Total Actual O&M Costs ($)	87,349	100,345	123,140	105,073	130,528	127,137	673,572
Total ROD Estimated Direct O&M Costs ($)	102,000	42,000	42,000	42,000	42,000	102,000	372,000

Table J-4. Summary of Passive SVE Monitoring Data

System	2012 Max		2013 Max		2014 Max		2015 Max		2016 Max	
	PCE	TCE	PCE	TCE	PCE	TCE	PCE	TCE	PCE	TCE
313-M	0.224	0.017	0.748	0.02	2.788	0.029	NA	NA	0.1301	0.0268
321-M Cell	51.133	2.772	26.1	0.772	1.353	0.07	87.2	5.73	8.529	0.2336
Passive SVE Cell	3.714	0.337	0.165	0.016	2.017	0.221	NA	NA	1.448	0.1274
320-M	2.574	14.757	3.67	12.6	1.82	4.56	NA	NA	0.5265	1.763
Manhole 4A (at 321-M)	93.184	0.03	53.3	0.024	105.6	0.091	NA	NA	0.8211	0.0268

N/A – not applicable

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Attachment J-1. Five-Year Review Site Inspection Checklist – M-Area Operable Unit

I. SITE INFORMATION			
Site Name:	**M-Area Operable Unit**	**Date of Inspection:**	**10/16/2017**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**CERCLIS #92**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**76°F and Cloudy**

Remedy Includes: *(Click all that apply)*

☒ Landfill Cover/Containment
☒ Access Controls
☒ Institutional Controls
☐ Groundwater Pump and Treatment
☐ Surface Water Pump and Treatment
☐ Monitored Natural Attenuation
☐ Groundwater Containment
☐ Vertical Barriers
☒ Other Soil Vapor Extraction, soil fracturing

Attachments: ☐ Inspection team roster attached ☐ Inspection team roster attached

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 10/12/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

Problems/Suggestions: ☐ Report Attached

2. **O&M Staff:** Richard Feagin (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord (Title) 10/11/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4416

Problems/Suggestions: ☐ Report Attached

Attachment J-1. Five-Year Review Site Inspection Checklist – M-Area Operable Unit *(continued)*

II. INTERVIEWS *(Click all that apply) (Continued)*

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

Agency: __________

Contact: ______ (Name) ______ (Title) ______ (Date) ______ (Phone No.)

Problems/Suggestions: ☐ Report Attached __________

Agency: __________

Contact: ______ (Name) ______ (Title) ______ (Date) ______ (Phone No.)

Problems/Suggestions: ☐ Report Attached __________

Agency: __________

Contact: ______ (Name) ______ (Title) ______ (Date) ______ (Phone No.)

Problems/Suggestions: ☐ Report Attached __________

4. **Other Interviews** *(Optional):* ☐ Report Attached __________

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Click all that apply)*

1. **O&M Documents:**

☐ O&M Manual	☐ Readily Available	☐ Up to Date	☐ N/A
☒ As-Built Drawings	☒ Readily Available	☒ Up to Date	☐ N/A
☐ Maintenance Logs	☐ Readily Available	☐ Up to Date	☐ N/A

Remarks: See *Waste Unit Inspection and Maintenance, ER-SOP-019, Field Inspection Checklist for MAOU*, ER-IDS-019-057.

Attachment J-1. Five-Year Review Site Inspection Checklist – M-Area Operable Unit *(continued)*

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)*

1. Health and Safety Plans (HASPs):

☐ Site-Specific Health and Safety Plans ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Contingency Plan/Emergency Response Plan ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.120 HAZWOPER. A SSHASP is prepared if needed.

2. O&M and OSHA Training Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix.

3. Permits and Service Agreements:

☒ Air Discharge Permit ☒ Readily Available ☒ Up to Date ☐ N/A
☐ Effluent Discharge ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Waste Disposal; POTW ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Other Permits ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

4. Gas Generation Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

5. Settlement Monument Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

6. Groundwater Monitoring Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks:

7. Leachate Extraction Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

8. Discharge Compliance Records:

☒ Air ☒ Readily Available ☒ Up to Date ☐ N/A
☐ Water (Effluent) ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

9. Daily Access/Security Logs: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

Attachment J-1. Five-Year Review Site Inspection Checklist – M-Area Operable Unit *(continued)*

IV. O&M COSTS

1. O&M Organization:

☐ State In-House ☐ Contractor for State
☐ PRP In-House ☐ Contractor for PRP
☒ Other: SRS

2. O&M Cost Records:

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

Total annual cost by year for review period, if available

From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached

3. Unanticipated or Unusually High O&M Costs During Review Period

Describe costs and reasons: ______

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing Damage: ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks: OU-specific perimeter fencing is not required by the remedial action.

B. Signs

1. Signs and Other Security Measures: ☐ Location shown on site map ☐ N/A
Remarks: Signs are in good condition.

Attachment J-1. Five-Year Review Site Inspection Checklist – M-Area Operable Unit *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Once in five years
Responsible Party/Agent: USDOE Savannah River Field Office
Contact: Karen Adams (Name) Federal Project Director (Title) 12/15/17 (Date) 803-952-7871 (Phone No.)

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

2. Adequacy: ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks:

D. General

1. Vandalism/Trespassing: ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

2. Land use changes onsite: ☒ N/A
Remarks:

3. Land use changes offsite: ☒ N/A
Remarks:

Attachment J-1. Five-Year Review Site Inspection Checklist – M-Area Operable Unit *(continued)*

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. Roads damaged: ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks:____
____

B. Other Site Conditions

Remarks: The annual inspections indicate there are no intrusive activities and the soil covers over the passive SVE systems are intact.____
____
____
____

VII. LANDFILL COVER / CONTAINMENT ☒ Applicable ☐ N/A

A. Landfill Surface

1. Settlement (Low spots)**:** ☐ Location shown on site map ☒ Settlement not evident
Areal extent__________________ Depth____________________
Remarks:____
____

2. Cracks: ☐ Location shown on site map ☒ Cracking not evident
Lengths____________________ Widths____________________ Depths____________________
Remarks:____
____

3. Erosion: ☐ Location shown on site map ☒ Erosion not evident
Areal extent__________________ Depth____________________
Remarks:____
____

4. Holes: ☐ Location shown on site map ☒ Holes not evident
Areal extent__________________ Depth____________________
Remarks:____
____

5. Vegetative Cover: ☒ Grass ☒ Cover properly established ☒ No signs of stress
Areal extent__________________ Depth____________________
Remarks:____
____

Attachment J-1. Five-Year Review Site Inspection Checklist – M-Area Operable Unit *(continued)*

VII. LANDFILL COVER / CONTAINMENT *(Continued)*

6. Alternative Cover (armored rock, concrete, etc.): ☒ N/A
Remarks:____

7. Bulges: ☐ Location shown on site map ☒ Bulges not evident
Areal extent_______________ Depth__________________
Remarks:____

8. Wet Areas / Water Damage: ☒ Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent_______________
☐ Ponding ☐ Location shown on site map Areal extent_______________
☐ Seeps ☐ Location shown on site map Areal extent_______________
☐ Soft subgrade ☐ Location shown on site map Areal extent_______________
Remarks:____

9. Slope Instability: ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability
Areal extent_______________
Remarks:____

B. Benches ☐ Applicable ☒ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel)

C. Letdown Channels ☐ Applicable ☒N/A

(Channel lined with erosion control mates, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies)

D. Cover Penetrations ☐ Applicable ☒ N/A

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

F. Cover Drainage Layer ☐ Applicable ☒ N/A

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

H. Retaining Walls ☐ Applicable ☒ N/A

I. Perimeter Ditches/Offsite Discharge ☐ Applicable ☒ N/A

Attachment J-1. Five-Year Review Site Inspection Checklist – M-Area Operable Unit *(continued)*

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A

X. OTHER REMEDIES

If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

A. Soil Vapor Extraction System ☒ Applicable ☐ N/A

1. Blowers, Wellhead Plumbing, and Electrical:

☒ Good Condition ☒ All required wells located ☐ Needs maintenance ☐ N/A

Remarks: Passive SVE systems are in service.

2. Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances:

☒ Good Condition ☐ Needs maintenance

Remarks:

3. Spare Parts and Equipment:

☒ Readily Available ☒ Good Condition ☐ Requires Upgrade ☐ Needs to be provided

Remarks:

Attachment J-1. Five-Year Review Site Inspection Checklist – M-Area Operable Unit *(continued/end)*

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

The remedial action for the MAOU is Passive SVE to prevent the migration of VOCs from the contaminated soils to groundwater above the MCLs, vegetative soil cover, and institutional controls to protect remedial workers and future industrial workers from unacceptable exposure to VOCs. As reported in Section VII, the Passive SVE operations demonstrate that these actions are effective and that the remedies are functioning as designed.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The O&M procedures are adequately maintaining the integrity of the Passive SVE Systems. The O&M procedures consisting of annual site inspections and site maintenance (vegetative cover and warning signs) and site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the OU) have been implemented. There are no issues requiring corrective actions.

C. Early Indicators of Potential Remedy Failure

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

N/A

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Attachment J-2. Passive SVE Monitoring Data

Passive soil vapor extraction (SVE) is used at 313-M, 320-M, 321-M, Manhole 4A and the Passive SVE Cell to treat chlorinated volatile organic compounds (cVOC) in the vadose zone and in excavated soil and concrete rubble (321-M Cell and Passive SVE Cell) at the M Area Operable Unit (MAOU). Contaminant migration (CM) issues center around tetrachloroethylene (PCE), and trichloroethylene (TCE). PCE is the CM constituent for the 313-M, 321-M, Manhole 4A and Passive SVE Cell, and TCE is the CM issue for 320-M. The remedial objective of the Passive SVE systems is to remove cVOCs from the vadose zone, soil and debris excavated during the MAOU removal action so that the remaining cVOCs no longer represent a CM threat. Figure J-2-1 illustrates the location of the MAOU Passive SVE systems at 313-M (MSVE-313), 321-M (321-M Cell), Manhole 4A (MSVE-4A) and Passive SVE Cell, and 320-M. All of these systems operate solely on barometric pressure change and do not have mechanical support. Each of the systems and their monitoring results are described in more detail below. The wells at 313-M, the Passive SVE Cell, 321-M, and Manhole 4A were not sampled during the 2015 sampling event due to no flow conditions.

313-M

The 313-M Passive SVE system consists of a single well (MSVE -313) to a depth of 15.2 m (50 ft) with a screened interval between 4.6 and 13.7 m (15 and 45 ft) below ground surface (bgs).

The 313-M Passive SVE system was sampled on 10/4/2012, 12/11/2013, 10/9/2014 and 11/14/2016. The data indicate that the primary contaminant is PCE. This is further supported by presence of 1,1,1-trichloroethane and TCE, which are much more volatile and are present at lower concentrations. The maximum detection of PCE (2.8 parts per million vapor [ppmv]) was during the 2014 sampling event. The lowest detection of PCE (0.13 ppmv) occurred during the 2016 sampling event. PCE concentrations increased during every sampling event until falling off in 2016. Table J-2-1 presents the analytes and detections. All sampling events were at a time of decreasing barometric pressure. Figures J-2-2 through J-2-6 show the daily barometric pressure changes during each sampling event. The fact that there is little concentration difference between the sampling events suggests that there is little contamination present.

321-M Passive SVE Cell

The 321-M Passive SVE Cell consists of a series of five perforated horizontal pipes placed on top of the vertical excavation area adjacent to the 321-M building, and one horizontal perforated pipe placed within the backfilled area of the excavation. Figures J-2-7 and J-2-8 illustrate the planar and vertical configurations of the cell, respectively. The five horizontal pipes are connected via manifold and are sampled at locations 1A, 2A, 3A, 4A, and 5A once per year. The single horizontal pipe in the backfill is sampled at location 6A once per year.

The 321-M Passive SVE Cell was sampled on 10/8/2012, 12/10/2013, 10/7/2014, 12/2/2015 and 11/9/2016. The samples from locations 1A to 6A indicate that the primary cVOC is PCE. The range of cVOCs at this unit are greater (i.e., 1,1-dichloroethylene, 1,1,2-trichloro-1,2,2-trifluoroethane, 1,1,1-trichloroethane, carbon tetrachloride, TCE, and PCE). The highest concentration of PCE (87.2 ppmv) occurred in the 2015 sampling event at location 3A, the lowest concentration of PCE (0.16 ppmv) occurred in the 2014 sampling event at location 5A. Table J-2-2 presents the analytes and detections. The atmospheric barometric pressure was increasing during the 2012, 2013, 2015, and 2016 sampling events. During the 2014 sampling event, the atmospheric barometric pressure was in a decreasing state. No trend was observed form increasing or decreasing barometric pressure. Lower cVOC concentrations were produced in 2014 and 2016, while higher concentrations were found in the other sampling events.

Passive SVE Cell

The Passive SVE Cell, located south of the M-1 Air Stripper (Figure J-2-1), consists of five horizontal perforated pipes installed in the contaminated soil and concrete debris from the 320-M and 321-M buildings removal actions. Figures J-2-9 and J-2-10 illustrate the planar and vertical configurations of the passive SVE cell, respectively. The Passive SVE Cell is currently monitored at locations 1B, 2B, 3B, 4B, and 5B, once per year.

The passive SVE cell was sampled on 10/4/2012, 12/9/2013, 10/8/2014 and 11/14/2016. The samples from locations 1B to 5B indicate that the primary cVOC is PCE. 1,1,1-trichloroethylene, TCE, and trichlorofluoromethane are also detected periodically at lower concentrations (< 1 ppmv). The cVOC concentrations from all the sampling events are relatively low; this fact is not a surprise because the cVOC concentrations in the soil within the cell are low. The highest concentration for PCE (3.7 ppmv) occurred in the 2012 sampling event at station 5B. The lowest concentration of PCE (0.014 ppmv) occurred in the 2013 sampling event at station 2B. Table J-2-3 presents the analytes and detections. Barometric pressure was falling during the 2012, 2013, and 2016 sampling, and increasing during the 2014 sampling. No trends of cVOC concentrations due to barometric pressure were evaluated, likely due to the low cVOC concentrations throughout.

320-M

The 320-M passive SVE system has two passive SVE wells, 320-1 and 320-2. The wells were placed between vertical excavation areas from the early removal actions and support cVOC removal in a similar fashion as the 321-M cell. Figure J-2-11 shows the location of the wells with respect to the vertical excavations. Both wells have a total depth of 10.5 m (35 ft), and are screened between 2.7 and 10.5 m (9 and 35 ft) bgs.

The wells were sampled 10/4/2012, 12/11/2013, 10/9/2014, 11/9/2016 and 11/14/2016. The gas data indicates that the primary constituent is TCE with lesser concentrations of PCE, with occasional detections of carbon tetrachloride and 1,1,1-trichloroethane. The highest (14.76 ppmv) and lowest (0.11 ppmv) concentration of TCE produced was during the 2012 sampling event at well MSVE-320-2 and MSVE-320-1, respectively. TCE increased every year at well MSVE-320-1 and decreased every year at well MSVE-320-2, however concentrations in 2016 were all low. Table J-2-4 presents the analytes and detections. The barometric pressure was decreasing during the 2012, 2013, 2014 and November 14, 2016 sampling. Barometric pressure was in an increasing state on November 9, 2016. No barometric trends were indicated by the cVOC results.

Manhole 4A (MSVE-4A)

The Passive SVE system at manhole 4A, located west of building 321-M, consists of a single Passive SVE well (MSVE-4A) to a depth of 15.2 m (50 ft) with a screened interval between 3.2 and 13.8 m (10.4 and 45.4 ft) bgs.

The Passive SVE well was sampled on 10/8/2012, 12/11/2013, 10/9/2014 and 11/14/2016. The samples indicate that the primary cVOC is PCE. Detections of 1,1,1-trichloroethane and TCE are also present during every sampling event except in 2016, but at much lower values (< 1 ppmv). PCE was also detected at a much lower concentration (0.8211 ppmv) in 2016, the lowest of all the sampling events. The highest concentration of PCE was detected in the 2014 sampling event at 105.6 ppmv. Table J-2-5 presents the analytes and detections. Barometric pressure was falling during the 2013, 2014 and 2016 sampling, and increasing during the 2012 sampling. No trends were observed from the barometric pressure.

Conclusion

All passive soil vapor extraction systems in MAOU appear to be operating as designed. The systems continue to extract cVOC but at a much lower rate. The cVOC concentrations have been lower in the 313-M, 320-M, Manhole 4A, and the Passive SVE Cell, over the past years because the sources are smaller and less concentrated. As of 2016, concentrations in all wells seem to be relatively low. In fact, PCE and TCE concentrations were all below MCLs in 2016 except at the 321-M Passive SVE Cell. Concentrations are not yet believed to be low enough to achieve remedial goals; therefore, continued passive operation and yearly monitoring of the passive SVE systems is expected until vapor levels drop and level off to diminishing returns. No confirmatory soil samples are proposed to be collected at this time.

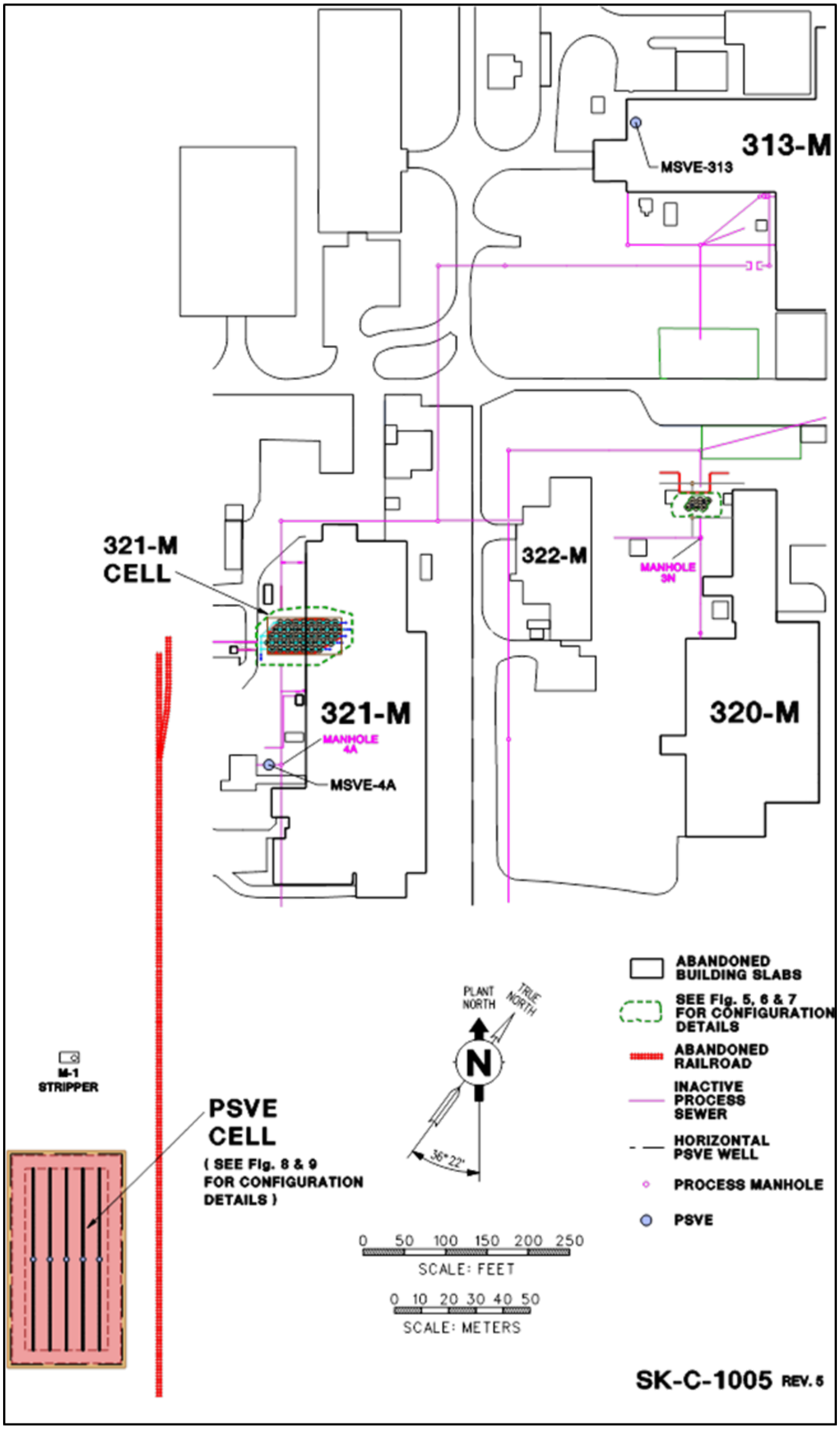

Figure J-2-1. Location of the Passive Soil Vapor Extraction Systems in MAOU

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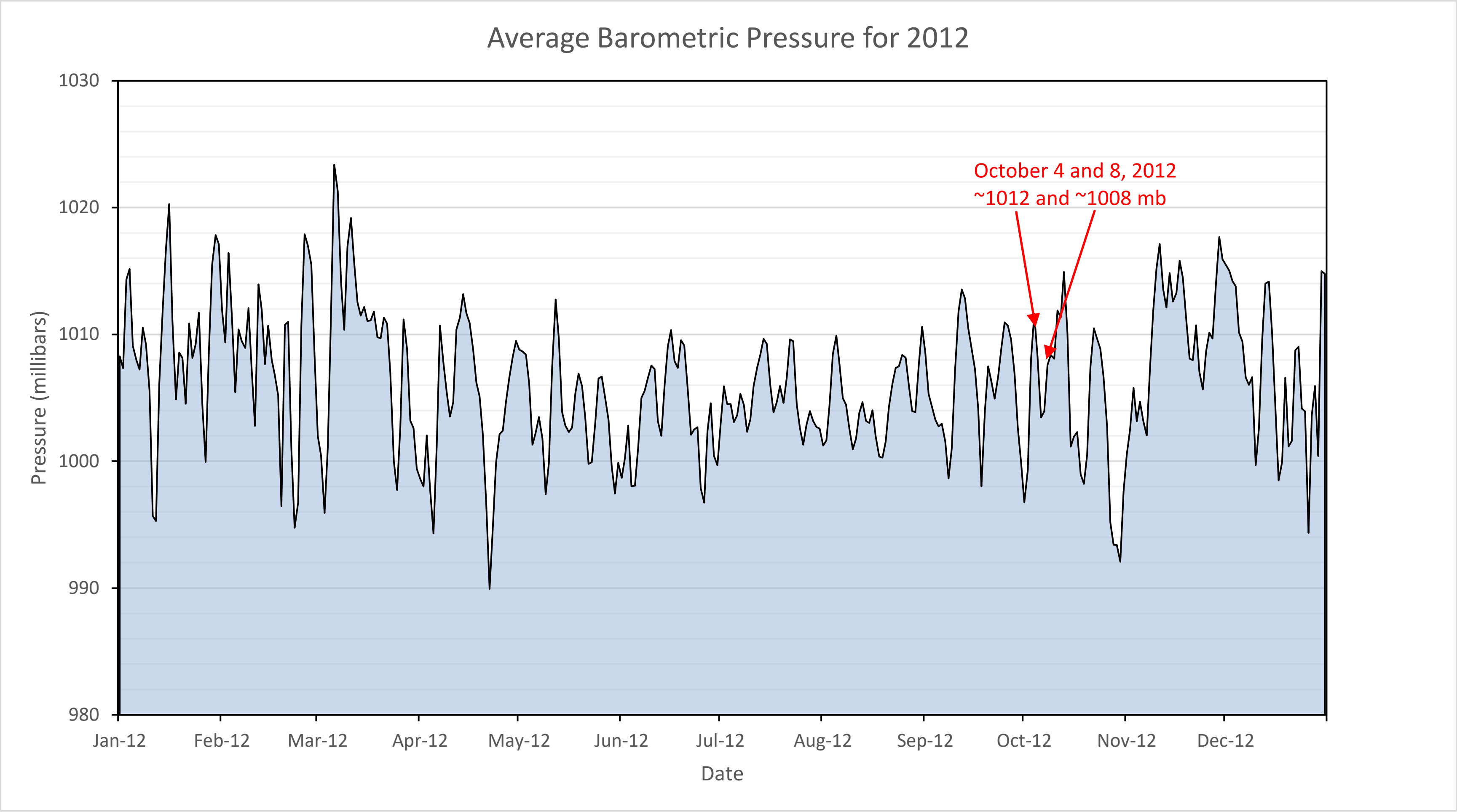

Figure J-2-2. **2012 Daily Barometric Pressure Measurements at SRS with Passive SVE Sampling Events Identified**

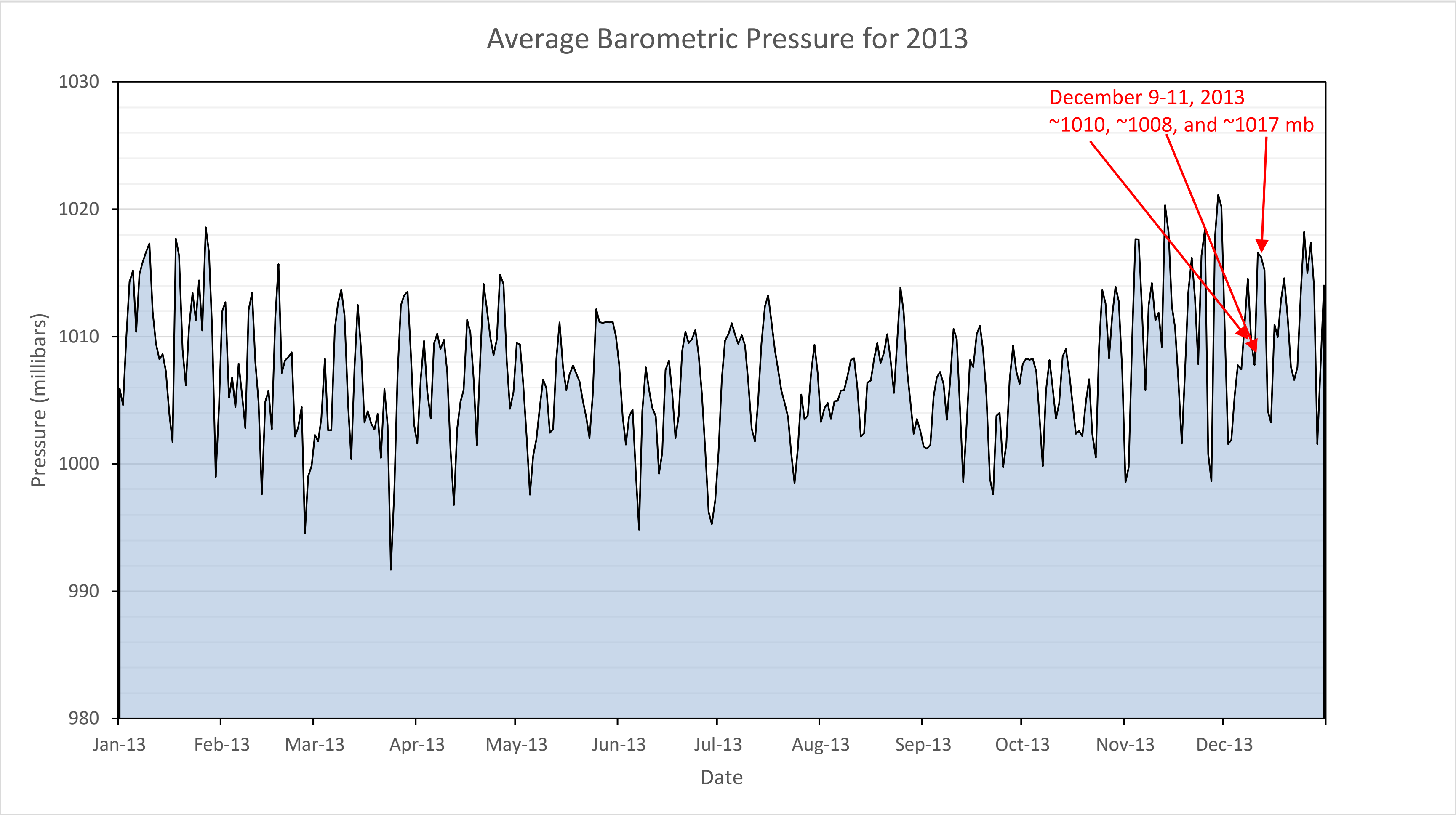

Figure J-2-3. 2013 Daily Barometric Pressure Measurements at SRS with Passive SVE Sampling Event Identified

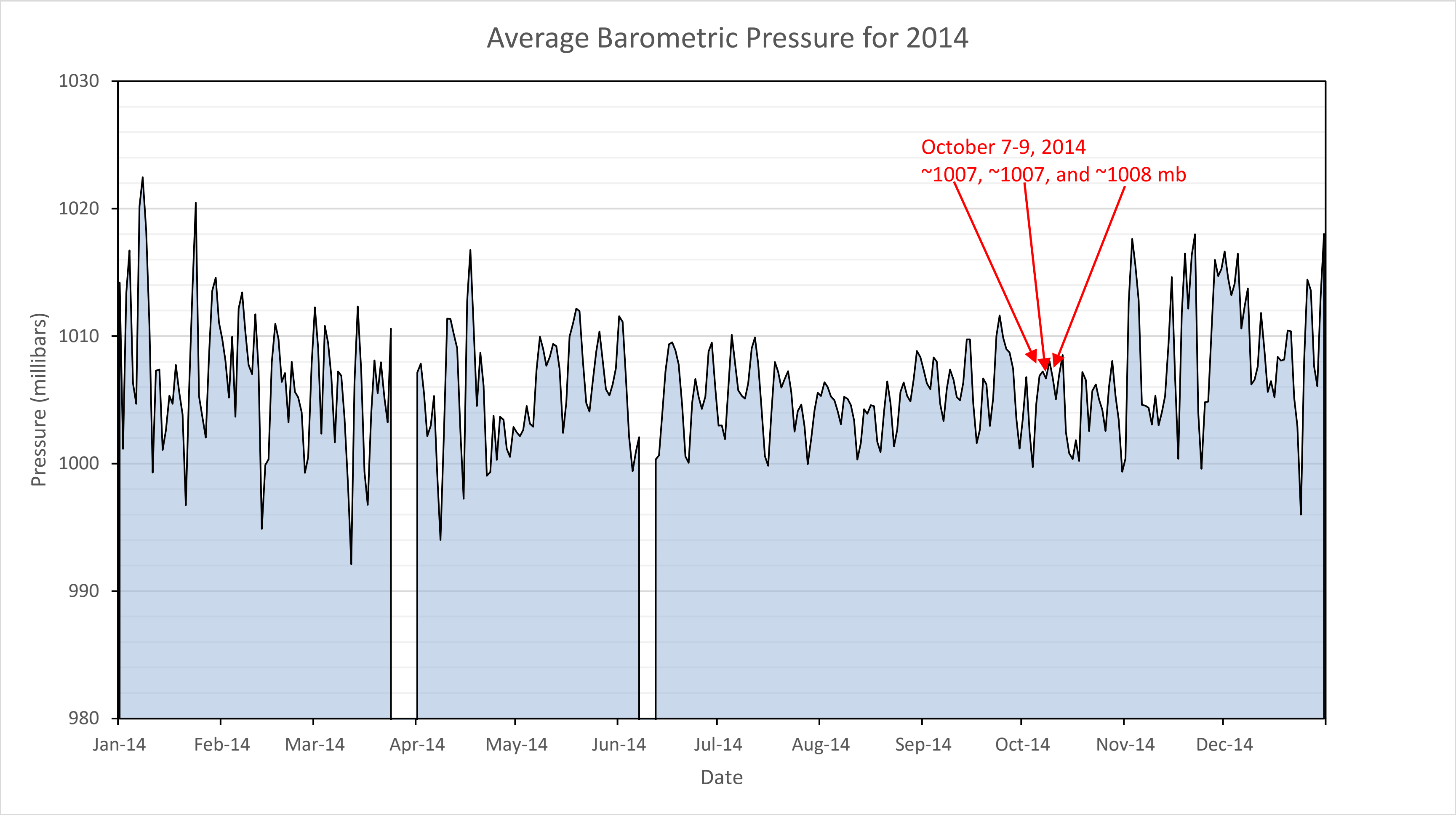

Figure J-2-4. **2014 Daily Barometric Pressure Measurements at SRS with Passive SVE Sampling Event Identified**

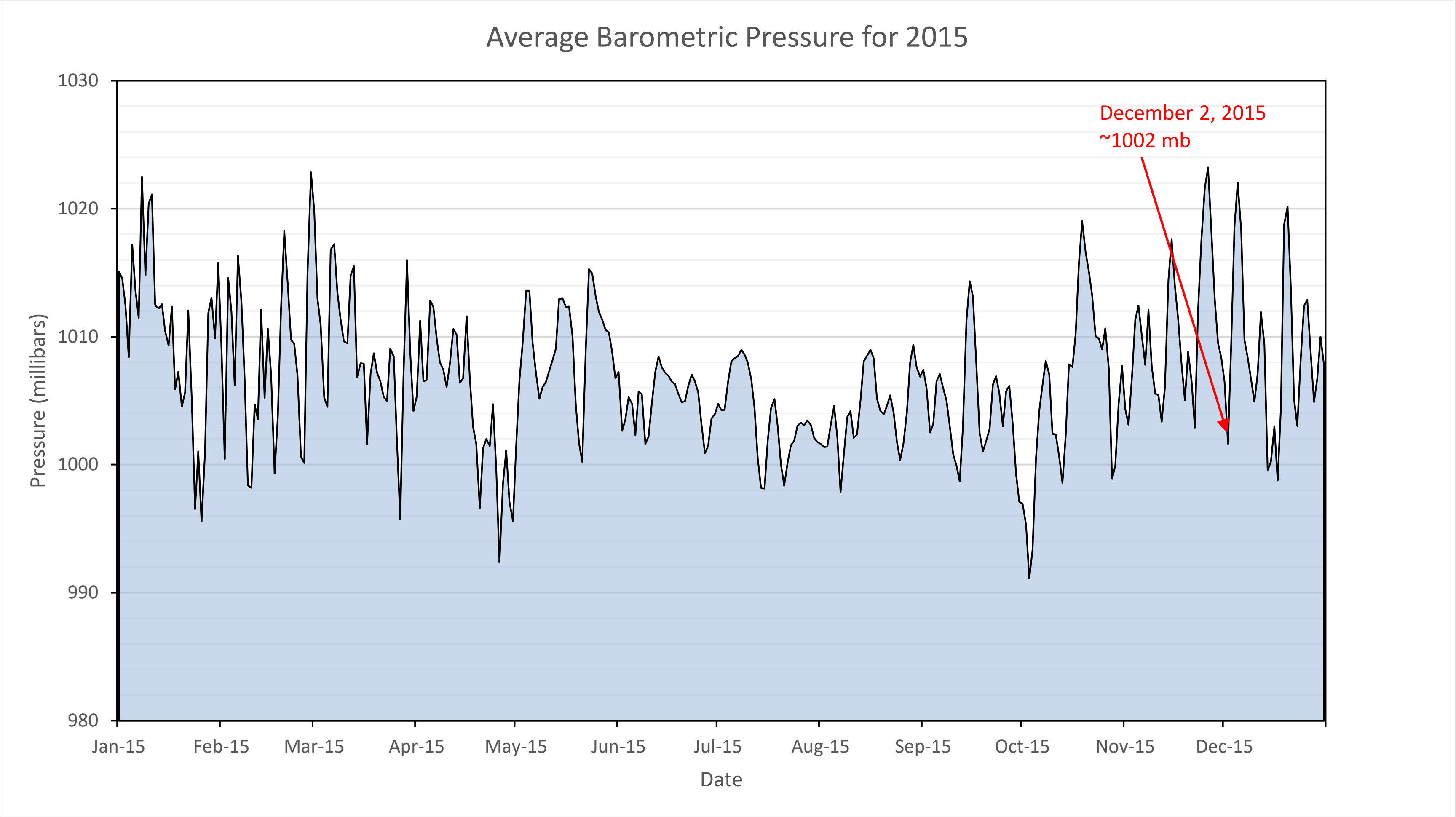

Figure J-2-5. **2015 Daily Barometric Pressure Measurements at SRS with Passive SVE Sampling Event Identified**

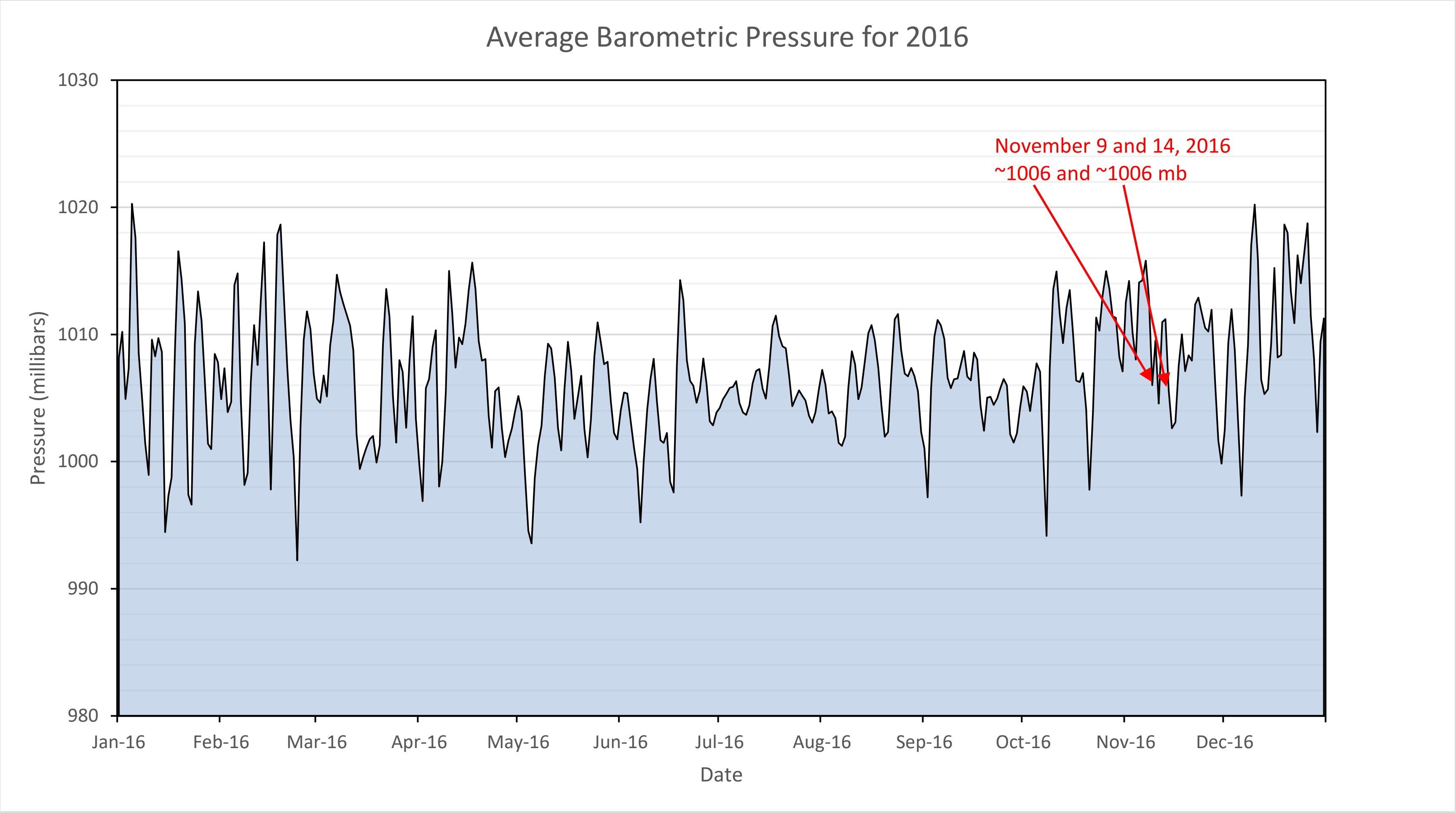

Figure J-2-6. **2016 Daily Barometric Pressure Measurements at SRS with Passive SVE Sampling Event Identified**

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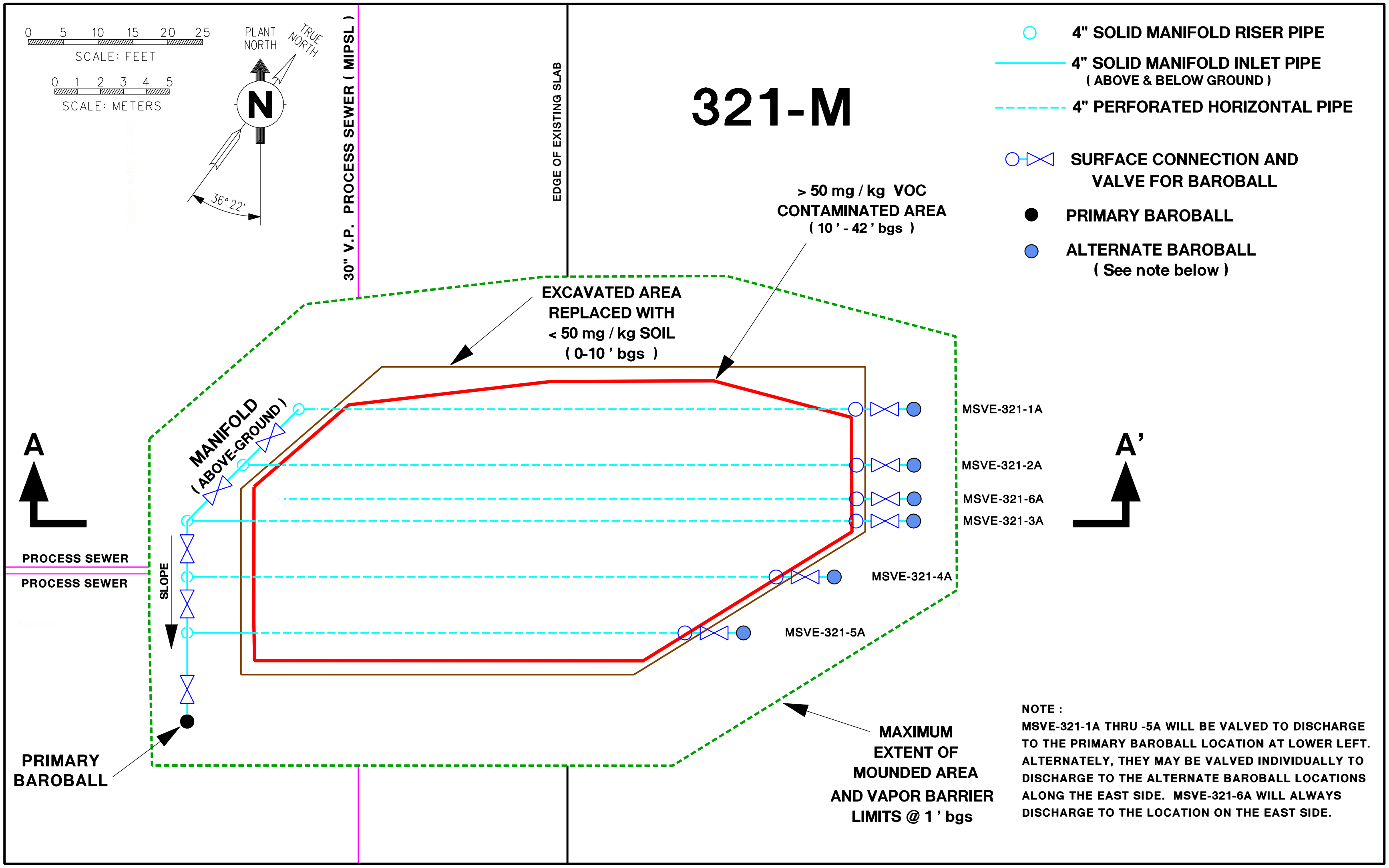


NOTE :
MSVE-321-1A THRU -5A WILL BE VALVED TO DISCHARGE TO THE PRIMARY BAROBALL LOCATION AT LOWER LEFT. ALTERNATELY, THEY MAY BE VALVED INDIVIDUALLY TO DISCHARGE TO THE ALTERNATE BAROBALL LOCATIONS ALONG THE EAST SIDE. MSVE-321-6A WILL ALWAYS DISCHARGE TO THE LOCATION ON THE EAST SIDE.

Figure J-2-7. Planar Configuration of the 321-M Passive SVE Cell

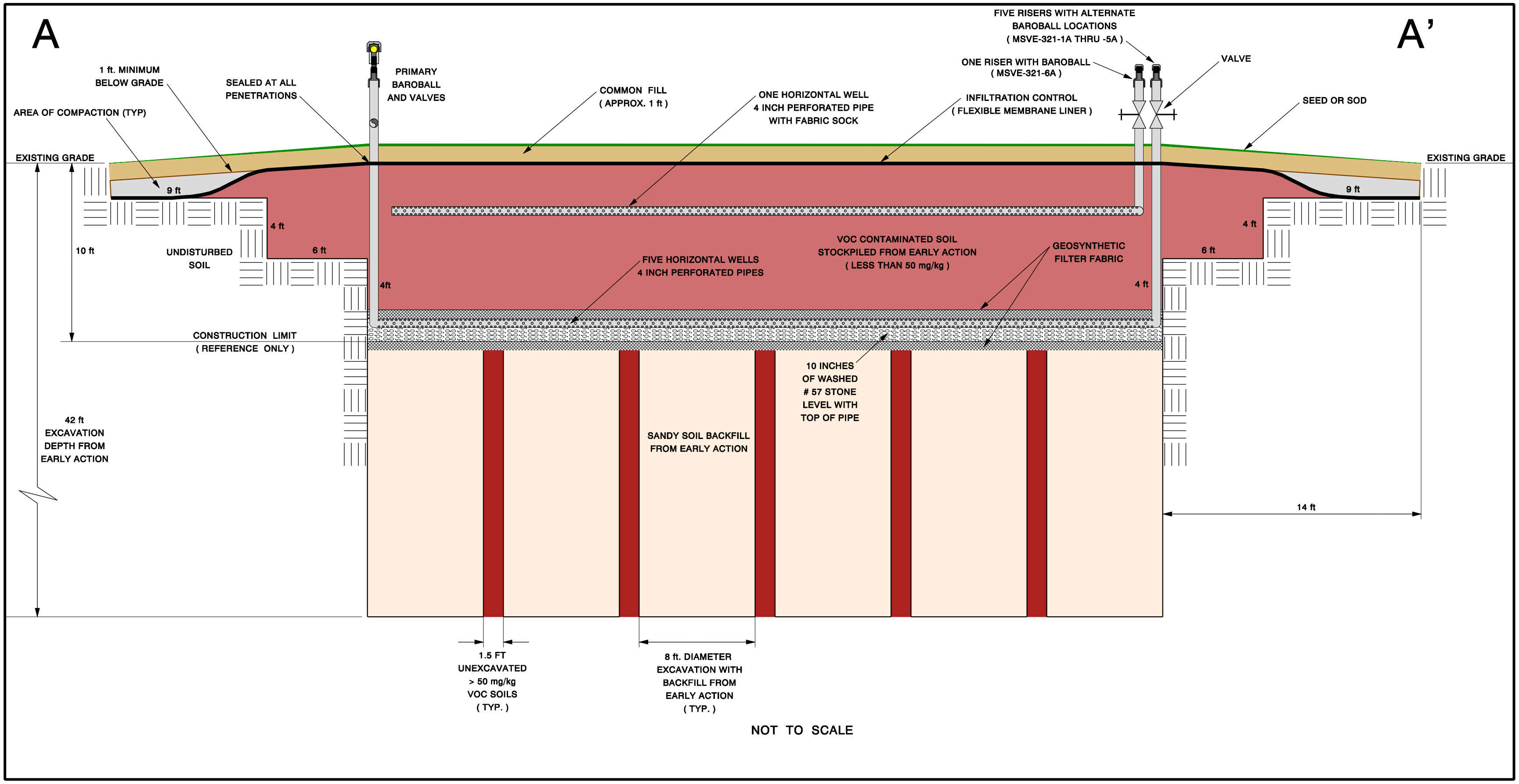


Figure J-2-8. **Vertical Configuration of the 321-M Passive SVE Cell, Showing Piping Above the Vertical Excavations and within the Fill**

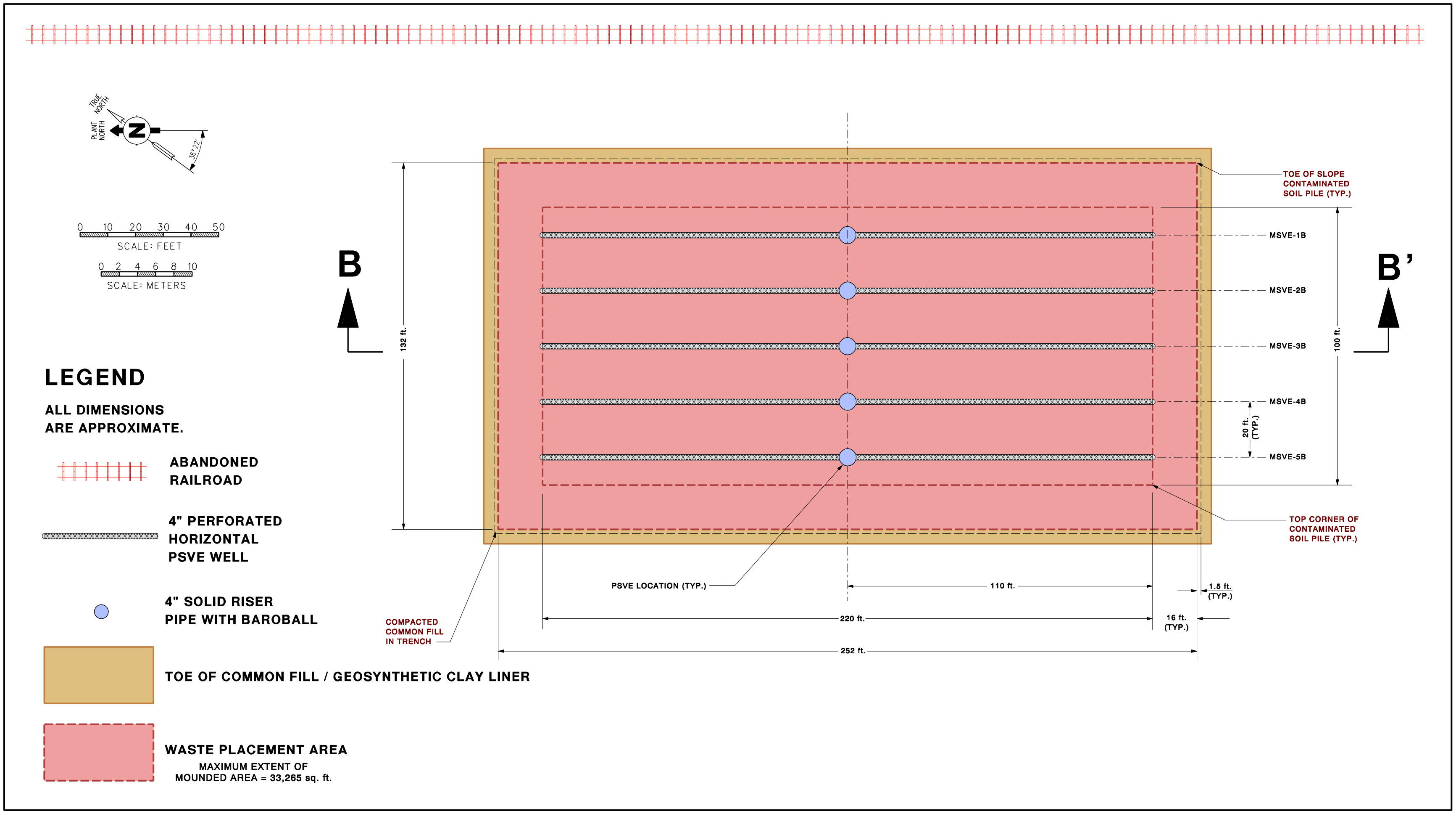
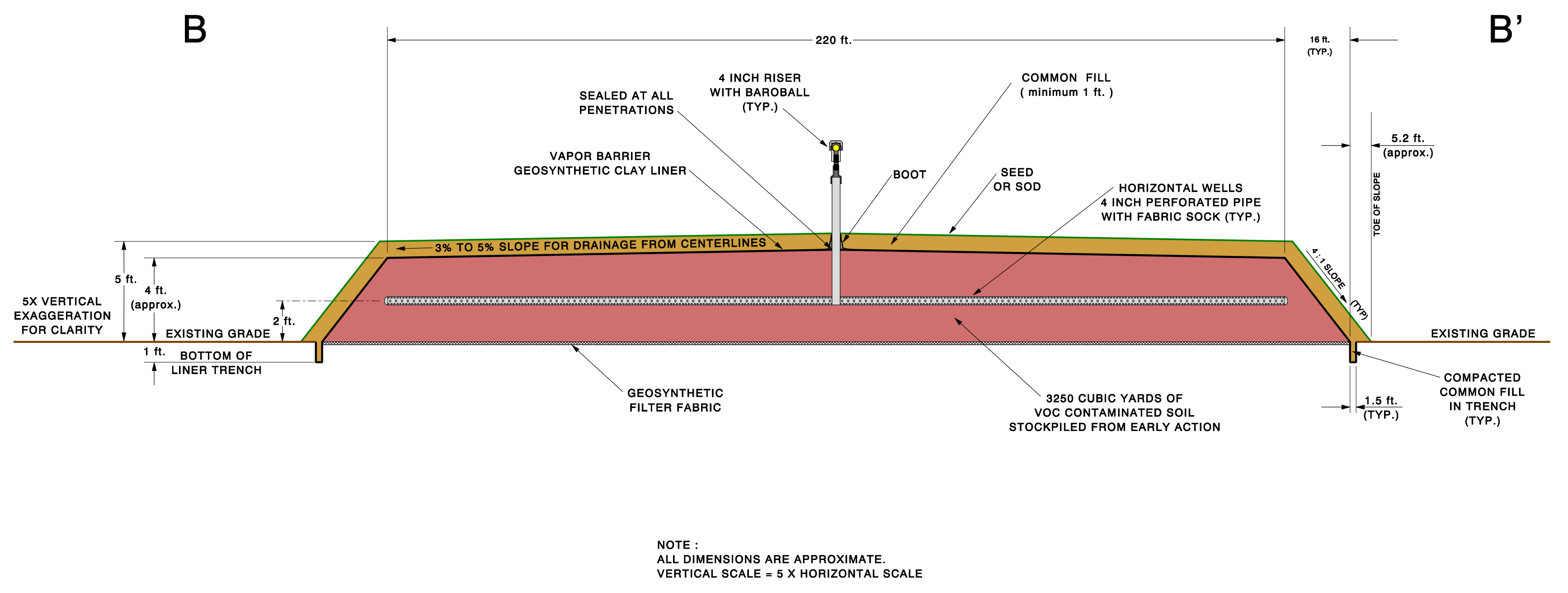


Figure J-2-9. **Planar Configuration of the Passive SVE Cell**



NOTE :
ALL DIMENSIONS ARE APPROXIMATE.
VERTICAL SCALE = 5 X HORIZONTAL SCALE

Figure J-2-10. Vertical Configuration of the Passive SVE Cell

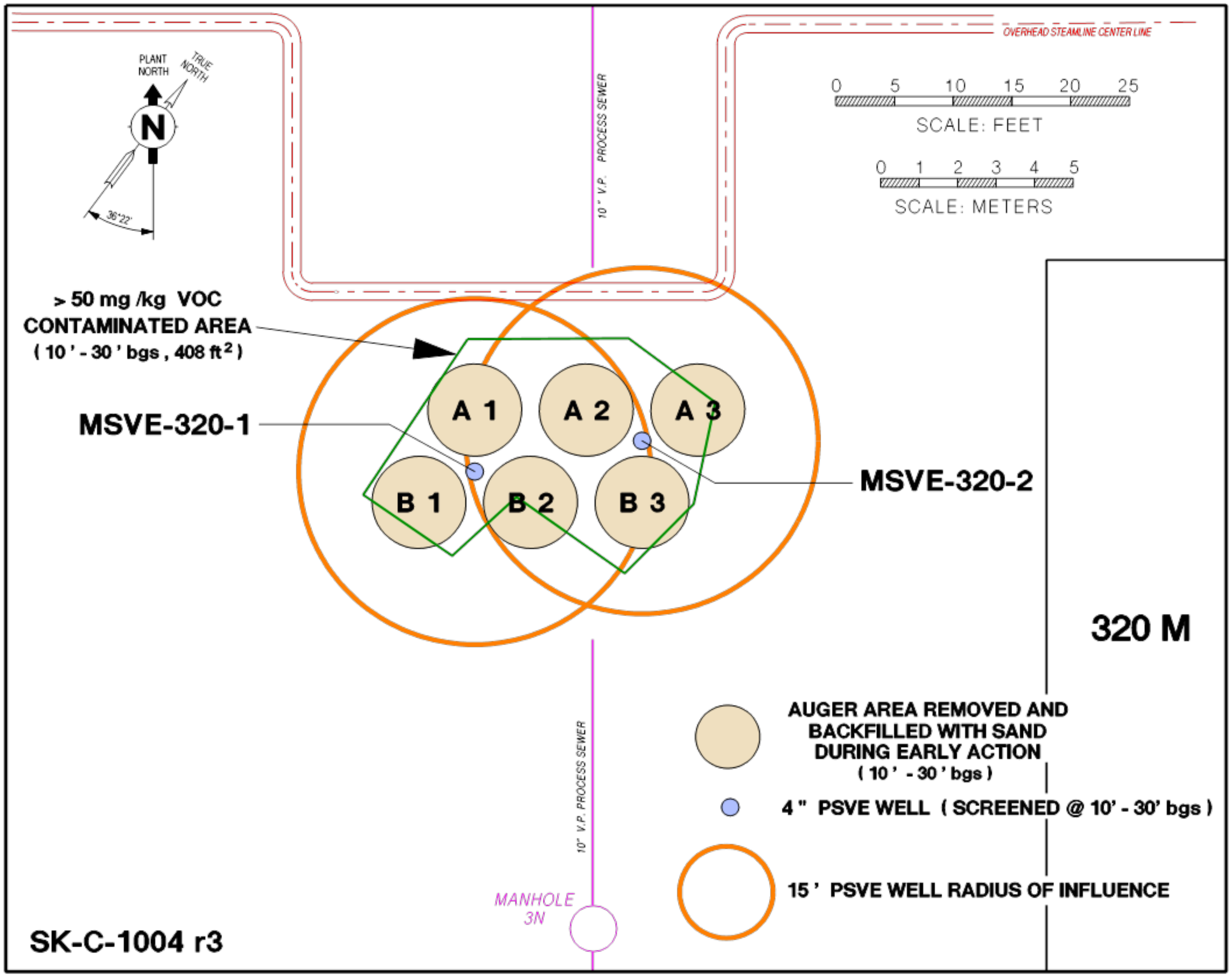


Figure J-2-11. Location of the Passive SVE wells 320-1 and 320-2 with Respect to Vertical Excavations

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Table J-2-1. Analytical Data for 313-M

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
2012 Sampling Event					
MSVE-313	10/4/2012	1,1,1-TRICHLOROETHANE	0.02	ppmv	
MSVE-313	10/4/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.016	ppmv	U
MSVE-313	10/4/2012	1,1-DICHLOROETHYLENE	0.209	ppmv	U
MSVE-313	10/4/2012	CARBON TETRACHLORIDE	0.003	ppmv	U
MSVE-313	10/4/2012	CHLOROFORM	0.043	ppmv	U
MSVE-313	10/4/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-313	10/4/2012	TETRACHLOROETHYLENE (PCE)	0.224	ppmv	
MSVE-313	10/4/2012	TOLUENE	0.421	ppmv	U
MSVE-313	10/4/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-313	10/4/2012	TRICHLOROETHYLENE (TCE)	0.017	ppmv	J
MSVE-313	10/4/2012	TRICHLOROFLUOROMETHANE	0.002	ppmv	U
2013 Sampling Event					
MSVE-313	12/11/2013	1,1,1-TRICHLOROETHANE	0.079	ppmv	
MSVE-313	12/11/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.006	ppmv	U
MSVE-313	12/11/2013	1,1-DICHLOROETHYLENE	0.11	ppmv	U
MSVE-313	12/11/2013	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-313	12/11/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U
MSVE-313	12/11/2013	CHLOROFORM	0.008	ppmv	U
MSVE-313	12/11/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-313	12/11/2013	TETRACHLOROETHYLENE (PCE)	0.748	ppmv	
MSVE-313	12/11/2013	TOLUENE	0.068	ppmv	U
MSVE-313	12/11/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U
MSVE-313	12/11/2013	TRICHLOROETHYLENE (TCE)	0.02	ppmv	
MSVE-313	12/11/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
2014 Sampling Event					
MSVE-313	10/9/2014	1,1,1-TRICHLOROETHANE	0.045	ppmv	
MSVE-313	10/9/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-313	10/9/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-313	10/9/2014	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-313	10/9/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-313	10/9/2014	CHLOROFORM	0.0081	ppmv	U
MSVE-313	10/9/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U

Table J-2-1. Analytical Data for 313-M *(continued/end)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-313	10/9/2014	TETRACHLOROETHYLENE (PCE)	2.788	ppmv	
MSVE-313	10/9/2014	TOLUENE	0.0682	ppmv	U
MSVE-313	10/9/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-313	10/9/2014	TRICHLOROETHYLENE (TCE)	0.029	ppmv	
MSVE-313	10/9/2014	TRICHLOROFLUOROMETHANE	0.0009	ppmv	U
2016 Sampling Event					
MSVE-313	11/14/2016	1,1,1-TRICHLOROETHANE	0.0274	ppmv	U
MSVE-313	11/14/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-313	11/14/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-313	11/14/2016	CHLOROFORM	0.0274	ppmv	U
MSVE-313	11/14/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-313	11/14/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-313	11/14/2016	TETRACHLOROETHYLENE (PCE)	0.1301	ppmv	
MSVE-313	11/14/2016	TOLUENE	0.0423	ppmv	U
MSVE-313	11/14/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-313	11/14/2016	TRICHLOROETHYLENE (TCE)	0.0268	ppmv	U
MSVE-313	11/14/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U

* Detections highlighted in red.
* U = non-detect
* J = estimated value

Table J-2-2. Analytical Data for 321-M Passive SVE Cell

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
2012 Sampling Event					
MSVE-321-1A	10/8/2012	1,1,1-TRICHLOROETHANE	3.513	ppmv	
MSVE-321-1A	10/8/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.018	ppmv	J
MSVE-321-1A	10/8/2012	1,1-DICHLOROETHYLENE	0.209	ppmv	U
MSVE-321-1A	10/8/2012	CARBON TETRACHLORIDE	0.003	ppmv	U
MSVE-321-1A	10/8/2012	CHLOROFORM	0.043	ppmv	U
MSVE-321-1A	10/8/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-321-1A	10/8/2012	TETRACHLOROETHYLENE (PCE)	15.561	ppmv	
MSVE-321-1A	10/8/2012	TOLUENE	0.421	ppmv	U
MSVE-321-1A	10/8/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-321-1A	10/8/2012	TRICHLOROETHYLENE (TCE)	0.658	ppmv	
MSVE-321-1A	10/8/2012	TRICHLOROFLUOROMETHANE	0.002	ppmv	U
MSVE-321-2A	10/8/2012	1,1,1-TRICHLOROETHANE	4.404	ppmv	
MSVE-321-2A	10/8/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.016	ppmv	U
MSVE-321-2A	10/8/2012	1,1-DICHLOROETHYLENE	0.231	ppmv	J
MSVE-321-2A	10/8/2012	CARBON TETRACHLORIDE	0.005	ppmv	
MSVE-321-2A	10/8/2012	CHLOROFORM	0.043	ppmv	U
MSVE-321-2A	10/8/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-321-2A	10/8/2012	TETRACHLOROETHYLENE (PCE)	15.162	ppmv	
MSVE-321-2A	10/8/2012	TOLUENE	0.421	ppmv	U
MSVE-321-2A	10/8/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-321-2A	10/8/2012	TRICHLOROETHYLENE (TCE)	0.81	ppmv	
MSVE-321-2A	10/8/2012	TRICHLOROFLUOROMETHANE	0.002	ppmv	U
MSVE-321-3A	10/8/2012	1,1,1-TRICHLOROETHANE	13.811	ppmv	
MSVE-321-3A	10/8/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.016	ppmv	U
MSVE-321-3A	10/8/2012	1,1-DICHLOROETHYLENE	0.568	ppmv	
MSVE-321-3A	10/8/2012	CARBON TETRACHLORIDE	0.021	ppmv	
MSVE-321-3A	10/8/2012	CHLOROFORM	0.043	ppmv	U
MSVE-321-3A	10/8/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-321-3A	10/8/2012	TETRACHLOROETHYLENE (PCE)	51.133	ppmv	
MSVE-321-3A	10/8/2012	TOLUENE	0.421	ppmv	U
MSVE-321-3A	10/8/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-321-3A	10/8/2012	TRICHLOROETHYLENE (TCE)	2.772	ppmv	
MSVE-321-3A	10/8/2012	TRICHLOROFLUOROMETHANE	0.002	ppmv	U
MSVE-321-4A	10/8/2012	1,1,1-TRICHLOROETHANE	4.409	ppmv	
MSVE-321-4A	10/8/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.016	ppmv	U
MSVE-321-4A	10/8/2012	1,1-DICHLOROETHYLENE	0.274	ppmv	J

Table J-2-2. Analytical Data for 321-M Passive SVE Cell *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-321-4A	10/8/2012	CARBON TETRACHLORIDE	0.004	ppmv	J
MSVE-321-4A	10/8/2012	CHLOROFORM	0.043	ppmv	U
MSVE-321-4A	10/8/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-321-4A	10/8/2012	TETRACHLOROETHYLENE (PCE)	19.259	ppmv	
MSVE-321-4A	10/8/2012	TOLUENE	0.421	ppmv	U
MSVE-321-4A	10/8/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-321-4A	10/8/2012	TRICHLOROETHYLENE (TCE)	0.844	ppmv	
MSVE-321-4A	10/8/2012	TRICHLOROFLUOROMETHANE	0.002	ppmv	U
MSVE-321-5A	10/8/2012	1,1,1-TRICHLOROETHANE	0.849	ppmv	
MSVE-321-5A	10/8/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.016	ppmv	U
MSVE-321-5A	10/8/2012	1,1-DICHLOROETHYLENE	0.209	ppmv	U
MSVE-321-5A	10/8/2012	CARBON TETRACHLORIDE	0.003	ppmv	U
MSVE-321-5A	10/8/2012	CHLOROFORM	0.043	ppmv	U
MSVE-321-5A	10/8/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-321-5A	10/8/2012	TETRACHLOROETHYLENE (PCE)	15.88	ppmv	
MSVE-321-5A	10/8/2012	TOLUENE	0.421	ppmv	U
MSVE-321-5A	10/8/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-321-5A	10/8/2012	TRICHLOROETHYLENE (TCE)	0.325	ppmv	
MSVE-321-5A	10/8/2012	TRICHLOROFLUOROMETHANE	0.002	ppmv	U
MSVE-321-6A	10/8/2012	1,1,1-TRICHLOROETHANE	0.74	ppmv	
MSVE-321-6A	10/8/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.079	ppmv	
MSVE-321-6A	10/8/2012	1,1-DICHLOROETHYLENE	0.209	ppmv	U
MSVE-321-6A	10/8/2012	CARBON TETRACHLORIDE	0.003	ppmv	U
MSVE-321-6A	10/8/2012	CHLOROFORM	0.043	ppmv	U
MSVE-321-6A	10/8/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-321-6A	10/8/2012	TETRACHLOROETHYLENE (PCE)	1.895	ppmv	
MSVE-321-6A	10/8/2012	TOLUENE	0.421	ppmv	U
MSVE-321-6A	10/8/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-321-6A	10/8/2012	TRICHLOROETHYLENE (TCE)	0.12	ppmv	
MSVE-321-6A	10/8/2012	TRICHLOROFLUOROMETHANE	0.002	ppmv	U
2013 Sampling Event					
MSVE-321-1A	12/10/2013	1,1,1-TRICHLOROETHANE	0.865	ppmv	
MSVE-321-1A	12/10/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.014	ppmv	
MSVE-321-1A	12/10/2013	1,1-DICHLOROETHYLENE	0.11	ppmv	U
MSVE-321-1A	12/10/2013	CARBON TETRACHLORIDE	0.001	ppmv	J
MSVE-321-1A	12/10/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U

Table J-2-2. Analytical Data for 321-M Passive SVE Cell *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-321-1A	12/10/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-321-1A	12/10/2013	TETRACHLOROETHYLENE (PCE)	6.77	ppmv	
MSVE-321-1A	12/10/2013	TOLUENE	0.068	ppmv	U
MSVE-321-1A	12/10/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U
MSVE-321-1A	12/10/2013	TRICHLOROETHYLENE (TCE)	0.241	ppmv	
MSVE-321-1A	12/10/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
MSVE-321-2A	12/10/2013	1,1,1-TRICHLOROETHANE	1.42	ppmv	
MSVE-321-2A	12/10/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.01	ppmv	J
MSVE-321-2A	12/10/2013	1,1-DICHLOROETHYLENE	0.11	ppmv	U
MSVE-321-2A	12/10/2013	CARBON TETRACHLORIDE	0.001	ppmv	J
MSVE-321-2A	12/10/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U
MSVE-321-2A	12/10/2013	CHLOROFORM	0.008	ppmv	U
MSVE-321-2A	12/10/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-321-2A	12/10/2013	TETRACHLOROETHYLENE (PCE)	10.6	ppmv	
MSVE-321-2A	12/10/2013	TOLUENE	0.068	ppmv	U
MSVE-321-2A	12/10/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U
MSVE-321-2A	12/10/2013	TRICHLOROETHYLENE (TCE)	0.348	ppmv	
MSVE-321-2A	12/10/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
MSVE-321-3A	12/10/2013	1,1,1-TRICHLOROETHANE	4.75	ppmv	
MSVE-321-3A	12/10/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.007	ppmv	J
MSVE-321-3A	12/10/2013	1,1-DICHLOROETHYLENE	0.423	ppmv	
MSVE-321-3A	12/10/2013	CARBON TETRACHLORIDE	0.005	ppmv	
MSVE-321-3A	12/10/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U
MSVE-321-3A	12/10/2013	CHLOROFORM	0.008	ppmv	U
MSVE-321-3A	12/10/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-321-3A	12/10/2013	TETRACHLOROETHYLENE (PCE)	26.1	ppmv	
MSVE-321-3A	12/10/2013	TOLUENE	0.068	ppmv	U
MSVE-321-3A	12/10/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U
MSVE-321-3A	12/10/2013	TRICHLOROETHYLENE (TCE)	0.772	ppmv	
MSVE-321-3A	12/10/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
MSVE-321-4A	12/10/2013	1,1,1-TRICHLOROETHANE	1.12	ppmv	
MSVE-321-4A	12/10/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.006	ppmv	U
MSVE-321-4A	12/10/2013	1,1-DICHLOROETHYLENE	0.11	ppmv	U
MSVE-321-4A	12/10/2013	CARBON TETRACHLORIDE	0.001	ppmv	J
MSVE-321-4A	12/10/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U
MSVE-321-4A	12/10/2013	CHLOROFORM	0.008	ppmv	U

Table J-2-2. Analytical Data for 321-M Passive SVE Cell *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-321-4A	12/10/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-321-4A	12/10/2013	TETRACHLOROETHYLENE (PCE)	7.85	ppmv	
MSVE-321-4A	12/10/2013	TOLUENE	0.068	ppmv	U
MSVE-321-4A	12/10/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U
MSVE-321-4A	12/10/2013	TRICHLOROETHYLENE (TCE)	0.279	ppmv	
MSVE-321-4A	12/10/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
MSVE-321-5A	12/10/2013	1,1,1-TRICHLOROETHANE	0.479	ppmv	
MSVE-321-5A	12/10/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.006	ppmv	U
MSVE-321-5A	12/10/2013	1,1-DICHLOROETHYLENE	0.11	ppmv	U
MSVE-321-5A	12/10/2013	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-321-5A	12/10/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U
MSVE-321-5A	12/10/2013	CHLOROFORM	0.008	ppmv	U
MSVE-321-5A	12/10/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-321-5A	12/10/2013	TETRACHLOROETHYLENE (PCE)	9.32	ppmv	
MSVE-321-5A	12/10/2013	TOLUENE	0.068	ppmv	U
MSVE-321-5A	12/10/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U
MSVE-321-5A	12/10/2013	TRICHLOROETHYLENE (TCE)	0.247	ppmv	
MSVE-321-5A	12/10/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
MSVE-321-6A	12/10/2013	1,1,1-TRICHLOROETHANE	0.759	ppmv	
MSVE-321-6A	12/10/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.006	ppmv	U
MSVE-321-6A	12/10/2013	1,1-DICHLOROETHYLENE	0.11	ppmv	U
MSVE-321-6A	12/10/2013	CARBON TETRACHLORIDE	0.001	ppmv	J
MSVE-321-6A	12/10/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U
MSVE-321-6A	12/10/2013	CHLOROFORM	0.008	ppmv	U
MSVE-321-6A	12/10/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-321-6A	12/10/2013	TETRACHLOROETHYLENE (PCE)	1.64	ppmv	
MSVE-321-6A	12/10/2013	TOLUENE	0.068	ppmv	U
MSVE-321-6A	12/10/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U
MSVE-321-6A	12/10/2013	TRICHLOROETHYLENE (TCE)	0.146	ppmv	
MSVE-321-6A	12/10/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
2014 Sampling Event					
MSVE-321-1A	10/7/2014	1,1,1-TRICHLOROETHANE	0.0048	ppmv	U
MSVE-321-1A	10/7/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-321-1A	10/7/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-321-1A	10/7/2014	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-321-1A	10/7/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-321-1A	10/7/2014	CHLOROFORM	0.0081	ppmv	U

Table J-2-2. Analytical Data for 321-M Passive SVE Cell *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-321-1A	10/7/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U
MSVE-321-1A	10/7/2014	TETRACHLOROETHYLENE (PCE)	1.253	ppmv	
MSVE-321-1A	10/7/2014	TOLUENE	0.0682	ppmv	U
MSVE-321-1A	10/7/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-321-1A	10/7/2014	TRICHLOROETHYLENE (TCE)	0.032	ppmv	
MSVE-321-1A	10/7/2014	TRICHLOROFLUOROMETHANE	0.0009	ppmv	U
MSVE-321-2A	10/7/2014	1,1,1-TRICHLOROETHANE	0.511	ppmv	
MSVE-321-2A	10/7/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-321-2A	10/7/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-321-2A	10/7/2014	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-321-2A	10/7/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-321-2A	10/7/2014	CHLOROFORM	0.0081	ppmv	U
MSVE-321-2A	10/7/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U
MSVE-321-2A	10/7/2014	TETRACHLOROETHYLENE (PCE)	1.353	ppmv	
MSVE-321-2A	10/7/2014	TOLUENE	0.0682	ppmv	U
MSVE-321-2A	10/7/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-321-2A	10/7/2014	TRICHLOROETHYLENE (TCE)	0.07	ppmv	
MSVE-321-2A	10/7/2014	TRICHLOROFLUOROMETHANE	0.0009	ppmv	U
MSVE-321-3A	10/7/2014	1,1,1-TRICHLOROETHANE	0.15	ppmv	
MSVE-321-3A	10/7/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-321-3A	10/7/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-321-3A	10/7/2014	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-321-3A	10/7/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-321-3A	10/7/2014	CHLOROFORM	0.0081	ppmv	U
MSVE-321-3A	10/7/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U
MSVE-321-3A	10/7/2014	TETRACHLOROETHYLENE (PCE)	0.47	ppmv	
MSVE-321-3A	10/7/2014	TOLUENE	0.0682	ppmv	U
MSVE-321-3A	10/7/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-321-3A	10/7/2014	TRICHLOROETHYLENE (TCE)	0.018	ppmv	
MSVE-321-3A	10/7/2014	TRICHLOROFLUOROMETHANE	0.0009	ppmv	U
MSVE-321-4A	10/7/2014	1,1,1-TRICHLOROETHANE	0.012	ppmv	
MSVE-321-4A	10/7/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-321-4A	10/7/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-321-4A	10/7/2014	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-321-4A	10/7/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-321-4A	10/7/2014	CHLOROFORM	0.0081	ppmv	U
MSVE-321-4A	10/7/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U

Table J-2-2. Analytical Data for 321-M Passive SVE Cell *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-321-4A	10/7/2014	TETRACHLOROETHYLENE (PCE)	0.259	ppmv	
MSVE-321-4A	10/7/2014	TOLUENE	0.0682	ppmv	U
MSVE-321-4A	10/7/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-321-4A	10/7/2014	TRICHLOROETHYLENE (TCE)	0.0082	ppmv	U
MSVE-321-4A	10/7/2014	TRICHLOROFLUOROMETHANE	0.0009	ppmv	U
MSVE-321-5A	10/7/2014	1,1,1-TRICHLOROETHANE	0.0048	ppmv	U
MSVE-321-5A	10/7/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-321-5A	10/7/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-321-5A	10/7/2014	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-321-5A	10/7/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-321-5A	10/7/2014	CHLOROFORM	0.0081	ppmv	U
MSVE-321-5A	10/7/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U
MSVE-321-5A	10/7/2014	TETRACHLOROETHYLENE (PCE)	0.163	ppmv	
MSVE-321-5A	10/7/2014	TOLUENE	0.0682	ppmv	U
MSVE-321-5A	10/7/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-321-5A	10/7/2014	TRICHLOROETHYLENE (TCE)	0.0082	ppmv	U
MSVE-321-5A	10/7/2014	TRICHLOROFLUOROMETHANE	0.0009	ppmv	U
MSVE-321-6A	10/7/2014	1,1,1-TRICHLOROETHANE	0.028	ppmv	
MSVE-321-6A	10/7/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-321-6A	10/7/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-321-6A	10/7/2014	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-321-6A	10/7/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-321-6A	10/7/2014	CHLOROFORM	0.0081	ppmv	U
MSVE-321-6A	10/7/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U
MSVE-321-6A	10/7/2014	TETRACHLOROETHYLENE (PCE)	0.539	ppmv	
MSVE-321-6A	10/7/2014	TOLUENE	0.0682	ppmv	U
MSVE-321-6A	10/7/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-321-6A	10/7/2014	TRICHLOROETHYLENE (TCE)	0.018	ppmv	
MSVE-321-6A	10/7/2014	TRICHLOROFLUOROMETHANE	0.0009	ppmv	U
2015 Sampling Event					
MSVE-321-1A	12/2/2015	1,1,1-TRICHLOROETHANE	6.61	ppmv	
MSVE-321-1A	12/2/2015	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-321-1A	12/2/2015	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-321-1A	12/2/2015	CHLOROFORM	0.0274	ppmv	U
MSVE-321-1A	12/2/2015	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-321-1A	12/2/2015	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U

Table J-2-2. Analytical Data for 321-M Passive SVE Cell *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-321-1A	12/2/2015	TETRACHLOROETHYLENE (PCE)	25.1	ppmv	
MSVE-321-1A	12/2/2015	TOLUENE	0.0423	ppmv	U
MSVE-321-1A	12/2/2015	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-321-1A	12/2/2015	TRICHLOROETHYLENE (TCE)	1.69	ppmv	
MSVE-321-1A	12/2/2015	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
MSVE-321-2A	12/2/2015	1,1,1-TRICHLOROETHANE	6.8	ppmv	
MSVE-321-2A	12/2/2015	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-321-2A	12/2/2015	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-321-2A	12/2/2015	CHLOROFORM	0.0274	ppmv	U
MSVE-321-2A	12/2/2015	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-321-2A	12/2/2015	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-321-2A	12/2/2015	TETRACHLOROETHYLENE (PCE)	23	ppmv	
MSVE-321-2A	12/2/2015	TOLUENE	0.0423	ppmv	U
MSVE-321-2A	12/2/2015	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-321-2A	12/2/2015	TRICHLOROETHYLENE (TCE)	1.41	ppmv	
MSVE-321-2A	12/2/2015	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
MSVE-321-3A	12/2/2015	1,1,1-TRICHLOROETHANE	25.2	ppmv	
MSVE-321-3A	12/2/2015	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-321-3A	12/2/2015	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-321-3A	12/2/2015	CHLOROFORM	0.0274	ppmv	U
MSVE-321-3A	12/2/2015	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-321-3A	12/2/2015	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-321-3A	12/2/2015	TETRACHLOROETHYLENE (PCE)	87.2	ppmv	
MSVE-321-3A	12/2/2015	TOLUENE	0.0423	ppmv	U
MSVE-321-3A	12/2/2015	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-321-3A	12/2/2015	TRICHLOROETHYLENE (TCE)	5.73	ppmv	
MSVE-321-3A	12/2/2015	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
MSVE-321-4A	12/2/2015	1,1,1-TRICHLOROETHANE	5.42	ppmv	
MSVE-321-4A	12/2/2015	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-321-4A	12/2/2015	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-321-4A	12/2/2015	CHLOROFORM	0.0274	ppmv	U
MSVE-321-4A	12/2/2015	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-321-4A	12/2/2015	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-321-4A	12/2/2015	TETRACHLOROETHYLENE (PCE)	24.4	ppmv	
MSVE-321-4A	12/2/2015	TOLUENE	0.0423	ppmv	U

Table J-2-2. Analytical Data for 321-M Passive SVE Cell *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-321-4A	12/2/2015	TRICHLOROETHYLENE (TCE)	1.62	ppmv	
MSVE-321-4A	12/2/2015	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
MSVE-321-5A	12/2/2015	1,1,1-TRICHLOROETHANE	0.97	ppmv	
MSVE-321-5A	12/2/2015	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-321-5A	12/2/2015	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-321-5A	12/2/2015	CHLOROFORM	0.0274	ppmv	U
MSVE-321-5A	12/2/2015	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-321-5A	12/2/2015	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-321-5A	12/2/2015	TETRACHLOROETHYLENE (PCE)	5.94	ppmv	
MSVE-321-5A	12/2/2015	TOLUENE	0.0423	ppmv	U
MSVE-321-5A	12/2/2015	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-321-5A	12/2/2015	TRICHLOROETHYLENE (TCE)	0.418	ppmv	
MSVE-321-5A	12/2/2015	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
MSVE-321-6A	12/2/2015	1,1,1-TRICHLOROETHANE	2.99	ppmv	
MSVE-321-6A	12/2/2015	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-321-6A	12/2/2015	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-321-6A	12/2/2015	CHLOROFORM	0.0274	ppmv	U
MSVE-321-6A	12/2/2015	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-321-6A	12/2/2015	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-321-6A	12/2/2015	TETRACHLOROETHYLENE (PCE)	0.946	ppmv	
MSVE-321-6A	12/2/2015	TOLUENE	0.0423	ppmv	U
MSVE-321-6A	12/2/2015	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-321-6A	12/2/2015	TRICHLOROETHYLENE (TCE)	0.08	ppmv	
MSVE-321-6A	12/2/2015	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
2016 Sampling Event					
MSVE-321-1A	11/9/2016	1,1,1-TRICHLOROETHANE	0.2946	ppmv	
MSVE-321-1A	11/9/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-321-1A	11/9/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-321-1A	11/9/2016	CHLOROFORM	0.0274	ppmv	U
MSVE-321-1A	11/9/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-321-1A	11/9/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-321-1A	11/9/2016	TETRACHLOROETHYLENE (PCE)	2.052	ppmv	
MSVE-321-1A	11/9/2016	TOLUENE	0.0423	ppmv	U
MSVE-321-1A	11/9/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U

Table J-2-2. Analytical Data for 321-M Passive SVE Cell *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-321-1A	11/9/2016	TRICHLOROETHYLENE (TCE)	0.0635	ppmv	
MSVE-321-1A	11/9/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
MSVE-321-2A	11/9/2016	1,1,1-TRICHLOROETHANE	1.529	ppmv	
MSVE-321-2A	11/9/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-321-2A	11/9/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-321-2A	11/9/2016	CHLOROFORM	0.0274	ppmv	U
MSVE-321-2A	11/9/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-321-2A	11/9/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-321-2A	11/9/2016	TETRACHLOROETHYLENE (PCE)	2.11	ppmv	
MSVE-321-2A	11/9/2016	TOLUENE	0.0423	ppmv	U
MSVE-321-2A	11/9/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-321-2A	11/9/2016	TRICHLOROETHYLENE (TCE)	0.0964	ppmv	
MSVE-321-2A	11/9/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
MSVE-321-3A	11/9/2016	1,1,1-TRICHLOROETHANE	14.39	ppmv	
MSVE-321-3A	11/9/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-321-3A	11/9/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-321-3A	11/9/2016	CHLOROFORM	0.0274	ppmv	U
MSVE-321-3A	11/9/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-321-3A	11/9/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-321-3A	11/9/2016	TETRACHLOROETHYLENE (PCE)	8.529	ppmv	
MSVE-321-3A	11/9/2016	TOLUENE	0.0423	ppmv	U
MSVE-321-3A	11/9/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-321-3A	11/9/2016	TRICHLOROETHYLENE (TCE)	0.2336	ppmv	
MSVE-321-3A	11/9/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
MSVE-321-4A	11/9/2016	1,1,1-TRICHLOROETHANE	0.1983	ppmv	
MSVE-321-4A	11/9/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-321-4A	11/9/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-321-4A	11/9/2016	CHLOROFORM	0.0274	ppmv	U
MSVE-321-4A	11/9/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-321-4A	11/9/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-321-4A	11/9/2016	TETRACHLOROETHYLENE (PCE)	0.9232	ppmv	
MSVE-321-4A	11/9/2016	TOLUENE	0.0423	ppmv	U
MSVE-321-4A	11/9/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-321-4A	11/9/2016	TRICHLOROETHYLENE (TCE)	0.0527	ppmv	J
MSVE-321-4A	11/9/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U

Table J-2-2. Analytical Data for 321-M Passive SVE Cell *(continued/end)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-321-5A	11/9/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-321-5A	11/9/2016	1,1,1-TRICHLOROETHANE	0.224	ppmv	
MSVE-321-5A	11/9/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-321-5A	11/9/2016	CHLOROFORM	0.0274	ppmv	U
MSVE-321-5A	11/9/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-321-5A	11/9/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-321-5A	11/9/2016	TETRACHLOROETHYLENE (PCE)	1.122	ppmv	
MSVE-321-5A	11/9/2016	TOLUENE	0.0423	ppmv	U
MSVE-321-5A	11/9/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-321-5A	11/9/2016	TRICHLOROETHYLENE (TCE)	0.1275	ppmv	
MSVE-321-5A	11/9/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
MSVE-321-6A	11/9/2016	1,1,1-TRICHLOROETHANE	0.3865	ppmv	
MSVE-321-6A	11/9/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-321-6A	11/9/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-321-6A	11/9/2016	CHLOROFORM	0.0274	ppmv	U
MSVE-321-6A	11/9/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-321-6A	11/9/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-321-6A	11/9/2016	TETRACHLOROETHYLENE (PCE)	0.4979	ppmv	
MSVE-321-6A	11/9/2016	TOLUENE	0.0423	ppmv	U
MSVE-321-6A	11/9/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-321-6A	11/9/2016	TRICHLOROETHYLENE (TCE)	0.111	ppmv	
MSVE-321-6A	11/9/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U

* Detections highlighted in red.
* U = non-detect
* J = estimated value

Table J-2-3. Analytical Data for the Passive SVE Cell

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
2012 Sampling Event					
MSVE-1B	10/4/2012	1,1,1-TRICHLOROETHANE	0.183	ppmv	
MSVE-1B	10/4/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.016	ppmv	U
MSVE-1B	10/4/2012	1,1-DICHLOROETHYLENE	0.209	ppmv	U
MSVE-1B	10/4/2012	CARBON TETRACHLORIDE	0.003	ppmv	U
MSVE-1B	10/4/2012	CHLOROFORM	0.043	ppmv	U
MSVE-1B	10/4/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-1B	10/4/2012	TETRACHLOROETHYLENE (PCE)	2.031	ppmv	
MSVE-1B	10/4/2012	TOLUENE	0.421	ppmv	U
MSVE-1B	10/4/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-1B	10/4/2012	TRICHLOROETHYLENE (TCE)	0.057	ppmv	
MSVE-1B	10/4/2012	TRICHLOROFLUOROMETHANE	0.004	ppmv	
MSVE-2B	10/4/2012	1,1,1-TRICHLOROETHANE	0.227	ppmv	
MSVE-2B	10/4/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.016	ppmv	U
MSVE-2B	10/4/2012	1,1-DICHLOROETHYLENE	0.209	ppmv	U
MSVE-2B	10/4/2012	CARBON TETRACHLORIDE	0.003	ppmv	U
MSVE-2B	10/4/2012	CHLOROFORM	0.043	ppmv	U
MSVE-2B	10/4/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-2B	10/4/2012	TETRACHLOROETHYLENE (PCE)	1.949	ppmv	
MSVE-2B	10/4/2012	TOLUENE	0.421	ppmv	U
MSVE-2B	10/4/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-2B	10/4/2012	TRICHLOROETHYLENE (TCE)	0.075	ppmv	
MSVE-2B	10/4/2012	TRICHLOROFLUOROMETHANE	0.004	ppmv	
MSVE-3B	10/4/2012	1,1,1-TRICHLOROETHANE	0.186	ppmv	
MSVE-3B	10/4/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.016	ppmv	U
MSVE-3B	10/4/2012	1,1-DICHLOROETHYLENE	0.209	ppmv	U
MSVE-3B	10/4/2012	CARBON TETRACHLORIDE	0.003	ppmv	U
MSVE-3B	10/4/2012	CHLOROFORM	0.043	ppmv	U
MSVE-3B	10/4/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-3B	10/4/2012	TETRACHLOROETHYLENE (PCE)	0.731	ppmv	
MSVE-3B	10/4/2012	TOLUENE	0.421	ppmv	U
MSVE-3B	10/4/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-3B	10/4/2012	TRICHLOROETHYLENE (TCE)	0.068	ppmv	
MSVE-3B	10/4/2012	TRICHLOROFLUOROMETHANE	0.003	ppmv	J

Table J-2-3 Analytical Data for the Passive SVE Cell *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-4B	10/4/2012	1,1,1-TRICHLOROETHANE	0.12	ppmv	
MSVE-4B	10/4/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.016	ppmv	U
MSVE-4B	10/4/2012	1,1-DICHLOROETHYLENE	0.209	ppmv	U
MSVE-4B	10/4/2012	CARBON TETRACHLORIDE	0.003	ppmv	U
MSVE-4B	10/4/2012	CHLOROFORM	0.043	ppmv	U
MSVE-4B	10/4/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-4B	10/4/2012	TETRACHLOROETHYLENE (PCE)	0.469	ppmv	
MSVE-4B	10/4/2012	TOLUENE	0.421	ppmv	U
MSVE-4B	10/4/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-4B	10/4/2012	TRICHLOROETHYLENE (TCE)	0.045	ppmv	
MSVE-4B	10/4/2012	TRICHLOROFLUOROMETHANE	0.002	ppmv	U
MSVE-5B	10/4/2012	1,1,1-TRICHLOROETHANE	0.92	ppmv	
MSVE-5B	10/4/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.016	ppmv	U
MSVE-5B	10/4/2012	1,1-DICHLOROETHYLENE	0.209	ppmv	U
MSVE-5B	10/4/2012	CARBON TETRACHLORIDE	0.003	ppmv	U
MSVE-5B	10/4/2012	CHLOROFORM	0.043	ppmv	U
MSVE-5B	10/4/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-5B	10/4/2012	TETRACHLOROETHYLENE (PCE)	3.714	ppmv	
MSVE-5B	10/4/2012	TOLUENE	0.421	ppmv	U
MSVE-5B	10/4/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-5B	10/4/2012	TRICHLOROETHYLENE (TCE)	0.337	ppmv	
MSVE-5B	10/4/2012	TRICHLOROFLUOROMETHANE	0.013	ppmv	
2013 Sampling Event					
MSVE-1B	12/9/2013	1,1,1-TRICHLOROETHANE	0.005	ppmv	U
MSVE-1B	12/9/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.006	ppmv	U
MSVE-1B	12/9/2013	1,1-DICHLOROETHYLENE	0.11	ppmv	U
MSVE-1B	12/9/2013	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-1B	12/9/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U
MSVE-1B	12/9/2013	CHLOROFORM	0.008	ppmv	U
MSVE-1B	12/9/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-1B	12/9/2013	TETRACHLOROETHYLENE (PCE)	0.046	ppmv	
MSVE-1B	12/9/2013	TOLUENE	0.068	ppmv	U
MSVE-1B	12/9/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U
MSVE-1B	12/9/2013	TRICHLOROETHYLENE (TCE)	0.008	ppmv	U

Table J-2-3 Analytical Data for the Passive SVE Cell *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-1B	12/9/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
MSVE-2B	12/9/2013	1,1,1-TRICHLOROETHANE	0.005	ppmv	U
MSVE-2B	12/9/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.006	ppmv	U
MSVE-2B	12/9/2013	1,1-DICHLOROETHYLENE	0.11	ppmv	U
MSVE-2B	12/9/2013	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-2B	12/9/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U
MSVE-2B	12/9/2013	CHLOROFORM	0.008	ppmv	U
MSVE-2B	12/9/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-2B	12/9/2013	TETRACHLOROETHYLENE (PCE)	0.014	ppmv	
MSVE-2B	12/9/2013	TOLUENE	0.068	ppmv	U
MSVE-2B	12/9/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U
MSVE-2B	12/9/2013	TRICHLOROETHYLENE (TCE)	0.008	ppmv	U
MSVE-2B	12/9/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
MSVE-3B	12/9/2013	1,1,1-TRICHLOROETHANE	0.005	ppmv	U
MSVE-3B	12/9/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.006	ppmv	U
MSVE-3B	12/9/2013	1,1-DICHLOROETHYLENE	0.11	ppmv	U
MSVE-3B	12/9/2013	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-3B	12/9/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U
MSVE-3B	12/9/2013	CHLOROFORM	0.008	ppmv	U
MSVE-3B	12/9/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-3B	12/9/2013	TETRACHLOROETHYLENE (PCE)	0.026	ppmv	
MSVE-3B	12/9/2013	TOLUENE	0.068	ppmv	U
MSVE-3B	12/9/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U
MSVE-3B	12/9/2013	TRICHLOROETHYLENE (TCE)	0.008	ppmv	U
MSVE-3B	12/9/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
MSVE-4B	12/9/2013	1,1,1-TRICHLOROETHANE	0.005	ppmv	U
MSVE-4B	12/9/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.006	ppmv	U
MSVE-4B	12/9/2013	1,1-DICHLOROETHYLENE	0.11	ppmv	U
MSVE-4B	12/9/2013	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-4B	12/9/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U
MSVE-4B	12/9/2013	CHLOROFORM	0.008	ppmv	U
MSVE-4B	12/9/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-4B	12/9/2013	TETRACHLOROETHYLENE (PCE)	0.05	ppmv	
MSVE-4B	12/9/2013	TOLUENE	0.068	ppmv	U

Table J-2-3 Analytical Data for the Passive SVE Cell *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-4B	12/9/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U
MSVE-4B	12/9/2013	TRICHLOROETHYLENE (TCE)	0.008	ppmv	U
MSVE-4B	12/9/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
MSVE-5B	12/9/2013	1,1,1-TRICHLOROETHANE	0.022	ppmv	
MSVE-5B	12/9/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.006	ppmv	U
MSVE-5B	12/9/2013	1,1-DICHLOROETHYLENE	0.11	ppmv	U
MSVE-5B	12/9/2013	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-5B	12/9/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U
MSVE-5B	12/9/2013	CHLOROFORM	0.008	ppmv	U
MSVE-5B	12/9/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-5B	12/9/2013	TETRACHLOROETHYLENE (PCE)	0.165	ppmv	
MSVE-5B	12/9/2013	TOLUENE	0.068	ppmv	U
MSVE-5B	12/9/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U
MSVE-5B	12/9/2013	TRICHLOROETHYLENE (TCE)	0.016	ppmv	
MSVE-5B	12/9/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
2014 Sampling Event					
MSVE-1B	10/8/2014	1,1,1-TRICHLOROETHANE	0.0048	ppmv	U
MSVE-1B	10/8/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-1B	10/8/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-1B	10/8/2014	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-1B	10/8/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-1B	10/8/2014	CHLOROFORM	0.0081	ppmv	U
MSVE-1B	10/8/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U
MSVE-1B	10/8/2014	TETRACHLOROETHYLENE (PCE)	0.116	ppmv	
MSVE-1B	10/8/2014	TOLUENE	0.0682	ppmv	U
MSVE-1B	10/8/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-1B	10/8/2014	TRICHLOROETHYLENE (TCE)	0.0082	ppmv	U
MSVE-1B	10/8/2014	TRICHLOROFLUOROMETHANE	0.0009	ppmv	U
MSVE-2B	10/8/2014	1,1,1-TRICHLOROETHANE	0.0048	ppmv	U
MSVE-2B	10/8/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-2B	10/8/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-2B	10/8/2014	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-2B	10/8/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-2B	10/8/2014	CHLOROFORM	0.0081	ppmv	U

Table J-2-3 Analytical Data for the Passive SVE Cell *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-2B	10/8/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U
MSVE-2B	10/8/2014	TETRACHLOROETHYLENE (PCE)	0.022	ppmv	
MSVE-2B	10/8/2014	TOLUENE	0.0682	ppmv	U
MSVE-2B	10/8/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-2B	10/8/2014	TRICHLOROETHYLENE (TCE)	0.0082	ppmv	U
MSVE-2B	10/8/2014	TRICHLOROFLUOROMETHANE	0.0009	ppmv	U
MSVE-3B	10/8/2014	1,1,1-TRICHLOROETHANE	0.0048	ppmv	U
MSVE-3B	10/8/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-3B	10/8/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-3B	10/8/2014	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-3B	10/8/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-3B	10/8/2014	CHLOROFORM	0.0081	ppmv	U
MSVE-3B	10/8/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U
MSVE-3B	10/8/2014	TETRACHLOROETHYLENE (PCE)	0.089	ppmv	
MSVE-3B	10/8/2014	TOLUENE	0.0682	ppmv	U
MSVE-3B	10/8/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-3B	10/8/2014	TRICHLOROETHYLENE (TCE)	0.0082	ppmv	U
MSVE-3B	10/8/2014	TRICHLOROFLUOROMETHANE	0.0009	ppmv	U
MSVE-4B	10/8/2014	1,1,1-TRICHLOROETHANE	0.134	ppmv	
MSVE-4B	10/8/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-4B	10/8/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-4B	10/8/2014	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-4B	10/8/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-4B	10/8/2014	CHLOROFORM	0.0081	ppmv	U
MSVE-4B	10/8/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U
MSVE-4B	10/8/2014	TETRACHLOROETHYLENE (PCE)	0.6	ppmv	
MSVE-4B	10/8/2014	TOLUENE	0.0682	ppmv	U
MSVE-4B	10/8/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-4B	10/8/2014	TRICHLOROETHYLENE (TCE)	0.068	ppmv	
MSVE-4B	10/8/2014	TRICHLOROFLUOROMETHANE	0.002	ppmv	
MSVE-5B	10/8/2014	1,1,1-TRICHLOROETHANE	0.491	ppmv	
MSVE-5B	10/8/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-5B	10/8/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-5B	10/8/2014	CARBON TETRACHLORIDE	0.0006	ppmv	U

Table J-2-3 Analytical Data for the Passive SVE Cell *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-5B	10/8/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-5B	10/8/2014	CHLOROFORM	0.0081	ppmv	U
MSVE-5B	10/8/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U
MSVE-5B	10/8/2014	TETRACHLOROETHYLENE (PCE)	2.017	ppmv	
MSVE-5B	10/8/2014	TOLUENE	0.0682	ppmv	U
MSVE-5B	10/8/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-5B	10/8/2014	TRICHLOROETHYLENE (TCE)	0.221	ppmv	
MSVE-5B	10/8/2014	TRICHLOROFLUOROMETHANE	0.0009	ppmv	
2016 Sampling Event					
MSVE-1B	11/14/2016	1,1,1-TRICHLOROETHANE	0.3865	ppmv	
MSVE-1B	11/14/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-1B	11/14/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-1B	11/14/2016	CHLOROFORM	0.0274	ppmv	U
MSVE-1B	11/14/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-1B	11/14/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-1B	11/14/2016	TETRACHLOROETHYLENE (PCE)	1.261	ppmv	
MSVE-1B	11/14/2016	TOLUENE	0.0423	ppmv	U
MSVE-1B	11/14/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-1B	11/14/2016	TRICHLOROETHYLENE (TCE)	0.1102	ppmv	
MSVE-1B	11/14/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
MSVE-2B	11/14/2016	1,1,1-TRICHLOROETHANE	0.2625	ppmv	
MSVE-2B	11/14/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-2B	11/14/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-2B	11/14/2016	CHLOROFORM	0.0274	ppmv	U
MSVE-2B	11/14/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-2B	11/14/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-2B	11/14/2016	TETRACHLOROETHYLENE (PCE)	1.448	ppmv	
MSVE-2B	11/14/2016	TOLUENE	0.0423	ppmv	U
MSVE-2B	11/14/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-2B	11/14/2016	TRICHLOROETHYLENE (TCE)	0.1241	ppmv	
MSVE-2B	11/14/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
MSVE-3B	11/14/2016	1,1,1-TRICHLOROETHANE	0.2779	ppmv	
MSVE-3B	11/14/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-3B	11/14/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-3B	11/14/2016	CHLOROFORM	0.0274	ppmv	U

Table J-2-3 Analytical Data for the Passive SVE Cell *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-3B	11/14/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-3B	11/14/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-3B	11/14/2016	TETRACHLOROETHYLENE (PCE)	1.314	ppmv	
MSVE-3B	11/14/2016	TOLUENE	0.0423	ppmv	U
MSVE-3B	11/14/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-3B	11/14/2016	TRICHLOROETHYLENE (TCE)	0.1274	ppmv	
MSVE-3B	11/14/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
MSVE-4B	11/14/2016	1,1,1-TRICHLOROETHANE	0.2497	ppmv	
MSVE-4B	11/14/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-4B	11/14/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-4B	11/14/2016	CHLOROFORM	0.0274	ppmv	U
MSVE-4B	11/14/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-4B	11/14/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-4B	11/14/2016	TETRACHLOROETHYLENE (PCE)	1.185	ppmv	
MSVE-4B	11/14/2016	TOLUENE	0.0423	ppmv	U
MSVE-4B	11/14/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-4B	11/14/2016	TRICHLOROETHYLENE (TCE)	0.1133	ppmv	
MSVE-4B	11/14/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
MSVE-5B	11/14/2016	1,1,1-TRICHLOROETHANE	0.2299	ppmv	
MSVE-5B	11/14/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-5B	11/14/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-5B	11/14/2016	CHLOROFORM	0.0274	ppmv	U
MSVE-5B	11/14/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-5B	11/14/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-5B	11/14/2016	TETRACHLOROETHYLENE (PCE)	1.13	ppmv	
MSVE-5B	11/14/2016	TOLUENE	0.0423	ppmv	U
MSVE-5B	11/14/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-5B	11/14/2016	TRICHLOROETHYLENE (TCE)	0.1038	ppmv	
MSVE-5B	11/14/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U

* Detections highlighted in red.
* U = non-detect
* J = estimated value

Table J-2-4. Analytical Data for 320-M

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
2012 Sampling Event					
MSVE-320-1	10/4/2012	1,1,1-TRICHLOROETHANE	0.009	ppmv	U
MSVE-320-1	10/4/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.016	ppmv	U
MSVE-320-1	10/4/2012	1,1-DICHLOROETHYLENE	0.209	ppmv	U
MSVE-320-1	10/4/2012	CARBON TETRACHLORIDE	0.003	ppmv	U
MSVE-320-1	10/4/2012	CHLOROFORM	0.043	ppmv	U
MSVE-320-1	10/4/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-320-1	10/4/2012	TETRACHLOROETHYLENE (PCE)	0.074	ppmv	
MSVE-320-1	10/4/2012	TOLUENE	0.421	ppmv	U
MSVE-320-1	10/4/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-320-1	10/4/2012	TRICHLOROETHYLENE (TCE)	0.108	ppmv	
MSVE-320-1	10/4/2012	TRICHLOROFLUOROMETHANE	0.002	ppmv	U
MSVE-320-2	10/4/2012	1,1,1-TRICHLOROETHANE	0.009	ppmv	U
MSVE-320-2	10/4/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.016	ppmv	U
MSVE-320-2	10/4/2012	1,1-DICHLOROETHYLENE	0.209	ppmv	U
MSVE-320-2	10/4/2012	CARBON TETRACHLORIDE	0.003	ppmv	U
MSVE-320-2	10/4/2012	CHLOROFORM	0.043	ppmv	U
MSVE-320-2	10/4/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-320-2	10/4/2012	TETRACHLOROETHYLENE (PCE)	2.574	ppmv	
MSVE-320-2	10/4/2012	TOLUENE	0.421	ppmv	U
MSVE-320-2	10/4/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-320-2	10/4/2012	TRICHLOROETHYLENE (TCE)	14.757	ppmv	
MSVE-320-2	10/4/2012	TRICHLOROFLUOROMETHANE	0.002	ppmv	U
2013 Sampling Event					
MSVE-320-1	12/11/2013	1,1,1-TRICHLOROETHANE	0.005	ppmv	U
MSVE-320-1	12/11/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.006	ppmv	U
MSVE-320-1	12/11/2013	1,1-DICHLOROETHYLENE	0.11	ppmv	U
MSVE-320-1	12/11/2013	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-320-1	12/11/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U
MSVE-320-1	12/11/2013	CHLOROFORM	0.008	ppmv	U
MSVE-320-1	12/11/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-320-1	12/11/2013	TETRACHLOROETHYLENE (PCE)	0.137	ppmv	
MSVE-320-1	12/11/2013	TOLUENE	0.068	ppmv	U
MSVE-320-1	12/11/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U

Table J-2-4. Analytical Data for 320-M *(continued)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-320-1	12/11/2013	TRICHLOROETHYLENE (TCE)	0.295	ppmv	
MSVE-320-1	12/11/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
MSVE-320-2	12/11/2013	1,1,1-TRICHLOROETHANE	0.009	ppmv	
MSVE-320-2	12/11/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.006	ppmv	U
MSVE-320-2	12/11/2013	1,1-DICHLOROETHYLENE	0.11	ppmv	U
MSVE-320-2	12/11/2013	CARBON TETRACHLORIDE	0.002	ppmv	
MSVE-320-2	12/11/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U
MSVE-320-2	12/11/2013	CHLOROFORM	0.008	ppmv	U
MSVE-320-2	12/11/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-320-2	12/11/2013	TETRACHLOROETHYLENE (PCE)	3.67	ppmv	
MSVE-320-2	12/11/2013	TOLUENE	0.068	ppmv	U
MSVE-320-2	12/11/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U
MSVE-320-2	12/11/2013	TRICHLOROETHYLENE (TCE)	12.6	ppmv	
MSVE-320-2	12/11/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
2014 Sampling Event					
MSVE-320-1	10/9/2014	1,1,1-TRICHLOROETHANE	0.0048	ppmv	U
MSVE-320-1	10/9/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-320-1	10/9/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-320-1	10/9/2014	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-320-1	10/9/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-320-1	10/9/2014	CHLOROFORM	0.0081	ppmv	U
MSVE-320-1	10/9/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U
MSVE-320-1	10/9/2014	TETRACHLOROETHYLENE (PCE)	0.187	ppmv	
MSVE-320-1	10/9/2014	TOLUENE	0.0682	ppmv	U
MSVE-320-1	10/9/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-320-1	10/9/2014	TRICHLOROETHYLENE (TCE)	0.551	ppmv	
MSVE-320-1	10/9/2014	TRICHLOROFLUOROMETHANE	0.001	ppmv	J
MSVE-320-2	10/9/2014	1,1,1-TRICHLOROETHANE	0.006	ppmv	J
MSVE-320-2	10/9/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-320-2	10/9/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-320-2	10/9/2014	CARBON TETRACHLORIDE	0.001	ppmv	J
MSVE-320-2	10/9/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-320-2	10/9/2014	CHLOROFORM	0.0081	ppmv	U
MSVE-320-2	10/9/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U

Table J-2-4. Analytical Data for 320-M *(continued/end)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-320-2	10/9/2014	TETRACHLOROETHYLENE (PCE)	1.82	ppmv	
MSVE-320-2	10/9/2014	TOLUENE	0.0682	ppmv	U
MSVE-320-2	10/9/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-320-2	10/9/2014	TRICHLOROETHYLENE (TCE)	4.56	ppmv	
MSVE-320-2	10/9/2014	TRICHLOROFLUOROMETHANE	0.001	ppmv	J
2016 Sampling Event					
MSVE-320-1	11/9/2016	1,1,1-TRICHLOROETHANE	0.0274	ppmv	U
MSVE-320-1	11/9/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-320-1	11/9/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-320-1	11/9/2016	CHLOROFORM	0.0274	ppmv	U
MSVE-320-1	11/9/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-320-1	11/9/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-320-1	11/9/2016	TETRACHLOROETHYLENE (PCE)	0.27	ppmv	
MSVE-320-1	11/9/2016	TOLUENE	0.0423	ppmv	U
MSVE-320-1	11/9/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-320-1	11/9/2016	TRICHLOROETHYLENE (TCE)	1.086	ppmv	
MSVE-320-1	11/9/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U
MSVE-320-2	11/14/2016	1,1,1-TRICHLOROETHANE	0.0274	ppmv	U
MSVE-320-2	11/14/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-320-2	11/14/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-320-2	11/14/2016	CHLOROFORM	0.0274	ppmv	U
MSVE-320-2	11/14/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-320-2	11/14/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-320-2	11/14/2016	TETRACHLOROETHYLENE (PCE)	0.5265	ppmv	
MSVE-320-2	11/14/2016	TOLUENE	0.0423	ppmv	U
MSVE-320-2	11/14/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-320-2	11/14/2016	TRICHLOROETHYLENE (TCE)	1.763	ppmv	
MSVE-320-2	11/14/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U

* Detections highlighted in red.
* U = non-detect
* J = estimated value

Table J-2-5. Analytical Data for the Manhole 4A Passive SVE

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
2012 Sampling Event					
MSVE-4A	10/8/2012	1,1,1-TRICHLOROETHANE	0.062	ppmv	
MSVE-4A	10/8/2012	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.016	ppmv	U
MSVE-4A	10/8/2012	1,1-DICHLOROETHYLENE	0.209	ppmv	U
MSVE-4A	10/8/2012	CARBON TETRACHLORIDE	0.003	ppmv	U
MSVE-4A	10/8/2012	CHLOROFORM	0.043	ppmv	U
MSVE-4A	10/8/2012	CIS-1,2-DICHLOROETHYLENE	3	ppmv	U
MSVE-4A	10/8/2012	TETRACHLOROETHYLENE (PCE)	93.184	ppmv	
MSVE-4A	10/8/2012	TOLUENE	0.421	ppmv	U
MSVE-4A	10/8/2012	TRANS-1,2-DICHLOROETHYLENE	2	ppmv	U
MSVE-4A	10/8/2012	TRICHLOROETHYLENE (TCE)	0.03	ppmv	
MSVE-4A	10/8/2012	TRICHLOROFLUOROMETHANE	0.002	ppmv	U
2013 Sampling Event					
MSVE-4A	12/11/2013	1,1,1-TRICHLOROETHANE	0.023	ppmv	
MSVE-4A	12/11/2013	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.006	ppmv	U
MSVE-4A	12/11/2013	1,1-DICHLOROETHYLENE	0.11	ppmv	U
MSVE-4A	12/11/2013	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-4A	12/11/2013	CHLOROETHENE (VINYL CHLORIDE)	0.391	ppmv	U
MSVE-4A	12/11/2013	CHLOROFORM	0.008	ppmv	U
MSVE-4A	12/11/2013	CIS-1,2-DICHLOROETHYLENE	0.497	ppmv	U
MSVE-4A	12/11/2013	TETRACHLOROETHYLENE (PCE)	53.3	ppmv	
MSVE-4A	12/11/2013	TOLUENE	0.068	ppmv	U
MSVE-4A	12/11/2013	TRANS-1,2-DICHLOROETHYLENE	0.462	ppmv	U
MSVE-4A	12/11/2013	TRICHLOROETHYLENE (TCE)	0.024	ppmv	
MSVE-4A	12/11/2013	TRICHLOROFLUOROMETHANE	0.001	ppmv	U
2014 Sampling Event					
MSVE-4A	10/9/2014	1,1,1-TRICHLOROETHANE	0.127	ppmv	
MSVE-4A	10/9/2014	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	0.0064	ppmv	U
MSVE-4A	10/9/2014	1,1-DICHLOROETHYLENE	0.1104	ppmv	U
MSVE-4A	10/9/2014	CARBON TETRACHLORIDE	0.0006	ppmv	U
MSVE-4A	10/9/2014	CHLOROETHENE (VINYL CHLORIDE)	0.3913	ppmv	U
MSVE-4A	10/9/2014	CHLOROFORM	0.0081	ppmv	U
MSVE-4A	10/9/2014	CIS-1,2-DICHLOROETHYLENE	0.4972	ppmv	U
MSVE-4A	10/9/2014	TETRACHLOROETHYLENE (PCE)	105.6	ppmv	

Table J-2-5. Analytical Data for the Manhole 4A Passive SVE *(continued/end)*

Location	Sample Date	Analyte	Result	Unit	Lab Qualifier
MSVE-4A	10/9/2014	TOLUENE	0.0682	ppmv	U
MSVE-4A	10/9/2014	TRANS-1,2-DICHLOROETHYLENE	0.4615	ppmv	U
MSVE-4A	10/9/2014	TRICHLOROETHYLENE (TCE)	0.091	ppmv	
MSVE-4A	10/9/2014	TRICHLOROFLUOROMETHANE	0.0009	ppmv	U
2016 Sampling Event					
MSVE-4A	11/14/2016	1,1,1-TRICHLOROETHANE	0.0274	ppmv	U
MSVE-4A	11/14/2016	CARBON TETRACHLORIDE	0.0282	ppmv	U
MSVE-4A	11/14/2016	CHLOROETHENE (VINYL CHLORIDE)	0.0346	ppmv	U
MSVE-4A	11/14/2016	CHLOROFORM	0.0274	ppmv	U
MSVE-4A	11/14/2016	CIS-1,2-DICHLOROETHYLENE	0.0308	ppmv	U
MSVE-4A	11/14/2016	DICHLOROMETHANE (METHYLENE CHLORIDE)	0.0309	ppmv	U
MSVE-4A	11/14/2016	TETRACHLOROETHYLENE (PCE)	0.8211	ppmv	
MSVE-4A	11/14/2016	TOLUENE	0.0423	ppmv	U
MSVE-4A	11/14/2016	TRANS-1,2-DICHLOROETHYLENE	0.0305	ppmv	U
MSVE-4A	11/14/2016	TRICHLOROETHYLENE (TCE)	0.0268	ppmv	U
MSVE-4A	11/14/2016	TRICHLOROFLUOROMETHANE	0.0262	ppmv	U

* Detections highlighted in red.
* U = non-detect
* J = estimated value

M-AREA INACTIVE PROCESS SEWER LINES OPERABLE UNIT (081-M)

I. Introduction

This report is the third five-year review for the M-Area Inactive Process Sewer Lines to Manhole 1 (081-M) (MIPSL) Operable Unit (OU). The review was conducted from August 2017 through November 2017. Contaminants have been left in place at the MIPSL OU at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the MIPSL OU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table K-1 lists the chronology of site events for the MIPSL OU.

III. Background

MIPSL OU is listed as a Resource Conservation and Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) unit in Appendix C of the Federal Facility Agreement (FFA) for Savannah River Site (SRS) (FFA 1993). The media associated with the MIPSL OU is vadose zone soil. Groundwater is not addressed under this OU. Any groundwater contamination resulting from the MIPSL OU is regulated by the South Carolina Department of Health and Environmental Control (SCDHEC) RCRA Permit Renewal for the SRS (Hazardous and Mixed Waste Permit SC1 890 008 989) and addressed by the requirements of the M-Area and Metallurgical Laboratory Hazardous Waste Management Facilities Groundwater Monitoring and Corrective Action agreements.

Physical Characteristics

MIPSL OU is in M Area in the northwest portion of SRS (Figure K-1). It is comprised of portions of the MIPSL, including the segment of pipe from the slab of the 320-M Alloy Building to the Former Security Fence and the segment of pipeline starting adjacent to the slab of the 322-M Metallurgical Laboratory and extending to the A-014 Outfall (Figure K-2).

The MIPSL OU includes approximately 1,140 m (3,800 ft) of underground piping and extends from the edges of the buildings (or former buildings) to the downstream discharge points of each line (WSRC 2006). The sewer pipes are made of vitrified clay, with diameters ranging from 30 to 75 cm (12 to 30 in) and pipe depths ranging from about 2.1 to 3.6 m (7 to 12 ft) below ground surface (bgs). High-density polyethylene pipe liner, installed inside portions of the M-Area Inactive Process Sewer (MIPS) and 313-MIPS pipelines in 1983, range from 18.6 to 30 cm (6 to 12 in) in diameter.

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 105 to 120 m (350 to 400 ft) apart along the MIPS and 313-MIPS sewer lines. An engineering review examined the construction, effluent capacity, and operational history for MIPS and 313-MIPS and found little probability of process overflows at the manholes.

The primary contaminant release mechanism at the MIPSL OU is leakage of effluents from the process sewer lines serving multiple facilities in M Area. Surficial soils in M Area consist of fine-grained sediments to a depth of approximately 9 m (30 ft). This low-permeability formation is referred to as the “Upland Unit”. The Upland Unit has limited contaminant mobility to a significant degree although volatile organic compounds have migrated downward, principally by diffusion from the source zone.

Figures K-3 and K-4 are photos of the area prior to remediation and the current state (2017).

Land and Resource Use

According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The *Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999) designates MIPSL OU as being within an industrial area. The future land use for MIPSL OU is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

From 1958 until early 1985, several M-Area facilities (313-M, 320-M, and 321-M) manufactured reactor fuel and target assemblies (WSRC 2006). 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 K-2). The MIPS network discharged waste to the M-Area Settling Basin; 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 L/day (430,000 to 800,000 gal/day). In November 1982, process waters from 313-MIPS were redirected back to Tims Branch through the A-014 Outfall, resulting in a reduction of the flow to the M-Area Settling Basin to 950,000 L/day (250,000 gal/day) by the end of 1982 (WSRC 2003).

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, aluminum, copper, iron, lead, magnesium, manganese, mercury, nickel, zinc, and uranium.

Initial Response

By May 2003, M-Area facilities had been sufficiently deactivated. Decommissioning of various buildings, including Buildings 313-M, 322-M, 320-M, and 321-M, was completed prior to implementation of the remedial action for the MIPSL OU.

Basis for Taking Action

Findings from the risk assessment indicate that there are no exposure pathways for human or ecological receptors at the MIPSL OU (WSRC 2005).

Extensive characterization and modeling activities predicted that TCE and PCE could travel to groundwater within 1,000 years at levels that exceed maximum contaminant levels

(MCLs). TCE and PCE were identified as contaminant migration (CM) constituents of concern (COCs) in the vadose zone soil adjacent to and beneath the manholes at depths greater than 1.2 m (4 ft) bgs. The higher contaminant concentrations were located beneath the manholes.

A remedial action was necessary at the MIPSL OU because there is a potential that TCE and PCE could leach to groundwater at concentrations that would exceed MCLs and present an unacceptable risk to human receptors. For TCE, the CM remedial goal (RG) is 0.0408 mg/kg and the CM RG for PCE is 0.307 mg/kg. Exceedances of these values in soils indicate that TCE and PCE may leach to groundwater at levels above the MCL (5 µg/L). Final RGs for MIPSL OU are shown in Table K-2.

IV. Remedial Actions

Remedy Selection

As stated in the Record of Decision (ROD) (WSRC 2006), the remedial action objective (RAO) for the MIPSL OU is to prevent TCE and PCE from leaching to groundwater above MCLs.

The selected remedy for the MIPSL OU was Phased Soil Vapor Extraction (SVE) enhanced with Soil Fracturing and Institutional Controls (i.e., Land Use Controls [LUCs]).

The following LUC objectives for the MIPSL OU 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 soil and pipelines);
- Prohibit the development and use of property for residential housing, elementary and secondary 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; and
- Prevent access or use of contaminated groundwater until cleanup levels are met.

Remedy Implementation

The selected final remedy for the MIPSL OU provides the greatest level of protection to human health and ecological receptors. The remedy included the following:

- Installed four fractured wells at each of the four manhole locations for SVE. One deep SVE well was installed at the center of each fracture well area. Hydraulic fracturing was used to improve the permeability of the fine-grained soils ("Upland Unit") where residual contamination remains. A threshold value of 10 ppmv was recognized as appropriate for transition from active SVE to passive SVE;
- Grouted the process sewer connections at all the manholes and the sewer discharge point at the A-014 Outfall was plugged; and
- Established LUCs for 2.14 hectares (5.29 acres) to include the following:
    - Providing access controls for on-site workers via the Site Use/Site Clearance Program. Other administrative controls to ensure worker safety include work controls, worker training, and worker briefings of health, safety requirements, and identification of signs located at the waste unit boundaries;
    - Notifying U.S. Environmental Protection Agency (USEPA) and SCDHEC in advance of any changes in land use or excavation of waste:
    - Providing access controls against trespassers, as described in the 2013 RCRA 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 or any portion thereof, is ever transferred from USDOE, notice of the type and quantity of any hazardous substances that were known to have stored (for more than one year), released, or disposed of on the property will be provided. In addition, if the property or any portion thereof, is every transferred by deed, the U.S. Government will satisfy the requirements of CERCLA 120(h)(3) to include a description of the remedial action taken, a covenant, and an access clause.

System Operations/Operation and Maintenance

The following system operations are ongoing:

- Operation of the SVE system continues. Since 2008, the MIPSL OU SVE system has removed 3,597 and 877 lbs of PCE and TCE, respectively, through 2016;
- Operation of the MicroBlowers^{TM} continues.

The following maintenance activities are ongoing:

- Annual site inspections and site maintenance; and
- Site controls and land use restrictions via the SRS Site Use/Site Clearance program, which restricts invasive and permanent installation activities at the MIPSL OU.

Table K-3 compares the actual operation and maintenance (O&M) costs for the five-year remedy review period to the estimated direct O&M costs from the ROD (WSRC 2006). The estimated cost for Fiscal Year (FY) 2012 to FY2017 is $975,240 for O&M of the SVE system, MicroBlowers^{TM}, institutional controls (i.e., LUCs), and five-year remedy reviews. The actual O&M cost for FY2012 to FY2017 is $761,227. The actual O&M costs from FY2012 to FY2017 are as expected.

V. Progress Since Last Review

The previous protectiveness statement concluded that the remedial action at MIPSL OU is expected to be protective of human health and the environment. Exposure pathways that could result in unacceptable risks have been controlled through institutional controls (i.e., LUCs). There were no recommendations or follow-up actions from the last five-year remedy review.

VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII, Documents Reviewed;
- Confirmed the implementation of the remedial action;

- Reviewed all process and performance monitoring data provided by the annual performance evaluation reports (PERs) (SRNS 2014, SRNS 2015, SRNS 2016, and SRNS 2017) and provided a technical assessment of whether the SVE is functioning as intended by the ROD and whether the shutdown criteria have been achieved;
- Inspected the OU, interviewed maintenance personnel and documented the results on the Inspection Checklist provided in Attachment K-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance.

Data Review

The data and results presented in the 2016 PER were reviewed (SRNS 2017).

The active SVE system at the MIPSL OU started operations in 2008. The contamination exists primarily within fine-grained sediments of the Upland Formation; therefore, the active SVE system will only operate for short periods of time before the mobile contaminants are exhausted. Hydraulic fracturing was used to increase the surface area available for vapor extraction and improve permeability.

The active SVE unit is portable and can be cycled between the four manhole (MH) locations (i.e., MH-01, MH-11, MH-12, and MH-13) to better match the depletion and rebound behavior of soil vapor in the Upland Formation. At each MH, there are four fractured wells, one conventional SVE well, and one or two pressure monitoring wells. When the MHs are not undergoing active SVE a MicroBlower™ is connected to the conventional SVE well.

The portable active SVE system was cycled between two locations (MH-01 and MH-12) between 2012 and 2017. In 2012, concentrations exceeded 10 ppmv at MH-12, so the active SVE system was transferred from MH-01 to MH-12, which was considered the fifth cycle. The fifth cycle ended on approximately March 31, 2012, when active SVE was discontinued at MH-12 because all soil vapor samples were less than 10 ppmv. Active

SVE was reinitiated at MH-01 on April 2, 2012. The sixth cycle continued at MH-01 for all of 2013. Two rebound tests to assess mass removal efforts were conducted in 2013. The seventh cycle occurred in early 2014 as Fracture Well Testing was conducted at all four MHs. The SVE was moved to MH-12 on April 1, 2014, to reduce concentrations at Well F12-3. Active SVE lasted for three months at MH-12. The eighth cycle began as active SVE was reinitiated at MH-01 on July 1, 2014. Active SVE continued at MH-01 for all of 2016.

Since 2008, the active SVE system at the MIPSL OU has removed 3,597 lbs of PCE and 877 lbs of TCE through 2016. MH-01 and MH-12 are responsible for over 99% of the VOCs extracted from the active SVE system. Active SVE will continue to be utilized at MH-01 until the system reaches a point of diminished returns.

Summary of Inspections and Interviews

Interviews were conducted with Richard Feagin, O&M staff member, on October 11, 2017 and George Joyner, O&M Site Manager, on October 12, 2017 at the O&M organization offices. No issues were identified for the MIPSL OU during this inspection.

The MIPSL OU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) and USDOE personnel on December 15, 2017. No issues were identified for the MIPSL OU during these inspections.

A site inspection will be conducted by USEPA and SCDHEC personnel, accompanied by USDOE and SRNS personnel, prior to submittal of the Revision 1 of this document. It is anticipated that no significant problems regarding this OU will be identified during the inspection.

Scheduled annual site inspections conducted from FY2012 through FY2017 identified the presence of ant mounds and a sign needing replacement. These findings were documented on the field inspection checklist and resolved soon after discovery.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The remedy is functioning as intended as demonstrated below:

- The selected remedy of Phased SVE enhanced with Soil Fracturing and institutional controls (i.e., LUCs) is effective in preventing TCE and PCE from leaching to groundwater above MCLs. The Land Use Control Implementation Plan for MIPSL OU governs LUC implementation, maintenance, monitoring, reporting, and enforcement of LUCs (WSRC 2007). The LUCs that are in place include physical access to controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), use restrictions to prevent unauthorized contact, removal or excavation of contaminated soils, and restrictions to prevent unauthorized access to or use of groundwater until cleanup levels are met. Warning signs are in good condition, and no activities were observed that would have violated the LUCs. All LUC objectives are being met. Based on the 2016 PER (SRNS 2017), the MIPSL OU SVE system has removed 3,597 lbs and 877 lbs of PCE and TCE, respectively, through 2016.

Are Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still valid?

The exposure assumptions, toxicity data, and cleanup levels used at the time of final remedy selection are still valid. There have been no changes in standards or to-be-considered guidance identified in the ROD that call into question the protectiveness of the remedy.

The USEPA standards and toxicity values have been updated since the last five-year remedy review as shown in Appendix B. The changes to the values for COCs at the MIPSL OU were not significant, and the RAOs continue to be met by the remedial action. No new standards or to-be-considered guidance have been identified that call into question the protectiveness of the remedy.

Fact sheets provided on the USEPA webpage regarding emerging contaminants were reviewed for applicability to this site. None of the listed emerging contaminants were identified as applicable to this OU.

Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No new information has come to light that could call into question the protectiveness of the remedy.

VIII. Issues

There are no issues related to current site conditions or activities that currently prevent the remedy from being protective.

IX. Recommendations and Follow-up Actions

There are no recommendations or follow-up actions for this OU.

X. Protectiveness Statement(s)

The remedy at MIPSL OU is protective of human health and the environment.

Exposure pathways that could result in unacceptable risks are being controlled by institutional controls (i.e. LUCs) to prevent exposure to or ingestion of contaminated groundwater and soil media. All threats to contaminated vadose zone soil at the MIPSL OU are being addressed through SVE systems and implementation of physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the MIPSL OU for industrial use only, and warning signs and use restrictions via the SRS Site Use/Site Clearance Program.

XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Operating Equipment is scheduled for January 2024.

XII. Documents Reviewed

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

SRNS, 2014. *Performance Evaluation Report of 2013 for the M-Area Inactive Process Sewer Lines (MIPSL) (081-M) Operable Unit (OU) (U) January through December 2013*, SRNS-RP-2014-00077, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2015. *Performance Evaluation Report of 2014 for the M-Area Inactive Process Sewer Lines (MIPSL) (081-M) Operable Unit (OU) (U) January through December 2014*, SRNS-RP-2015-00056, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2016. *Performance Evaluation Report of 2015 for the M-Area Inactive Process Sewer Lines (MIPSL) (081-M) Operable Unit (OU) (U) January through December 2015*, SRNS-RP-2016-00046, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2017. *Performance Evaluation Report of 2016 for the M-Area Inactive Process Sewer Lines (MIPSL) (081-M) Operable Unit (OU) (U) January through December 2016*, SRNS-RP-2015-00017, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 1999. *Land Use Control Assurance Plan for the Savannah River Site*, WSRC-RP-98-4125, Revision 1.1, latest revision, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC, 2003. *M-Area Inactive Process Sewer Lines (MIPSL) and 313-M Area Inactive Process Sewer (313-MIPS) Manhole Overflow Evaluation (U)*, ERD-EN-2003-0169, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

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

WSRC, 2006. *Record of Decision Remedial Alternative Selection for the M-Area Inactive Process Sewer Lines Operable Unit (U)*, WSRC-RP-2006-4001, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2007a. *Land Use Control Implementation Plan (LUCIP) for the M-Area Inactive Process Sewer Lines Operable Unit (081-M) (U)*, WSRC–RP–2006-4068, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

Various - *Inspection Data Sheets – Field Inspection Checklist, M-Area Inactive Process Sewer Lines (U)*, ER-IDS-019-050, Inspection period 2012 through 2017 (annually)

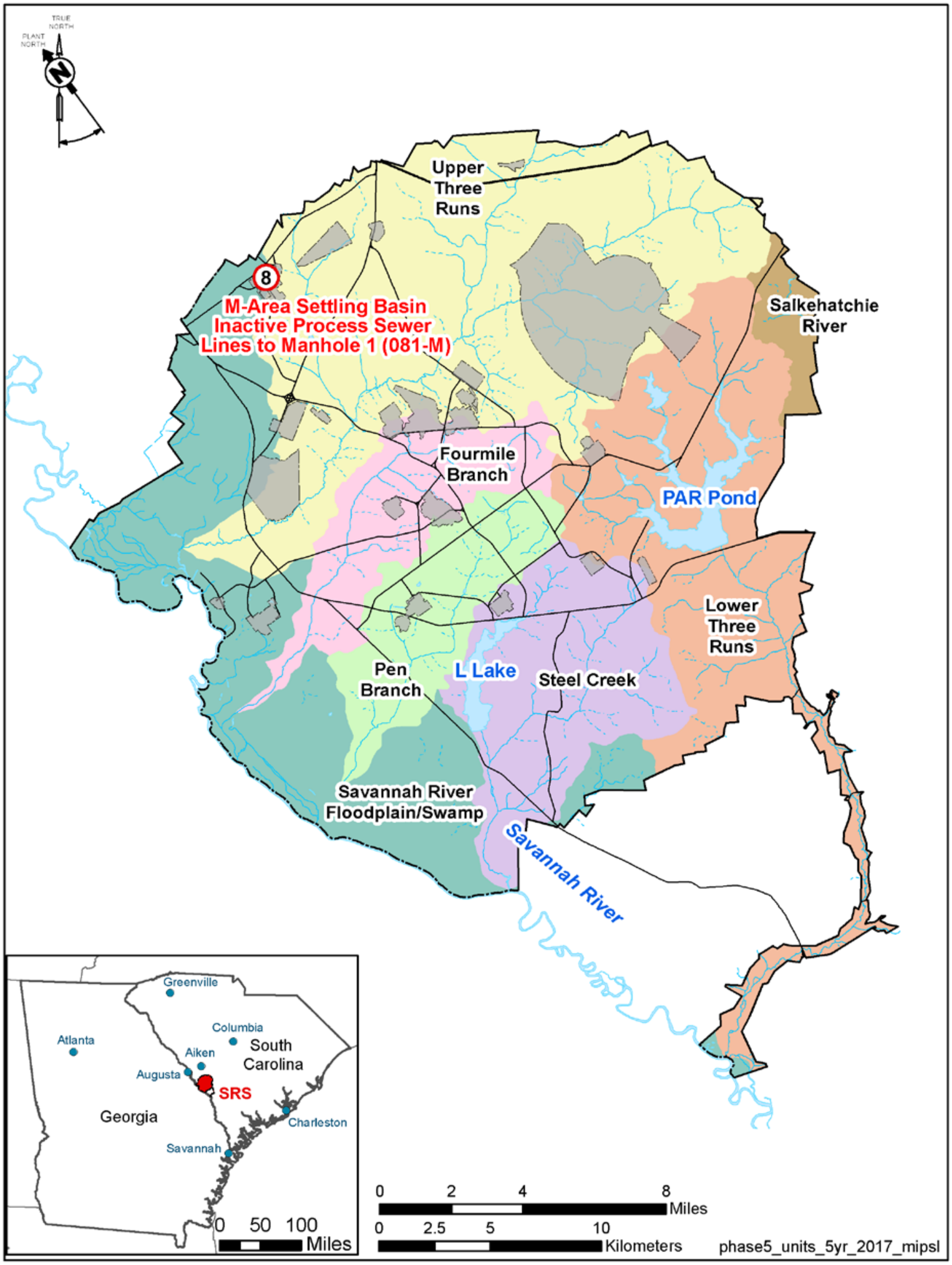

Figure K-1. M-Area Inactive Sewer Line OU at Savannah River Site

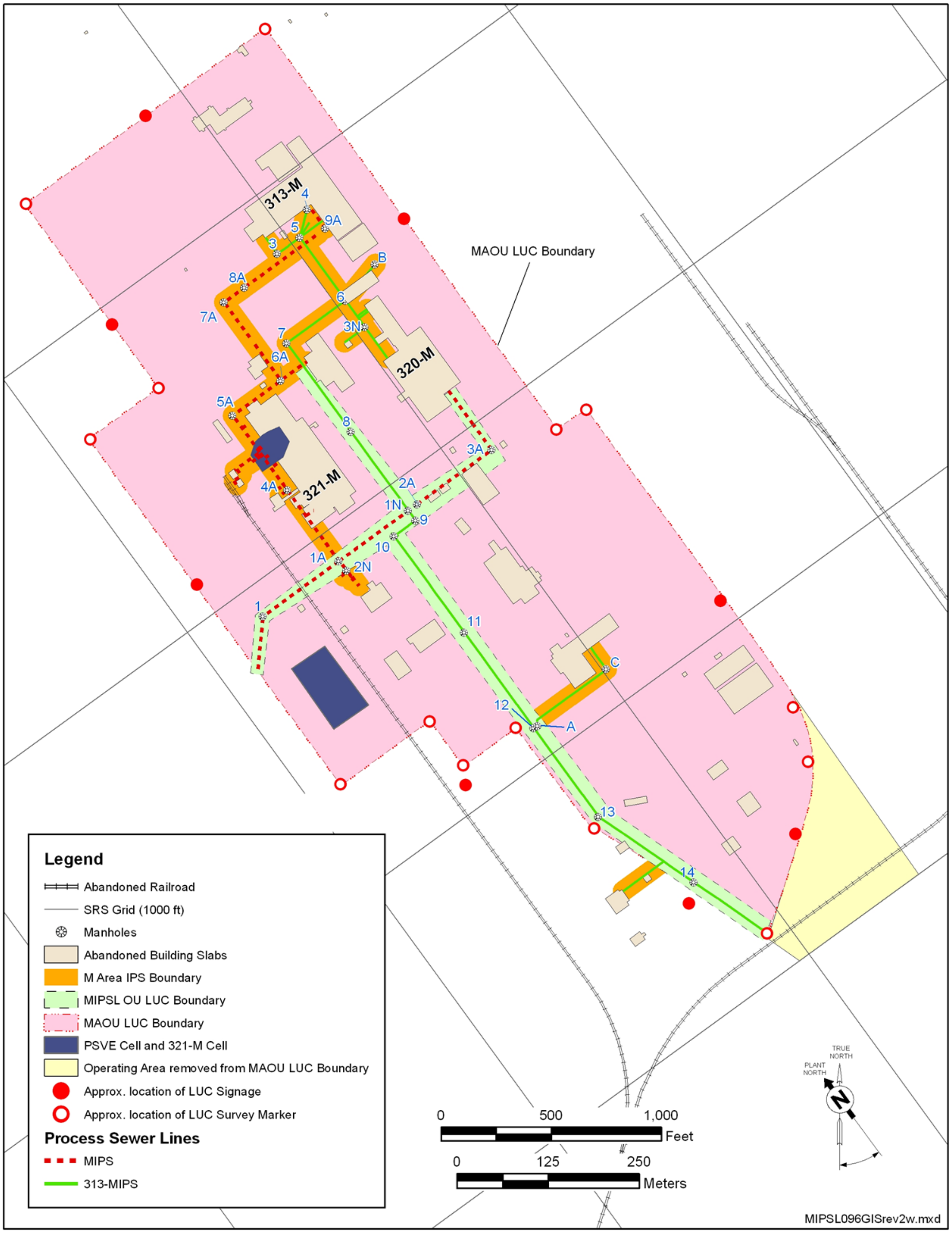

Figure K-2. Layout of the MIPSL OU

ARF/IRF PHOTO NUMBER: 000090
NEGATIVE NUMBER: 91-2171-2
MANHOLE #1 LOOKING EAST TOWARD
MANHOLE #1A

ARF/IRF PHOTO NUMBER: 000091
NEGATIVE NUMBER: 91-2171-1
MANHOLE #5 LOOKING WEST TOWARD
MANHOLE #8A

Figure K-3. Photos of MIPSL OU Before Remediation Activities (1991)

Figure K-4. Current Photos of MIPSL OU (2017)

Table K-1. Chronology of OU Events

Event	Date
Characterization Field Start	July 28, 2003
ROD Issuance	April 26, 2007
Remedial Action Construction Start / Completion	June 25, 2007 / April 30, 2008
Remedial Action Operations Start / Complete	January 1, 2008 / ongoing
Previous Five-Year Reviews Issuance	February 4, 2009 / February 4, 2014

Table K-2. MIPSL RCOCs with Final Remedial Goals

Medium	RCOC	Type of COC	RG (mg/kg)	Basis
Soil	Tetrachloroethylene (PCE)	CM	3.07E-01	CM soil clean up level
	Trichlorethylene (TCE)	CM	4.08E-02	CM soil clean up level

RCOC – refined COC

Table K-3. Actual versus Estimated O&M Costs ($)

	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	Five-Year Total
Total Actual O&M Costs ($)	101,614	126,288	188,916	57,681	122,828	163,900	761,227
Total ROD Estimated Direct O&M Costs ($)	289,580	274,580	274,580	40,500	40,500	55,500	975,240

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Attachment K-1. Five-Year Review Site Inspection Checklist – M-Area Inactive Process Sewer Lines (MIPSL) Operable Unit (OU)

I. SITE INFORMATION			
Site Name:	**M-Area Inactive Process Sewer Lines (MIPSL) Operable Unit (OU)**	**Date of Inspection:**	**08/9/2017**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**CERCLIS #92**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**80°F and Cloudy**

Remedy Includes: *(Click all that apply)*

☐ Landfill Cover / Containment
☒ Access Controls
☒ Institutional Controls
☐ Groundwater Pump and Treatment
☐ Surface Water Pump and Treatment
☐ Monitored Natural Attenuation
☐ Groundwater Containment
☐ Vertical Barriers

☒ Other Soil Vapor Extraction

Attachments: ☐ Inspection team roster attached ☐ Inspection team roster attached

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 10/12/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.:

Problems/Suggestions: ☐ Report Attached

2. **O&M Staff:** Richard Feagin (Name) EC&ACP Post Closure Waste Site Inspector Maintenance Coord (Title) 10/11/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3021

Problems/Suggestions: ☐ Report Attached

Attachment K-1. Five-Year Review Site Inspection Checklist – M-Area Inactive Process Sewer Lines (MIPSL) Operable Unit (OU) *(continued)*

II. INTERVIEWS *(Click all that apply)(Continued)*

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

Agency: ______________________

Contact: ______________ (Name) ______________ (Title) __________ (Date) __________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ______________________

____

Agency: ______________________

Contact: ______________ (Name) ______________ (Title) __________ (Date) __________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ______________________

____

Agency: ______________________

Contact: ______________ (Name) ______________ (Title) __________ (Date) __________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ______________________

____

4. **Other Interviews** *(Optional):* ☐ Report Attached ______________________

____

____

____

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Click all that apply)*

1. **O&M Documents:**

☐ O&M Manual	☐ Readily Available	☐ Up to Date	☒ N/A
☒ As-Built Drawings	☒ Readily Available	☒ Up to Date	☐ N/A
☐ Maintenance Logs	☐ Readily Available	☐ Up to Date	☒ N/A

Remarks: See *Waste Unit Inspection and Maintenance, ER-SOP-019, Field Inspection Checklist for M-Area Inactive Process Sewer Lines*, ER-IDS-019-050.

____

Attachment K-1. Five-Year Review Site Inspection Checklist – M-Area Inactive Process Sewer Lines (MIPSL) Operable Unit (OU) *(continued)*

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)*

2. Health and Safety Plans (HASPs):

☐ Site-Specific Health and Safety Plans ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Contingency Plan/Emergency Response Plan ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.120.HAZWOPER. A SSHASP is prepared if needed.

3. O&M and OSHA Training Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix.

4. Permits and Service Agreements:

☒ Air Discharge Permit ☒ Readily Available ☒ Up to Date ☐ N/A
☐ Effluent Discharge ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Waste Disposal; POTW ☐ Readily Available ☐ Up to Date ☒ N/A
☒ Other Permits ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Underground Injection Control Permit for fracturing was active from December 2007 to February 2012.

5. Gas Generation Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

6. Settlement Monument Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

7. Groundwater Monitoring Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks:

8. Leachate Extraction Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

9. Discharge Compliance Records:

☒ Air ☒ Readily Available ☒ Up to Date ☐ N/A
☐ Water (Effluent) ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

10. Daily Access/Security Logs: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

Attachment K-1. Five-Year Review Site Inspection Checklist – M-Area Inactive Process Sewer Lines (MIPSL) Operable Unit (OU) *(continued)*

IV. O&M COSTS

1. O&M Organization:

☐ State In-House
☐ PRP In-House
☒ Other: SRS
☐ Contractor for State
☐ Contractor for PRP

2. O&M Cost Records:

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place

☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

Total annual cost by year for review period, if available

From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached

From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached

From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached

From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached

From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached

3. Unanticipated or Unusually High O&M Costs During Review Period

Describe costs and reasons: ________

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing Damage: ☐ Location shown on site map ☐ Gates secured ☒ N/A

Remarks: OU-specific perimeter fencing is not required by the remedial action.

B. Signs

1. Signs and Other Security Measures: ☐ Location shown on site map ☐ N/A

Remarks: Signs are in good condition.

Attachment K-1. Five-Year Review Site Inspection Checklist – M-Area Inactive Process Sewer Lines (MIPSL) Operable Unit (OU) *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Once in five years
Responsible Party/Agent: USDOE Savannah River Field Office

	(Name)	(Title)	(Date)	(Phone No.)
Contact:	Karen Adams	Federal Project Director	12/15/17	803-952-7871

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

2. Adequacy: ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks:

D. General

1. Vandalism/Trespassing: ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

2. Land use changes onsite: ☒ N/A
Remarks:

3. Land use changes offsite: ☒ N/A
Remarks:

Attachment K-1. Five-Year Review Site Inspection Checklist – M-Area Inactive Process Sewer Lines (MIPSL) Operable Unit (OU) *(continued)*

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. Roads damaged: ☐ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks:______________________________

B. Other Site Conditions

Remarks: Annual site inspections conducted from FY2012 through FY2017 identified the presence of ant mounds and a sign needing replacement. These findings were resolved soon after discovery.

VII. LANDFILL COVER / CONTAINMENT ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☒ N/A

X. OTHER REMEDIES

If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

A. Soil Vapor Extraction System ☒ Applicable ☐ N/A

1. Blowers, Wellhead Plumbing, and Electrical:

☒ Good Condition ☐ All required wells located ☐ Needs maintenance ☐ N/A

Remarks:______________________________

2. Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances:

☒ Good Condition ☐ Needs maintenance

Remarks:______________________________

3. Spare Parts and Equipment:

☒ Readily Available ☒ Good Condition ☐ Requires Upgrade ☐ Needs to be provided

Remarks:______________________________

Attachment K-1. Five-Year Review Site Inspection Checklist – M-Area Inactive Process Sewer Lines (MIPSL) Operable Unit (OU) *(continued/end)*

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

The remedial action for the MIPSL OU is SVE and Soil Fracturing to prevent TCE and PCE in vadose zone soils from leaching to groundwater above MCLs. Exposure pathways that could result in unacceptable risks are being controlled through LUCs. The remedy is fully established and functioning as designed.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The O&M procedures consisting of annual site inspections and site maintenance (verify no invasive activities have occurred and warning signs) and site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the OU) have been implemented. The O&M procedures are adequately maintaining MIPSL and the condition of its warning signs is good. There are no issues requiring corrective actions.

C. Early Indicators of Potential Remedy Failure

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

N/A

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P-AREA BURNING/RUBBLE PIT (131-P) (PBRP) OPERABLE UNIT

I. Introduction

This report is the third five-year review for the P-Area Burning/Rubble Pit (131-P) (PBRP) Operable Unit (OU). The review was conducted from August 2017 through November 2017. Contaminants have been left in place at the PBRP OU at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the PBRP OU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table L-1 lists the chronology of site events for the PBRP OU.

III. Background

The PBRP OU is listed as a Resource Conservation and Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) unit in Appendix C of the Federal Facility Agreement (FFA) for the Savannah River Site (SRS) (FFA 1993). The media of concern is soil and groundwater.

Physical Characteristics

The PBRP OU is located in the central portion of the SRS in Barnwell County more than 8.0 km (5 mi) from the site boundary and is approximately 244 m (800 ft) west of the P-Area perimeter fence (Figure L-1). The PBRP OU is located within the Steel Creek watershed approximately 68 m (223 ft) north of Steel Creek. The OU consists of five subunits: PBRP, a small drainage ditch near PBRP, a seepline located along an embankment of Steel Creek, a segment of Steel Creek adjacent to the OU, and groundwater in the water table aquifer (Figure L-2). Characteristics of each subunit are described below:

- PBRP subunit is a single, inactive burial pit approximately 61 m (200 ft) long by 9 m (30 ft) wide. The depth of the pit ranges from 2.4 m (8 ft) below ground surface (bgs) in the western end to 3.4 m (11 ft) bgs in the eastern end.

- The ditch subunit is approximately 23 m (75 ft) to the southwest of PBRP. It is 0.3 m (1 ft) to 0.6 m (2 ft) deep and may, at times, receive surface water runoff from the vicinity of the western end of PBRP. Surface water occasionally collects in the ditch, but in general the ditch is dry.

- The seepline subunit is present on a terrace approximately 3 m (10 ft) above Steel Creek. The area identified as the seepline is approximately 3 m (10 ft) wide and 61 m (200 ft) long. Surface water is locally present at the seepline for much of the year. However, the seepline is not a significant source of surface water, as most of the seepline area has surface water only after heavy rainfall events. The seepline often dries up completely in the summer.

- The segment of Steel Creek subunit is approximately 68 m (223 ft) south of PBRP. There is a narrow (<7.6 m [25 ft] wide) floodplain along Steel Creek. Steel Creek is a discharge point for the water table aquifer southwest of PBRP.

- The groundwater subunit is the water table aquifer, which is the “upper” aquifer zone of the Upper Three Runs aquifer and is composed of interbedded sands, silts, and clays. The top of the water table is approximately 10.7 m (35 ft) bgs. The upper aquifer zone is approximately 17.4 m (57 ft) thick; it extends from the water table to a locally continuous clay layer (the “tan clay”) at a depth of approximately 24.4 m (80 ft) bgs. The general groundwater flow direction is to the southwest where it outcrops to Steel Creek.

Figures L-4 and L-5 are photos of the area prior to remediation and the current state (2017), respectively.

Land and Resource Use

The *Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999) designates PBRP OU as being outside of a site industrial zone. However, according to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The future land use for the PBRP OU is reasonably anticipated to be industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

The following summarizes the contamination at the PBRP OU subunits:

- PBRP subunit - From 1951 to 1973, the PBRP was used for periodic burning of combustible materials. Disposal records of individual burials were not kept for this unit; however, information obtained from historical records and from characterization of similar burning/rubble pits at SRS indicates that materials such as wood, cardboard, paper, plastics, rubber, rags, oils, and organic liquids of unknown origins were disposed of in the pit and burned on a monthly basis. In 1973, burning in open pits was discontinued at SRS, and a soil layer was placed over the pit contents. The pit continued to receive inert debris such as construction materials until 1978 when the pit reached capacity.
- Ditch subunit - No waste was placed in the ditch. The ditch was assessed to determine potential impacts from PBRP runoff and erosion.
- Seepline subunit - No waste was placed along the seepline. The seepline was assessed to determine potential impacts from PBRP leaching and seepage.
- Segment of Steel Creek and groundwater subunits - No waste associated with PBRP was placed in Steel Creek. Prior to 1997, cooling water, process sewer water, and stormwater runoff from P-Area were discharged to Steel Creek at a location upgradient of PBRP. In addition, groundwater in the water table aquifer under P-Area discharges to Steel Creek. Consequently, Steel Creek has been contaminated by upgradient sources in P-Area unrelated to the PBRP OU. All process/cooling water discharges were discontinued in February 1997.

Initial Response

When the PBRP reached capacity in 1978, the debris was covered with approximately 1.2 m (4 ft) of clean soil to grade. Seven groundwater monitoring wells were installed in 1983. No removal actions have been performed at the unit.

The ditch, seepline, a segment of Steel Creek, and the groundwater subunits were assessed as part of this OU to determine if there had been an impact from PBRP from runoff and/or erosion, leaching, or seepage.

Basis for Taking Action

The exposure to or ingestion of contaminated soil and groundwater poses a potential increased risk of cancer to human receptors and is the basis for taking action at the PBRP OU.

Based on the RCRA Facility Investigation (RFI)/Remedial Investigation (RI) with Baseline Risk Assessment report (WSRC 2001), the PBRP OU soil poses a threat to human receptors as it is contaminated with polyaromatic hydrocarbons (PAHs). Human health refined constituents of concern (RCOCs) for the current on-site worker include benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenzo[a,h]anthracene, and indeno[1,2,3-c,d]pyrene. Human health RCOCs for the future on-site resident include these constituents plus chrysene, fluoranthene, phenanthrene, and pyrene (Table L-2).

Nine constituents at PBRP present a contaminant migration (CM) (i.e., leachability) threat to groundwater. These CM constituents of concern (COCs) include antimony, chromium, copper, nickel, zinc, dibenzofuran, tetrachloroethylene (PCE), trichloroethylene (TCE), and Aroclor 1242 (a polychlorinated biphenyl [PCB]). These constituents were predicted to exceed maximum contaminant levels (MCLs) or risk-based concentrations (RBCs) within 1,000 years. The volume of contaminated soil is 2,678 m^3 (3,500 yd^3) per the Record of Decision (ROD) (WSRC 2002). There are no RCRA listed or characteristic wastes and no principal threat source material at this OU.

Groundwater also poses a threat to human health. Groundwater was determined to be contaminated with 1,1-dichloroethene (1,1-DCE) and TCE above the MCLs of 7 µg/L and 5 µg/L, respectively.

The small drainage ditch near PBRP, the seepline located along an embankment of Steel Creek, and the segment of Steel Creek adjacent to the OU were determined to not be impacted by PBRP OU. Although Steel Creek is contaminated, the contamination did not originate from the PBRP OU, but from an unrelated upgradient source in P-Area. Contamination in Steel Creek is being addressed separately under the Integrator Operable Unit program.

IV. Remedial Actions

Remedy Selection

In 2002, a final ROD was issued to address the soil and groundwater contamination at PBRP (WSRC 2002). As stated in the ROD, the remedial action objectives (RAOs) are as follows:

- Protect current workers from the exposure to benzo[a]pyrene in surface soil at concentrations that exceed 53.3 mg/kg
- Protect hypothetical future industrial workers from exposure to benzo[a]anthracene (2.56 mg/kg), benzo[a]pyrene (0.256 mg/kg), benzo[b]fluoranthene (2.56 mg/kg), benzo[k]fluoranthene (25.6 mg/kg), dibenzo[a,h]anthracene (0.256 mg/kg), and indeno[1,2,3-c,d]pyrene (2.56 mg/kg) in surface and subsurface soils at concentrations that exceed target risk levels.
- Protect hypothetical future industrial workers from exposure to 1,1-DCE (7.0 µg/L) and TCE (5.0 µg/L) in groundwater at concentrations that exceed MCLs.
- Protect groundwater resources from contaminant migration of antimony (4.588 mg/kg), chromium (35.22 mg/kg), copper (40.8 mg/kg), nickel (11.432 mg/kg), zinc (1,110 mg/kg), dibenzofuran (0.195 mg/kg), PCE (0.00338 mg/kg), TCE (0.00153

mg/kg), and Aroclor 1242 (0.00843 mg/kg) in PBRP soil that would impact the groundwater above MCLs or RBCs.

As stated in the ROD, the selected remedial actions for the PBRP OU are as follows:

- Engineered cover system with BaroBalls™;
- Institutional controls (i.e., land use controls [LUCs]);
- Natural biodegradation; and
- Continued groundwater monitoring and reporting.

Remedy Implementation

The implementation of the final remedial action included the following activities:

- Constructing an engineered cover system (e.g., native soil cover with a hydraulic conductivity of approximately 1E-05 cm/sec) over PBRP to (1) prevent exposure to contaminants in surface soil, (2) reduce rainwater infiltration and resulting leaching, and (3) slow the rate of contaminant migration through the soil to groundwater so that there is more time for natural processes such as biodegradation to reduce the leachability risk;
- Installing four passive soil venting wells (BaroBall^{TM}) to allow volatile organic compounds (VOCs) in the soil to vent to the atmosphere instead of leaching to groundwater;
- Monitoring the groundwater quality to confirm that a discernible groundwater plume above MCLs does not develop; and
- Implementing LUCs (i.e., site maintenance, warning signs, and institutional controls) to prevent unauthorized intrusion into the buried contamination.

System Operations/Operation and Maintenance

The following operation at the PBRP OU is now complete.

- The vapor phase monitoring of the BaroBall^{TM} wells (PSV-10, PSV-11, PSV-12, and PSV-13) was discontinued in 2006 as concentrations dropped to below the remedial goal (RG) of 10 parts per million vapors. The wells were left in place to continue passive operation until groundwater objectives are met. The location of the BaroBall^{TM} wells is shown on Figure L-3.

The following activities are ongoing:

- Groundwater monitoring for three wells (PRP 5, PRP 6, and PRP 7) (Figure L-3). Sampling will continue until MCLs have been attained for three consecutive years. The results were reported via annual Environmental Monitoring Reports since 2004. Starting in 2008, the monitoring results for PBRP OU were combined with the K-Area Burning/Rubble Pit (131-K) and K-Area Rubble Pile (631-20G) OU and L-Area Burning/Rubble Pit (131-L) / Gas Cylinder Disposal Facility (131-2L) / L-Area Rubble Pile (131-3L) OU monitoring reports in to a single abbreviated annual groundwater data summary, with full detailed reports every five years (WSRC 2008). The second five-year detailed report was submitted in June 2017 (SRNS 2017).
- Annual site inspections and site maintenance (repair of erosion damage, cover maintenance, and warning signs) and
- Site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the waste unit).

Table L-3 compares the actual operation and maintenance (O&M) costs for the five-year remedy review period to the estimated direct O&M costs from the ROD (WSRC 2002). The estimated cost for Fiscal Year (FY) 2012 to FY2017 is $186,292 for O&M of the passive SVE system, soil cover, groundwater monitoring, institutional controls (i.e., LUCs), and five-year remedy reviews. The actual O&M cost for FY2012 to FY2017 is $107,996. The actual O&M costs from FY2012 to FY2017 are lower than estimated because soil cover repairs expected every five years have not been necessary and inspections are performed annually instead of monthly as originally estimated.

V. Progress Since Last Review

The previous protectiveness statement concluded that the remedy of a soil cover at the PBRP OU with institutional controls (i.e. LUCs) and groundwater monitoring are protective of human health and the environment.

Since the previous review in 2012, 1,4-dioxane was added to the analyte list based on a recommendation in the Fourth Five-Year Remedy Review Report for the SRS (SRNS 2014).

VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII, Documents Reviewed;
- Confirmed implementation of the remedial action;
- Reviewed the groundwater monitoring data by comparing it to MCLs (Table L-4 and Figure L-6);
- Inspected the OU, interviewed maintenance personnel, and documented the results on the Inspection Checklist provided in Attachment L-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance.

Data Review

Annual groundwater reports or data summaries have been submitted for the PBRP OU since 2003 and were thoroughly reviewed for this Five-Year Remedy Review. The latest 2017 report includes time-series plots of 1,1-DCE and TCE at each station, a plume map, and a comprehensive review of the monitoring activities and monitoring results (SRNS 2017). The CM COCs are analyzed every five years. The last sampling of these constituents took place in 2011. Sampling will continue in fourth quarter of 2017.

Summary of Inspections and Interviews

Interviews were conducted with Richard Feagin, O&M staff member, on October 11, 2017, and George Joyner, O&M Site Manager, on October 12, 2017 at the O&M organization offices. No issues were identified for the PBRP OU during these interviews.

The PBRP OU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) and USDOE personnel on November 27, 2017. No issues were identified for the PBRP OU during this inspection.

A site inspection will be conducted by U.S. Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control personnel, accompanied by USDOE and SRNS personnel, prior to submittal of the Revision 1 of this document. It is anticipated that no significant problems regarding this OU will be identified during the inspection.

Scheduled annual site inspections conducted from FY2012 through FY2017 identified the presence of ant mounds and hog-related damage on the soil cover. These findings were documented on the field inspection checklist and resolved soon after discovery.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The remedy is functioning as intended as demonstrated below:

- LUCs are effective in preventing current and hypothetical future industrial workers from exposure to PAHs in the soil. LUCs continue to prevent human exposure to contaminated groundwater.
- The cover system and operation of the BaroBall^{TM} wells are mitigating further migration of CM refined constituents of concern (RCOCs) to the groundwater. Groundwater monitoring data indicates the integrity of the cover is intact and VOC concentrations are decreasing. The 2016 groundwater data is summarized in Table L-4. Times series plots of TCE are provided in Figure L-6.

As of 2016, the 1,1-DCE groundwater concentrations have been decreasing over the past several years as concentrations have declined to 6.6 µg/L, from the 2004 maximum of 34.8 µg/L. As of 2016, TCE and PCE concentrations have remained below the 5.0 µg/L MCL since 2007. There were no analytes with concentrations that exceeded their respective MCLs. 1,4-Dioxane was detected in the plume wells, PRP 6 and PRP 7, in exceedance of the tapwater regional screening level of 0.46 µg/L. Concentrations of 1,4-dioxane are beginning to decline from the relatively stable results of the three prior years. The background well, PRP 5, remains non-detect for all VOC analyses. Figure L-3 shows the location of the wells with listed contaminant concentrations, the 1,1-DCE plume, and potentiometric surface at PBRP.

The above remedial activities are meeting the RGs established for the PBRP OU, as discussed in Section IV, by eliminating or controlling all routes of exposure to human health.

The Land Use Control Implementation Plan for the PBRP OU is located in Appendix E of the Post-Construction Report and governs LUC implementation, maintenance, monitoring, reporting, and enforcement (WSRC 2004). The LUCs that are in place include physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), use restrictions to prevent unauthorized contact, removal or excavation of contaminated soils, restrictions to prevent unauthorized access to or use of groundwater until cleanup levels are met, and restrictions to prevent disturbance of the engineered cover system. Warning signs are in good condition, and no activities were observed that would have violated the LUCs. All LUC objectives are being met.

Are Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still valid?

The exposure assumptions, toxicity data, and cleanup levels used at the time of remedy selection are still valid. There have been no changes in standards or to-be-considered guidance identified in the ROD that call into question the protectiveness of the remedy.

The USEPA standards and toxicity values have been updated since the last five-year remedy review as shown in Appendix B. The changes to the values for COCs at the PBRP OU were not significant, and the RAOs continue to be met by the remedial action. No new standards or to-be-considered guidance have been identified that call into question the protectiveness of the remedy.

Fact sheets provided on the USEPA webpage regarding emerging contaminants were reviewed for applicability to this site. None of the listed emerging contaminants were identified as applicable to this OU.

Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No new information has come to light that could call into question the protectiveness of the remedy.

VIII. Issues

There are no issues related to the PBRP OU since the previous Five-Year Remedy Review.

IX. Recommendations and Follow-up Actions

There are no recommendations and/or follow-up actions for the PBRP OU since the previous Five-Year Remedy Review.

X. Protectiveness Statement(s)

The remedy at the PBRP OU is protective of human health and the environment.

Exposure pathways that could result in unacceptable risks are being controlled by institutional controls (i.e., LUCs) to prevent exposure to, or the ingestion of, contaminated soil and groundwater. All threats to contaminated soil at the PBRP OU have been addressed through implementation of the soil cover, physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the PBRP OU for industrial use only, and warning signs and use restrictions via the SRS Site Use/Site Clearance Program.

XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Operating Equipment is scheduled for January 2024.

XII. Documents Reviewed

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

SRNS, 2014. *Fourth Five Year Remedy Review Report for the Savannah River Site*, SRNS-RP-2012-00011, Revision 1.1, Savannah River Site, Aiken, SC

SRNS, 2017. *K-Area Burning/Rubble Pit and Rubble Pile (131-K and 631-20G) (KBRP), L-Area Burning/Rubble Pit and Rubble Pile (131-L, 131-3L, and 131-2L) (LBRP), and P-Area Burning/Rubble Pit (131-P) (PBRP) Operable Units (OUs) Detailed Combined Groundwater Monitoring Report (U)*, SRNS-RP-2017-00356, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 1999. *Land Use Control Assurance Plan for the Savannah River Site*, WSRC-RP-98-4125, Revision 1.1, latest revision Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC, 2001. *RFI/RI/BRA for the P-Area Burning/Rubble Pit (131-P) (U)*, WSRC-RP-98-4174, Revision 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2002. *Record of Decision Remedial Alternative Selection for the P-Area Burning/Rubble Pit (131-P) (U)*, WSRC-RP-2000-4197, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2004. *Post-Construction Report for the P-Area Burning/Rubble Pit (131-P) (U)*, WSRC-RP-2004-4051, Revision 1, Westinghouse, Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2008. *Proposal to Standardize Sampling and Reporting Requirements of Groundwater Data for P, L, and K Area Burning/Rubble Pit Operable Units*, ACP-08-133, Revision 0, Washington Savannah River Company, Savannah River Site, Aiken, SC

Various - *Inspection Data Sheets – Field Inspection Checklist P-Area Burning/Rubble Pits (U)*, ER-IDS-019-030, Inspection period 2012 through 2017 (annually)

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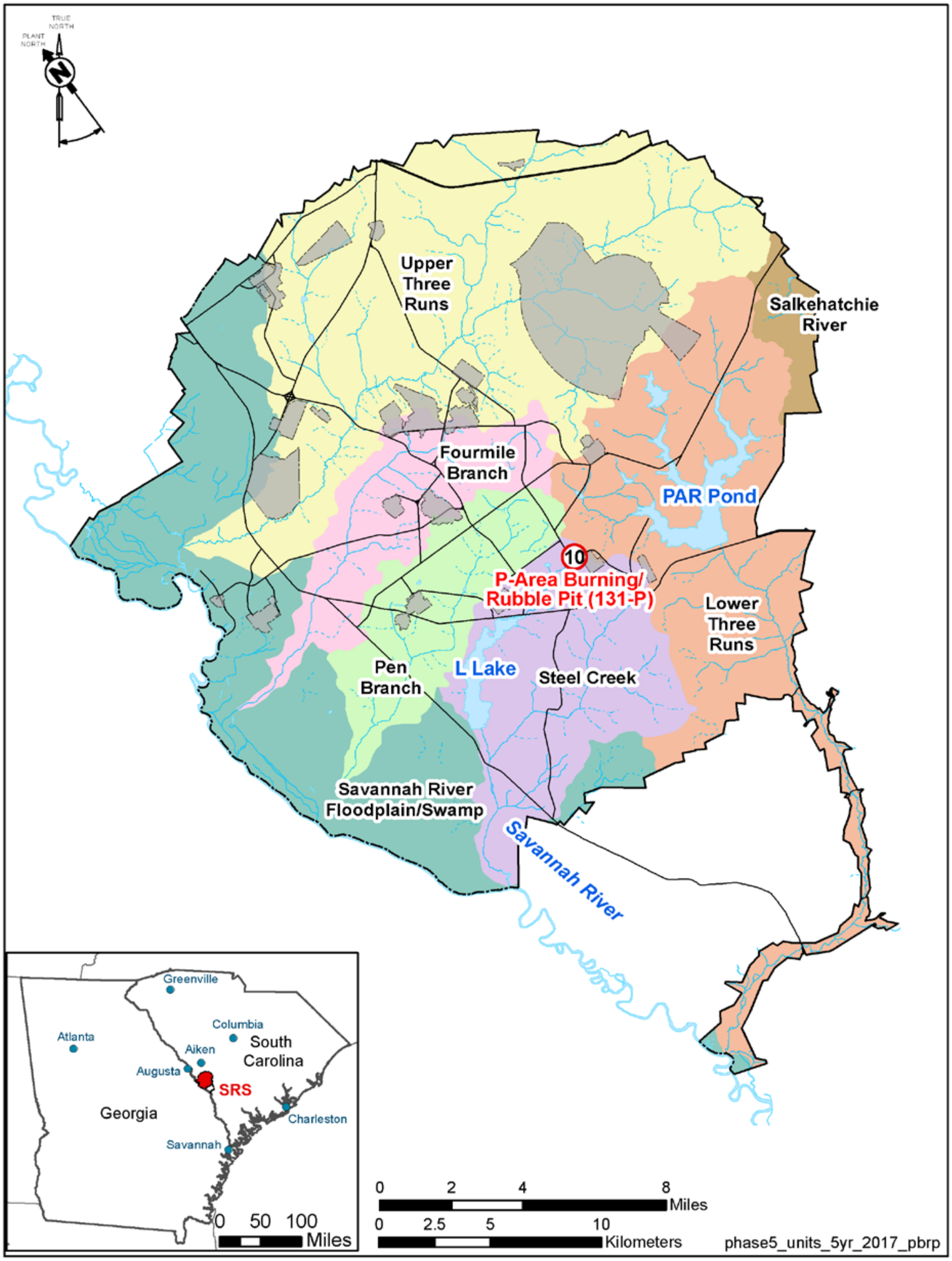

Figure L-1. Location of the PBRP OU at SRS

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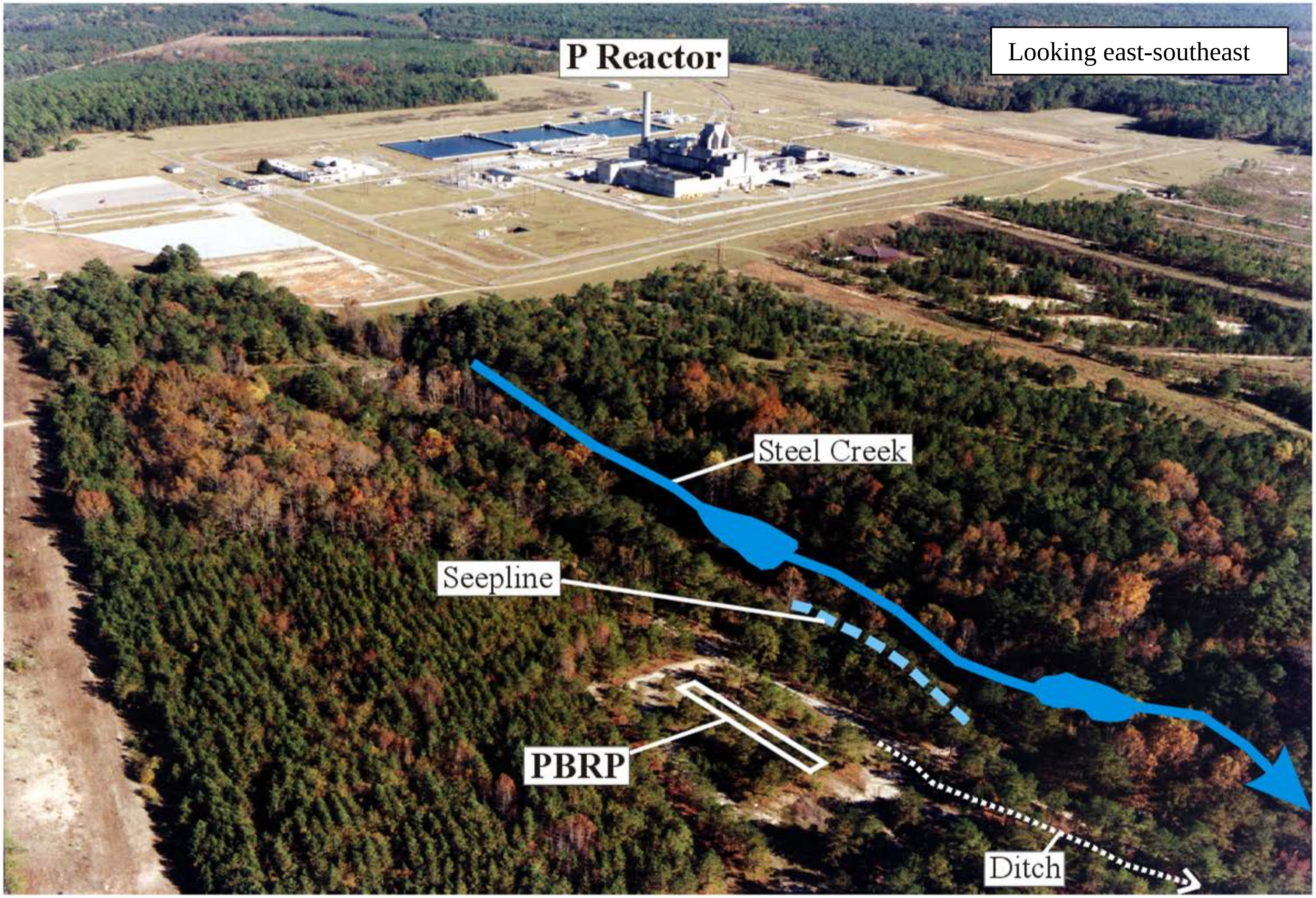


Figure L-2. Layout of the PBRP OU (1987)

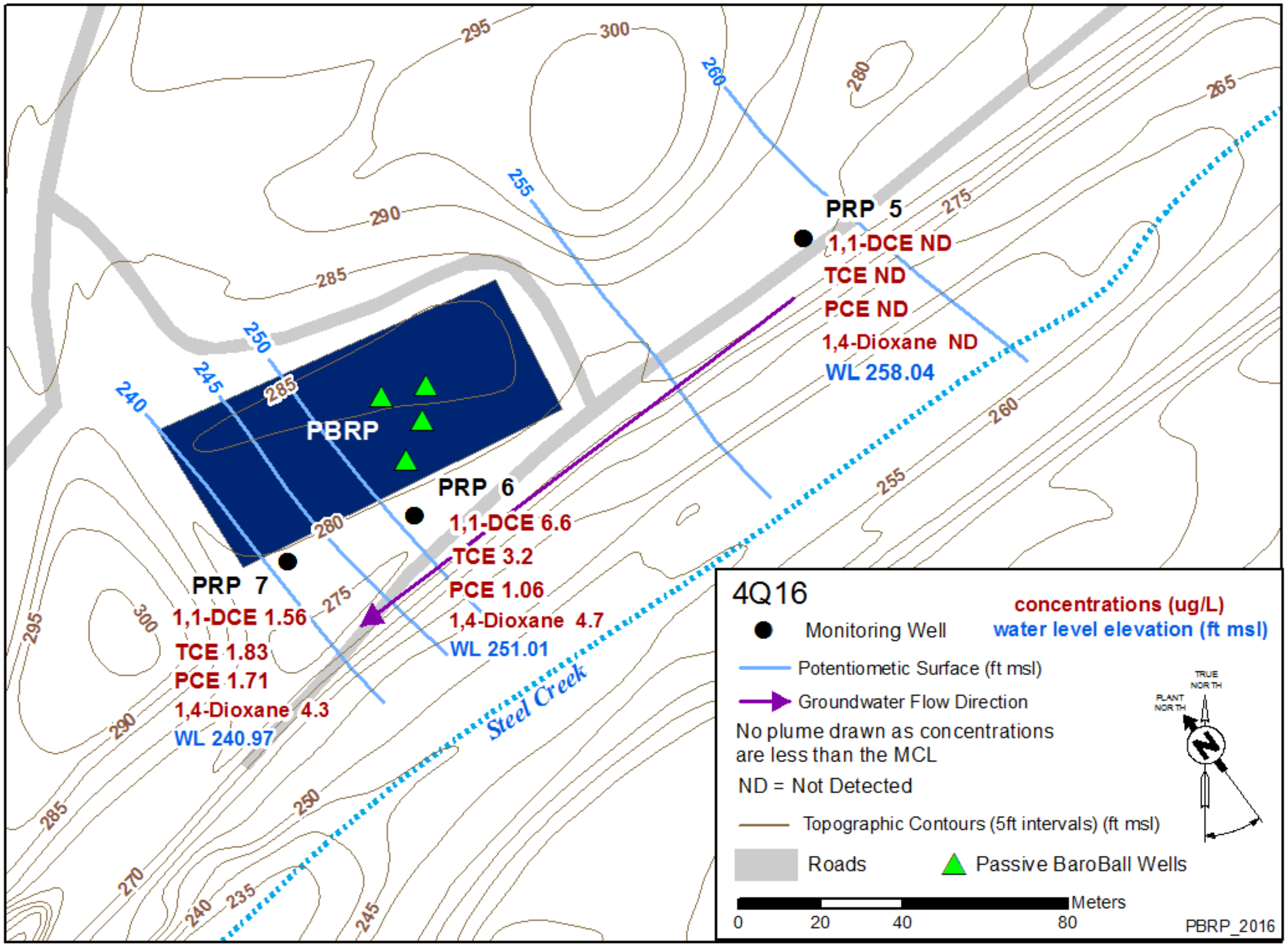


Figure L-3. 2016 1,1-DCE Plume and Potentiometric Surface at PBRP

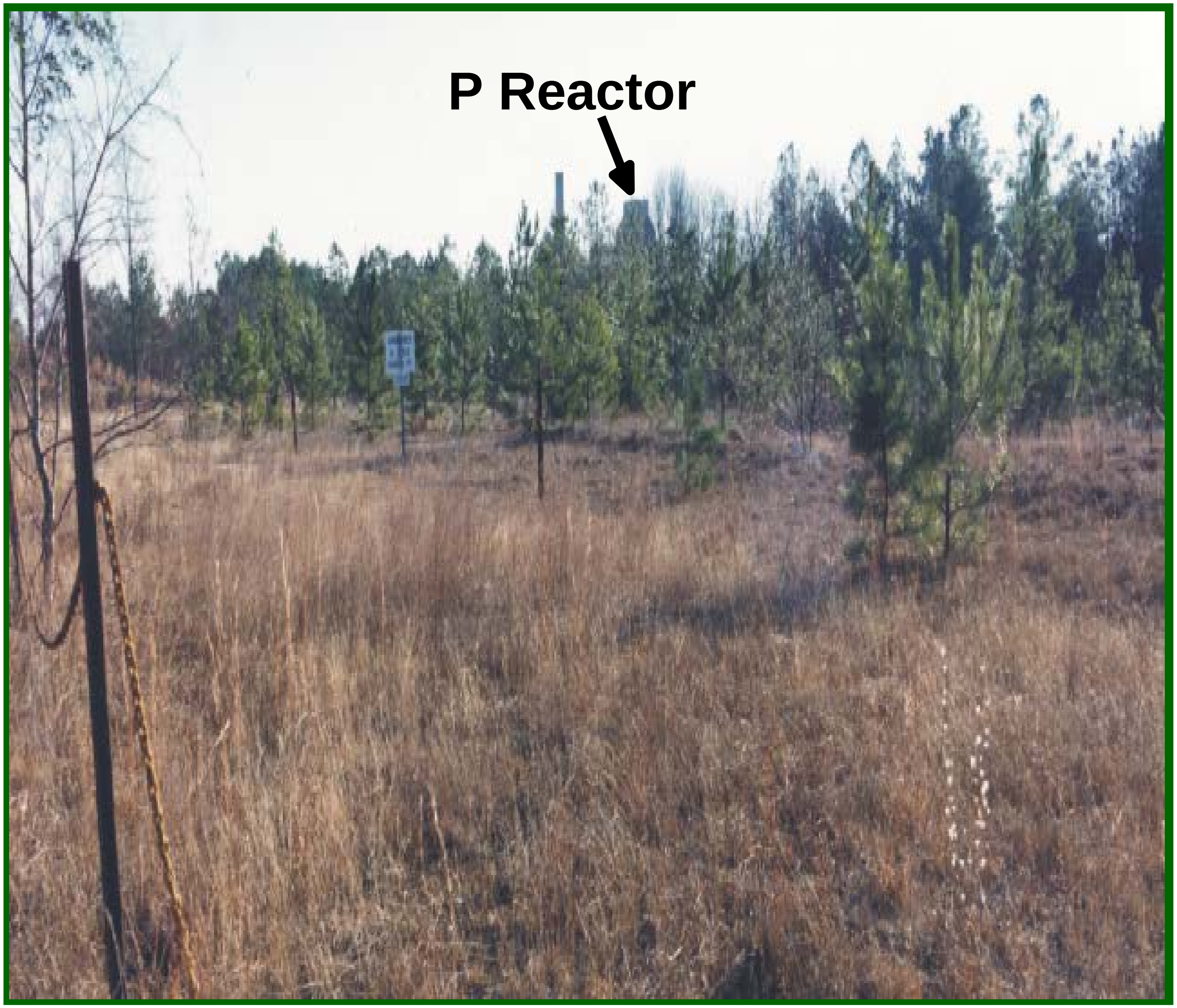
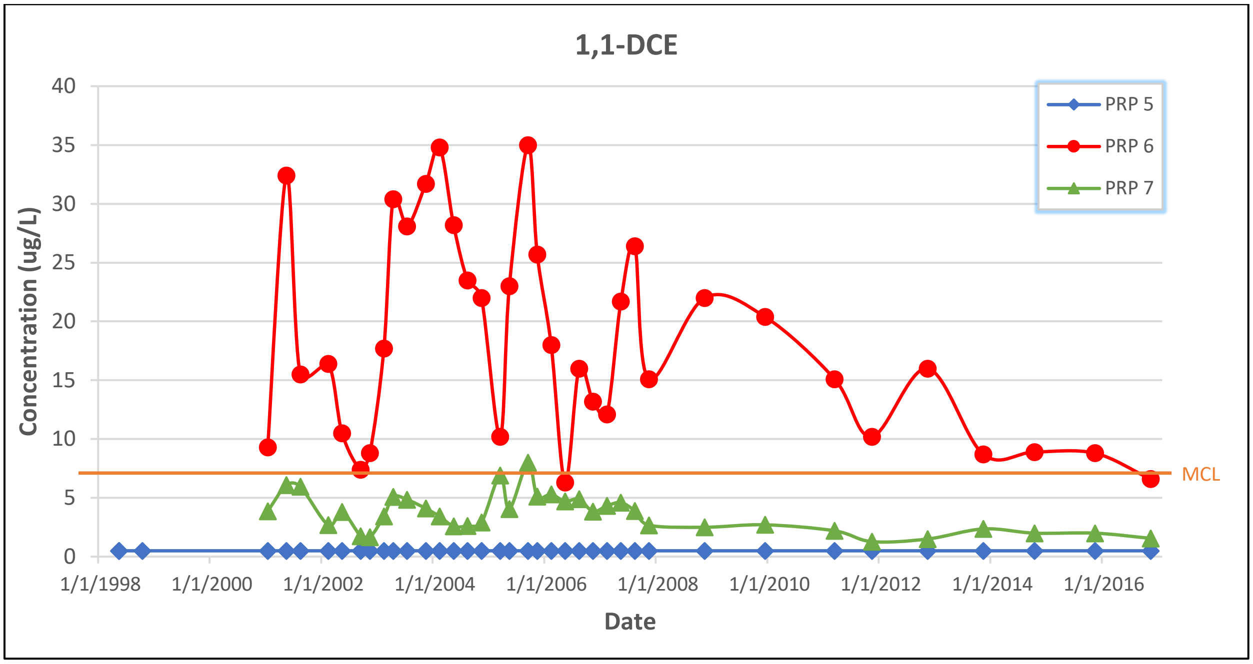
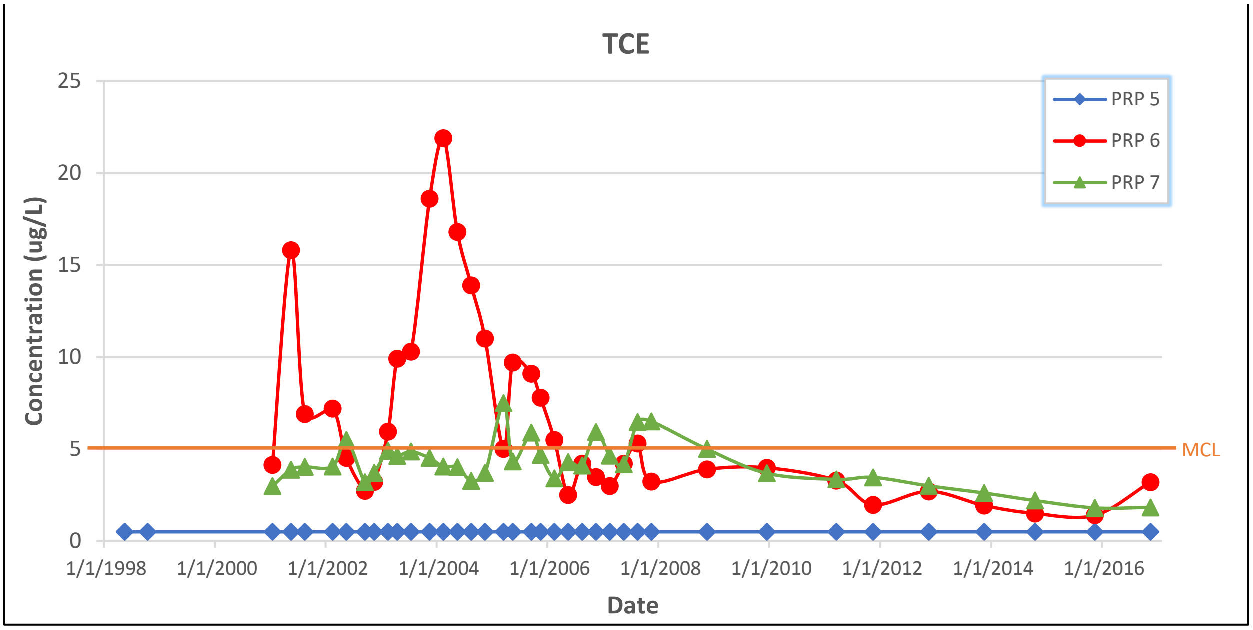


Figure L-4. Photo of PBRP Before Remediation Activities (1987)

Figure L-5. Photo of PBRP Currently (2017)





Non-detects are plotted as 0.5 µg/L (PRP 5 values)

Figure L-6. **Time-series plots of 1,1-DCE and TCE at wells PRP 5, PRP 6, and PRP 7**

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Table L-1. Chronology of OU Events

Event	Date
RFI/RI Start/Complete	1997 / May 21 ,2001
Record of Decision (ROD) Issuance	August 8, 2003
Remedial Action (RA) Construction Start / Completion	November 14, 2003/ June 8, 2004
RA Operations Start / Completion	February 24, 2004 / Ongoing
Previous Five-Year Reviews Issuance	February 4, 2009 / February 4, 2014

Table L-2. PBRP RCOCs by Medium and Subunit with Final Remedial Goals

Medium (Units)	RCOC	Type of RCOC			RG	Basis
		ARAR	CM	HH		
Soil - PAHs (mg/kg)	Benzo[a]anthracene			$X_{Res, IW}$	2.56	1E-06 risk level
	Benzo[a]pyrene			$X_{Res, IW, CW}$	0.256	1E-06 risk level
	Benzo[b]fluoranthene			$X_{Res, IW}$	2.56	1E-06 risk level
	Benzo[k]fluoranthene			$X_{Res, IW}$	25.6	1E-06 risk level
	Chrysene			X_{Res}	256	1E-06 risk level
	Dibenzo[a,h]anthracene			$X_{Res, IW}$	0.256	1E-06 risk level
	Fluoranthene			X_{Res}	2670	1E-06 risk level
	Indeno[1,2,3-c,d] pyrene			$X_{Res, IW}$	2.56	1E-06 risk level
	Phenanthrene			X_{Res}	3270	1E-06 risk level
	Pyrene			X_{Res}	2000	1E-06 risk level
Soil – CM COC (mg/kg)	Antimony		X		4.588	95th percentile background
	Chromium		X		35.22	95th percentile background
	Copper		X		40.8	CM soil clean up level
	Nickel		X		11.432	95th percentile background
	Zinc		X		1110	CM soil clean up level
	Tetrachloroethylene (PCE)		X		0.00338	CM soil clean up level
	Trichloroethylene (TCE)		X		0.00153	CM soil clean up level
	Aroclor 1242		X		0.00843	CM soil clean up level
	Dibenzofuran		X		0.195	CM soil clean up level
Groundwater (µg/L)	1,1-Dichloroethylene	X		$X_{Res, IW}$	7.0	MCL
	Trichloroethylene	X		X_{Res}	5.0	MCL

ARAR – applicable or relevant and appropriate requirement
CM – contaminant migration
CW – current worker
HH – human health
IW – industrial worker
MCL – maximum contaminant level
Res – Resident
RG – remedial goal

Table L-3. Actual versus Estimated O&M Costs

	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	5-Year Total
Total Actual O&M Costs ($)	24,067	20,387	14,127	15,744	14,197	19,474	107,996
Total ROD Estimated Direct O&M Costs ($)	57,946	17,600	17,600	17,600	17,600	57,946	186,292

Table L-4. Comparison of RGs and Groundwater Monitoring Data from 2016

RCOC	RG (MCL) (µg/L)	2016 Maximum Concentration (µg/L)	Well with Maximum Concentration
1,1-DCE*	7.0	6.6	PRP 6
TCE*	5.0	3.2	PRP 6
PCE	5.0	1.71	PRP 7
Antimony	6.0	NA	N/A
Chromium	100	NA	NA
Copper	1,300	NA	NA
Nickel	1,800	NA	NA
Zinc	11,000	NA	NA
Aroclor 1242	0.034	NA	N/A
Dibenzofuran	N/A	NA	N/A

*Time-series plots of 1,1-DCE and TCE are available in Figure L-6.

Attachment L-1. Five-Year Review Site Inspection Checklist – P-Area Burning/Rubble Pit (PBRP) (131-P) Operable Unit

I. SITE INFORMATION

Site Name:	**P-Area Burning/Rubble Pit (PBRP) (131-P) Operable Unit**	**Date of Inspection:**	**08/31/2017**
Location and Region	**SRS, USEPA Region 4**	**CERCLIS OU:**	**#59**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**77°F and overcast**

Remedy Includes: *(Click all that apply)*

☒ Landfill Cover / Containment
☒ Access Controls
☒ Institutional Controls
☐ Groundwater Pump and Treatment
☐ Surface Water Pump and Treatment
☐ Monitored Natural Attenuation
☐ Groundwater Containment
☐ Vertical Barriers

☒ Other Passive SVE, groundwater monitoring

Attachments: ☐ Inspection team roster attached ☐ Inspection team roster attached

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 10/12/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

Problems/Suggestions: ☐ Report Attached

2. **O&M Staff:** Richard Feagin (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 10/11/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4416

Problems/Suggestions: ☐ Report Attached

Attachment L-1. Five-Year Review Site Inspection Checklist – P-Area Burning/Rubble Pit (PBRP) (131-P) Operable Unit *(continued)*

II. INTERVIEWS *(Click all that apply) (Continued)*

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

Agency: ____________________

Contact: ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

Agency: ____________________

Contact: ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

Agency: ____________________

Contact: ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

4. **Other Interviews** *(Optional):* ☐ Report Attached ____________________

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Click all that apply)*

1. **O&M Documents:**

☐ O&M Manual ☐ Readily Available ☐ Up to Date ☒ N/A
☒ As-Built Drawings ☒ Readily Available ☒ Up to Date ☐ N/A
☐ Maintenance Logs ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks: See *Waste Unit Inspection and Maintenance, ER-SOP-019, Field Inspection Checklist for P-Area Burning/Rubble Pit*, ER-IDS-019-030.

Attachment L-1. Five-Year Review Site Inspection Checklist – P-Area Burning/Rubble Pit (PBRP) (131-P) Operable Unit *(continued)*

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)*

1. Health and Safety Plans (HASPs):

☐ Site-Specific Health and Safety Plans ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Contingency Plan/Emergency Response Plan ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.120.HAZWOPER. A SSHASP is prepared if needed.

2. O&M and OSHA Training Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix.

3. Permits and Service Agreements:

☐ Air Discharge Permit ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Effluent Discharge ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Waste Disposal; POTW ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Other Permits ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

4. Gas Generation Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

5. Settlement Monument Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

6. Groundwater Monitoring Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks:

7. Leachate Extraction Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

8. Discharge Compliance Records:

☐ Air ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Water (Effluent) ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

9. Daily Access/Security Logs: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

Attachment L-1. Five-Year Review Site Inspection Checklist – P-Area Burning/Rubble Pit (PBRP) (131-P) Operable Unit *(continued)*

IV. O&M COSTS

1. O&M Organization:

☐ State In-House
☐ PRP In-House
☒ Other: SRS
☐ Contractor for State
☐ Contractor for PRP

2. O&M Cost Records:

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place

☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

Total annual cost by year for review period, if available

From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached

From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached

From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached

From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached

From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached

3. Unanticipated or Unusually High O&M Costs During Review Period

Describe costs and reasons: ______

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing Damage: ☐ Location shown on site map ☐ Gates secured ☒ N/A

Remarks: OU-specific fencing is not required by the remedial action

B. Signs

1. Signs and Other Security Measures: ☐ Location shown on site map ☐ N/A

Remarks: Signs are in good condition.

Attachment L-1. Five-Year Review Site Inspection Checklist – P-Area Burning/Rubble Pit (PBRP) (131-P) Operable Unit *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Once in five years
Responsible Party/Agent: USDOE Savannah River Field Office

Contact:	Phil Prater	IACD Program Manager	11/27/2018	803-952-9333
	(Name)	(Title)	(Date)	(Phone No.)

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

2. Adequacy: ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks:

D. General

1. Vandalism/Trespassing: ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

2. Land use changes onsite: ☒ N/A
Remarks:

3. Land use changes offsite: ☒ N/A
Remarks:

Attachment L-1. Five-Year Review Site Inspection Checklist – P-Area Burning/Rubble Pit (PBRP) (131-P) Operable Unit *(continued)*

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. Roads damaged: ☒ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks:____________________

B. Other Site Conditions

Remarks: Annual site inspections conducted from FY2012 to FY2017 identified the presence of ant mounds and hog-related damage on the soil cover. These findings were resolved soon after discovery.

VII. LANDFILL COVER / CONTAINMENT ☒ Applicable ☐ N/A

A. Landfill Surface

1. Settlement (Low spots)**:** ☐ Location shown on site map ☒ Settlement not evident
Areal extent__________ Depth__________
Remarks:____________________

2. Cracks: ☐ Location shown on site map ☒ Cracking not evident
Lengths__________ Widths__________ Depths__________
Remarks:____________________

3. Erosion: ☐ Location shown on site map ☒ Erosion not evident
Areal extent__________ Depth__________
Remarks:____________________

4. Holes: ☐ Location shown on site map ☒ Holes not evident
Areal extent__________ Depth__________
Remarks:____________________

5. Vegetative Cover: ☒ Grass ☒ Cover properly established ☒ No signs of stress
Areal extent__________ Depth__________
Remarks: Vegetation is mowed routinely.

Attachment L-1. Five-Year Review Site Inspection Checklist – P-Area Burning/Rubble Pit (PBRP) (131-P) Operable Unit *(continued)*

VII. LANDFILL COVER / CONTAINMENT *(Continued)*

6. Alternative Cover (armored rock, concrete, etc.): ☒ N/A

Remarks:______________________________

7. Bulges: ☐ Location shown on site map ☒ Bulges not evident

Areal extent__________ Depth__________

Remarks:______________________________

8. Wet Areas / Water Damage: ☒ Wet areas/water damage not evident

☐ Wet areas ☐ Location shown on site map Areal extent__________

☐ Ponding ☐ Location shown on site map Areal extent__________

☐ Seeps ☐ Location shown on site map Areal extent__________

☐ Soft subgrade ☐ Location shown on site map Areal extent__________

Remarks:______________________________

9. Slope Instability: ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability

Areal extent__________

Remarks:______________________________

B. Benches ☐ Applicable ☒ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel)

C. Letdown Channels ☐ **Applicable** ☒ **N/A**

(Channel lined with erosion control mates, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies)

D. Cover Penetrations ☐ **Applicable** ☒ **N/A**

E. Gas Collection and Treatment ☐ **Applicable** ☒ **N/A**

F. Cover Drainage Layer ☐ **Applicable** ☒ **N/A**

G. Detention/Sedimentation Ponds ☐ **Applicable** ☒ **N/A**

H. Retaining Walls ☐ **Applicable** ☒ **N/A**

Attachment L-1. Five-Year Review Site Inspection Checklist – P-Area Burning/Rubble Pit (PBRP) (131-P) Operable Unit *(continued)*

VII. LANDFILL COVER / CONTAINMENT *(Continued)*

I. Perimeter Ditches/Offsite Discharge ☒ Applicable ☐ N/A

1. Siltation: ☐ Location shown on site map ☒ Siltation not evident
Areal extent__________ Depth__________
Remarks:__________

2. Vegetative Growth: ☐ Location shown on site map ☐ N/A
☒ Vegetation does not impede flow
Areal extent__________ Type__________
Remarks:__________

3. Erosion: ☐ Location shown on site map ☒ Erosion not evident
Areal extent__________ Depth__________
Remarks:__________

4. Discharge Structure: ☐ Location shown on site map ☒ N/A
Remarks:__________

VIII. VERTICAL BARRIER WALLS ☐ **Applicable** ☒ **N/A**

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ **Applicable** ☐ **N/A**

A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☒ N/A

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

C. Treatment System ☐ Applicable ☒ N/A

Attachment L-1. Five-Year Review Site Inspection Checklist – P-Area Burning/Rubble Pit (PBRP) (131-P) Operable Unit *(continued)*

IX. GROUNDWATER/SURFACE WATER REMEDIES *(Continued)*

D. Monitoring Data ☒ Applicable ☐ N/A

1. Monitoring Data:
☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring Data:
☒ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

E. Monitored Natural Attenuation ☐ Applicable ☒ N/A

1. Monitoring Wells *(natural attenuation remedy)***:**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs maintenance ☐ N/A
Remarks:________________________________

X. OTHER REMEDIES

If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

A. Soil Vapor Extraction System ☒ Applicable ☐ N/A

1. Blowers, Wellhead Plumbing, and Electrical:
☒ Good Condition ☒ All required wells located ☐ Needs maintenance ☐ N/A
Remarks: Soil Vapor Extraction System via BaroBall™

2. Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances:
☒ Good Condition ☐ Needs maintenance
Remarks:________________________________

3. Spare Parts and Equipment:
☒ Readily Available ☒ Good Condition ☐ Requires Upgrade ☐ Needs to be provided
Remarks:________________________________

Attachment L-1. Five-Year Review Site Inspection Checklist – P-Area Burning/Rubble Pit (PBRP) (131-P) Operable Unit *(continued/end)*

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

The remedy for the PBRP is an engineered cover system with BaroBall^{TM} wells, natural biodegradation, groundwater monitoring and reporting and LUCs to prevent exposure to contaminants in soil and groundwater. The remedy is fully established and functioning as designed.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The O&M procedures consisting of annual site inspections and site maintenance (verify no invasive activities have occurred and warning signs) and site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the OU) have been implemented. The O&M procedures are adequately maintaining PBRP OU and the condition of warning signs is good. There are no issues requiring corrective actions.

C. Early Indicators of Potential Remedy Failure

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

N/A

TNX AREA OPERABLE UNIT

I. Introduction

This report is the fifth five-year review for the TNX Area Operable Unit (OU). The review was conducted from August 2017 through November 2017. Contaminants have been left in place at the TNX Area OU at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the TNX Area OU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table M-1 lists the chronology of site events for the TNX Area OU.

III. Background

The TNX Area OU is listed as a Resource Conservation and Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) unit in Appendix C of the Federal Facility Agreement (FFA) for Savannah River Site (SRS) (FFA 1993). The media of concern is soil, sediment, surface water, and groundwater.

An area-based remedial strategy has been implemented in T Area; remedial decisions for the T-Area waste units and facilities addressed by the TNX Area OU Record of Decision (ROD) will continue as planned. All other remedial actions are addressed by the T-Area OU (TAOU) ROD.

Physical Characteristics

TNX Area OU is located in T Area in the southwestern portion of SRS, approximately 0.4 km (0.25 mi) east of the Savannah River (Figure M-1) between Upper Three Runs Creek to the north and Fourmile Branch to the south. The OU is at an elevation of 45 m (150 ft) above mean sea level. Local topography is relatively flat and slopes westward toward the Savannah River. Almost all of the TNX Area was covered by buildings and laboratories. The area was highly congested with structures, overhead obstructions, and underground obstructions; much of the available ground surface was covered with asphalt.

The TNX Area OU includes these subunits:

- New TNX Seepage Basin (904-102G) (NTSB)/Inactive Process Sewer Line (IPSL);
- TNX Burying Ground (643-5G) (TBG)/ Vadose Zone;
- Old TNX Seepage Basin (904-076G) (OTSB)/IPSL/Upper Discharge Gully (UDG); and
- TNX Groundwater (082-G) (TNXGW).

The NTSB is an unlined earthen basin approximately 78 by 120 m (260 by 400 ft) in size. The NTSB includes an inactive process sewer line, a smaller settling area (Inlet Basin), a larger basin (Main Basin), an Overflow Discharge Area (ODA), and a gravity fed IPSL. The Main Basin is connected to the Inlet basin and received the “decanted” wastewater. The ODA is an irregularly shaped area defined by site topography with an approximate area of 24,300 m^2 (27,000 ft^2). The IPSL is approximately 60 m (200 ft) long, running west-northwest from the Inlet Basin to a manhole located on the west side of Road 4A.

The OTSB was an unlined earthen basin approximately 24 by 52.5 m (80 by 175 ft). The OTSB includes an Inlet Basin, a Main Basin, IPSLs that run east and north, and the UDG.

The TBG/Vadose Zone consisted of four trenches at 1.8 to 2.4 m (6 to 8 ft) below ground surface and was created in 1953 to dispose of debris from the accidental explosion of an experimental evaporator. The debris included materials such as conduits, drums, and structural steel.

The TNXGW is the groundwater beneath the TNX Area OU surface units, beneath the TNX Outfall Delta (TNXOD) which is a subunit of the TAOU, and extending to the Savannah River (Figure M-2). Groundwater at TNX can be divided into two main aquifer systems, one shallow and one deep. The shallow system can be further subdivided into an upper unconfined water table aquifer (10.5 to 12 m [35 to 40 ft] thick) that outcrops in the TNX floodplain and a lower semi-confined aquifer. Groundwater flows progressively from deep to shallow aquifers (i.e., upward hydraulic gradient) and to the Savannah River. No contamination has been found in the deep aquifer, located below the Crouch Branch Confining Unit.

Land and Resource Use

According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. *The Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999) designates the TNX Area OU as being within an industrial area. The future land use for the TNX Area OU is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

The TNX Area was a pilot-scale testing and evaluation facility that supported nuclear fuel and target manufacturing chemical processes and the Defense Waste Processing Facility (DWPF). Past operations within the TNX Area resulted in contamination of the vadose zone and groundwater. Potential sources of groundwater contamination included seepage from unlined basins (OTSB, NTSB), leakage from the process sewers, leachate from contaminated media in the TBG, and leachate from other sources at TNX (e.g., a temporary storage facility for 55-gallon drums during the 1950s and an equipment staging area).

The OTSB operated from the mid-1950s until 1980 and received radioactive, organic, and inorganic contaminated process wastewaters generated from TNX facilities.

The NTSB began operation in 1980 after closure of the OTSB. From 1981 to 1988, the basin received water flow from pilot-scale simulations conducted at TNX in support of the DWPF and the Separations Area. Wastewaters consisted primarily of simulated, nonradioactive sludge along with other wastes such as small amounts of glass frit and laboratory sink discharges. In August 1988, the NTSB was removed from operation, at which time wastewaters were routed to the TNX Effluent Treatment Facility. Until the NTSB was covered as part of the TAOU cover system, the main section of the basin accumulated rainwater year-round.

The TBG was created in 1953 to dispose of contaminated debris from an accidental explosion of an experimental evaporator that was being used to concentrate a solution of uranyl nitrate (0.4 curies) and nitric acid. The debris included materials such as conduits, drums, and structural steel. Between 1982 and 1984, most of the buried material was excavated and sent to the SRS Radioactive Waste Burial Ground. The five small areas that were not excavated contain an estimated 0.02 Ci of uranyl nitrate. In 1996, an additional disposal area was discovered with three buried drums containing materials contaminated with radionuclides and metals, predominantly iron, aluminum, and mercury. The drums were removed and disposed in the SRS Low-Level Radioactive Waste Disposal Facility. At which time, the area was characterized.

Initial Response

The OTSB was closed in 1981 by backfilling the basin with clean sand and clay that was covered with clay. A portion of the cover was vegetated and an asphalt cover was placed over the remainder. The overflow discharge pipe was re-routed to drain stormwater runoff from the vegetated and asphalt surfaces covering the OTSB to the Lower Discharge Gully (LDG). Monitoring of the TNX groundwater has been performed since the 1980s. The monitoring identified chlorinated volatile organic compound (cVOC) contamination. In January 1999, the RCRA Facility Investigation (RFI)/Remedial Investigation (RI) with Baseline Risk Assessment (BRA) report was approved by U.S. Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control (SCDHEC). In September 2002, the Addendum to the RFI/RI/BRA report was approved by USEPA and SCDHEC.

Basis for Taking Action

The nature and extent of contamination in soil, sediment, surface water, and groundwater at TNX Area OU were characterized. Results from the RFI/RI/BRA demonstrated that the TNXGW exceeded the maximum contaminant levels (MCLs) for cVOCs, primarily trichloroethylene (TCE), and to a lesser extent, tetrachloroethylene (PCE), carbon tetrachloride, nitrate, mercury, and gross alpha. Groundwater beneath the TNXOD exceeded the MCL for gross alpha, uranium, and mercury. The refined contaminants of concern (RCOCs) and remedial goals (RGs) identified in the ROD for human health (HH), ecological (ECO) receptors, and contaminant migration (CM) are presented in Table M-2 for soil and sediment and Table M-3 for the groundwater.

IV. Remedial Actions

Remedy Selection

To control and remediate volatile organic carbon (VOC) source material and the groundwater plume, an Interim Action Record of Decision (IROD) for the TNX Area OU was issued on November 16, 1994 (WSRC 1994). The purpose of the interim action was to serve as an incremental step in part of an overall remedy to address groundwater contamination with the Hybrid Groundwater Corrective Action (HGCA). The HGCA consisted of two components: (1) a pump and treat system (recovery well network and low-profile air stripper) to treat and inhibit further migration of the 500 µg/L TCE plume core, and (2) an airlift recirculation well, located at the heart of the plume to expedite remediation. Testing performed in 1996 demonstrated that the recirculation well system was ineffective in the TBG area because of geological factors and the nature of the contamination. Furthermore, it was determined that the pump and treat system could adequately achieve the interim RGs. Consequently, the IROD was modified in 1997 with an Explanation of Significant Difference (ESD) to discontinue operation of the recirculation well (WSRC 1997).

A second ESD for the TNX Area OU (WSRC 2001) was signed by USEPA and SCDHEC on May 15, 2013 and May 16, 2013, respectively. This ESD modifies the remedy selected in the IROD for the TNXOU groundwater component as follows:

- Permanent removal of service of the T-1 Air Stripper.
- Addition of edible oil treatment as needed. A sustained rebound lasting over 1 year in excess of 75 µg/L of TCE, PCE, or carbon tetrachloride in any well will represent a viable trigger for injection of edible oil as determined appropriate by the USDOE, USEPA, and SCDHEC.

The basic remedy for the TNX OU groundwater (i.e., pump and treat) remains unaltered, and the cleanup level specified in the IROD will be met by the edible oil treatment. The scope, performance goals, and consistency with applicable or relevant and appropriate requirements (ARARs) are unchanged and the cost of the remedy modification is no greater than the known operational costs of the original remedy.

The ROD for the TNX Area OU was issued April 2004 (WSRC 2004b). The remedial action objectives (RAOs) were developed as a result of the characterization and risk assessment and screening of remedial alternatives. The RAOs can be summarized as follows:

- Protect future industrial workers from exposure to contaminants in the NTSB/IPSL sediments and LDG soils and groundwater above the MCL;
- Protect biota from exposure to contaminated sediments and surface water of the NTSB;
- Remove or treat contamination exceeding principal threat source material (PTSM) criteria in subsurface soils of the OTSB/IPSL and the 678-T and 677-T sumps to the extent practicable;
- Prevent leaching of contaminants above the MCL from soils of the OTSB/IPSL/UDG and LDG;
- Prevent or minimize perched water contact with PTSM or mercury in the OTSB/IPSL/Discharge Gully exceeding the CM RG;
- Identify and reduce the secondary source of VOCs representing PTSM in the vadose zone in order to reduce the time to achieve groundwater RAOs;
- Return groundwater to beneficial uses within a reasonable time period by remediating to ARARs (i.e., MCLs);
- Prevent, minimize, or eliminate discharge of contaminated groundwater to surface water that would result in unacceptable risk to human or ecological receptors; and
- Minimize adverse impact to the wetland ecosystem of the TNX Area flood plain through careful consideration and implementation of remedial actions.

The remedial actions selected to meet the RAOs for the TNX Area OU are summarized as follows:

- The NTSB is located across a paved road from the OTSB/Discharge Gully and the TBG (Figure M-3). Because this facility was not to be placed under the perimeter of the engineered cover, the remedial action involved *in situ* grouting of the IPSL, discharge of any surface water in the NTSB to an approved location, followed by backfill with clean soil.

- The OTSB, associated IPSL, discharge gully, and TBG are located in close proximity and are within the perimeter of the engineered cover for the TAOU. For the OTSB/IPSL/Discharge Gully, actions included excavation of soil, pipelines and sumps, disposal of all PTSM contaminated soil and pipeline at an approved disposal facility, plugging any sections of IPSL remaining, and placement of clean backfill where practical prior to installation of the engineered cover system. In addition, groundwater and vadose zone monitoring devices were installed to determine the impact, if any, to groundwater of leaving waste in place. Other than cVOC contamination in the vadose zone below the TBG that required remedial action, no other actions were required for the TBG.
- Identification of cVOCs in the vadose zone in the area close to the TBG, resulted in installation and operation of a soil vapor extraction (SVE) system to facilitate removal of an ongoing secondary source of contamination to the groundwater. Testing of SVE units was conducted in 1997 and 1998 followed by operation of a portable SVE unit beginning in 2002. The portable SVE unit was shut down in 2006 during the placement of the engineered cover system. In 2007 this system was replaced by passive MicroBlowers™.
- The groundwater actions have changed overtime in an effort to decrease the time to reach MCLs. A pump-and-treat system (recovery well network and air stripper) began operation in 1996 and was part of the remedy identified in the ROD (WSRC 2004b). The system operated until 2007 when its operation was suspended to facilitate the treatability study of edible oil technology to address the groundwater contamination. The pump-and-treat system will operate until monitoring determines that passive remediation and a mixing zone are appropriate.
- Institutional controls (i.e. land use controls [LUCs]) are in place for this OU. The controls consist of access controls, walkdowns, maintenance, deed restrictions and administrative directives and land use restrictions via the Site Use/Site Clearance

Program, prohibiting installation of drinking water wells to prevent use of groundwater beneath TNX where concentrations of contaminants are above MCLs. These controls will remain in effect until the USDOE, USEPA, and SCDHEC concur that contaminants of concern (COC) concentrations in groundwater do not present unacceptable risk to receptors.

Remedy Implementation

The selected remedies met the RAOs at TNX Area OU (WSRC 2007a) by implementing the following activities:

- The NTSB remedial action was initiated by discharge of surface water to the ground in the vicinity of the NTSB after sampling confirmed acceptability. Approximately 690 m^3 (900 yd^3) of stone was placed into the basin bottom prior to backfilling the Main and Inlet Basins with clean surplus soil to grade. The associated IPSL was stabilized in situ.
- The OTSB remedial action was initiated by removing the accessible IPSL and grouting the inaccessible IPSL. The Main Basin of the OTSB was excavated resulting in the removal of approximately 1,670 m^3 (2,180 yd^3) of PTSM with remaining soil retained for use as backfill. The Inlet Basin was excavated to a 3-m (10-ft) depth and soil retained for use as backfill. The excavated suspect soil was placed into the OTSB as backfill, followed by clean common fill to achieve proper grading. To monitor moisture in the vadose zone, a piezometer was installed.
- The sumps associated with 678-T and 677-T, as well as a small area of contamination on the western exterior of Building 678-T had potential PTSM levels of material and were excavated and evaluated (WSRC 2005). Approximately 17 m^3 (22 yd^3) of contaminated soil was removed and disposed in an approved off-site disposal facility.
- Confirmatory soil sampling was conducted for all excavations of PTSM identified soil. Results of all samples indicated contaminant levels were below RGs prior to placement of fill materials.
- Groundwater remediation efforts began in 1996 with installation of a pump-and-treat

system consisting of four recovery wells feeding an air stripper (WSRC 1994). In 2007, the pump and treat system was shutdown to allow a treatability study of edible oils to treat the residual VOCs in the source (vadose zone/groundwater interface and near source groundwater). In 2013, edible oil became the remedial action reducing the treatment time to achieve MCLs by approximately 20 years.

- Based on the successful SVE treatability study, the active SVE network was expanded (WSRC 2001). In 2007, the active SVE system was transitioned to a passive system (MicroBlowers™).
- LUCs were established for 0.9 hectares (2.24 acres).

System Operations/Operation and Maintenance

The system operation requirements include the following activities:

- SVE operations in the high concentration areas of the vadose zone extracted 12.9 kg (28.5 lbs) of VOCs from 2002 through 2011. In 2006, the system was shut down temporarily during the placement of the engineered cover system over the former TNX Area. The SVE system remained in operation during the edible oil treatability study.
- Operation of the pump and treat system has ceased and the T-1 Air Stripper system has been dismantled and removed.
- There are no operation and maintenance activities associated with the edible oil remedial action.

The following activities are ongoing:

- Passive MicroBlowers™ and groundwater monitoring for support of a mixing zone;
- Annual site inspections are conducted for evidence of damage to the NTSB cover system due to erosion, settlement or intrusion by burrowing animals and address upkeep of the vegetative cover and access control barriers (e.g., the warning signs);
- Necessary repairs (e.g., replacing eroded or disturbed soil, sign repair, etc.) and vegetation management (e.g., mowing, removal of larger vegetation, etc.) are performed when required; and

- Institutional controls (i.e., LUCs) are being enforced to preclude access through the SRS Site Use/ Site Clearance program and SRS site security.

Maintenance and inspection activities associated with the engineered cover system over the OTSB/Discharge Gully and TBG and the cover system for the NTSB are integrated into the TAOU. Therefore, review of the operation and maintenance (O&M) activities associated with the cover system are addressed in the five-year remedy review for the TAOU.

Table M-4 compares the actual O&M costs for the five-year remedy review period to the estimated direct O&M costs from the ROD (WSRC 2004b). The estimated cost for Fiscal Year (FY) 2012 to FY2017 is $1,512,918 for the O&M costs of the SVE systems, institutional controls (i.e., LUCs), and five-year remedy reviews. The actual O&M cost for FY2012 to FY2017 is $1,350,984. The actual O&M costs from FY2012 to FY2017 are as expected.

V. Progress Since Last Review

The previous protectiveness statement concluded that the remedy is protective of human health and the environment. Exposure pathways that could result in unacceptable risks are being controlled by removing TCE from the most concentrated portion of the contaminated plume and through institutional controls (i.e., LUCs).

VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII, Documents Reviewed;
- Confirmed the implementation of the remedial action;
- Reviewed all process and performance monitoring data provided by the annual effectiveness monitoring strategy reports (SRNS 2013a, SRNS 2014a, SRNS 2015a, SRNS 2016, and SRNS 2017a) and provided a technical assessment of whether the groundwater remedial actions are performing as expected;
- Inspected the OU and documented the results on the Inspection Checklist provided in

Attachment M-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and

- Reviewed changes in standards and to-be-considered guidance

Data Review

Central to the TNX groundwater remedial efforts has been remediating the cVOCs (TCE, PCE and carbon tetrachloride) to reach ARARs (i.e., MCLs), which has been conducted in a phased approach. The initial efforts were identified in the IROD as the HGCA, which consisted of pump-and-treat systems: a classic system of pumping followed by treatment in an air stripper; and an in-situ system - airlift recirculation well (WSRC 1994). The recirculation well was identified as being ineffective in addressing the interim action goals and was removed from the HGCA system in 1997 (WSRC 1997). The recovery well network and air stripper was the sole engineered remediation system for this OU until 2002. The impact of the pump-and-treat system on the TCE plume was a measurable reduction in the 500 µg/L contour (Figure M-4). This system continued to operate until 2007 at which time operation was suspended in order to evaluate the use of edible oils to address the remaining secondary/residual contaminants in the groundwater. The pump and treat system was permanently shut down in 2013 when the second ESD to the TNX ROD (SRNS 2012b) was approved making edible oil the selected remedial action.

With the approval of an ESD to the IROD (WSRC 2001), the next phase of the cVOCs remediation addressed the contaminants in the vadose zone, an ongoing source of contamination to the groundwater representing PTSM, by using SVE technology. At TNX Area OU, the conventional active SVE system was transitioned to a passive system (MicroBlowers™) in 2007 (Figure M-5). The only extended shut down of the system was in 2006. Passive SVE systems are most effective at removing low/residual concentrations of volatile in the unsaturated zone. They are considered a polishing technology when active SVE performance no longer warrants its operating costs (SRNS 2010b). As shown in Figure M-6, the MicroBlowers™ are effectively removing small volumes of cVOCs from the vadose.

In 2008, a treatability study began injections of edible oils to treat the residual VOCs in the source (vadose zone and near source groundwater) (Figure M-7). Effectiveness monitoring of this remedial technology treatability study continued through 2011. Based on the positive results of this treatability study (SRNS 2012), an ESD to the ROD (SRNS 2012b) was approved by SCDHEC and USEPA changing groundwater remedy to edible oil treatment. Additional edible oil treatment will be applied if a sustained rebound lasting over one (1) year in excess of 75 µg/L (ppb) of TCE, PCE, or carbon tetrachloride in any well if determined appropriate by the USDOE, USEPA, and SCDHEC.

In 2015, a third amendment of edible oil was applied to a larger area outside of the originally targeted treatment zone (SRNS 2015b). This injection was initiated based on TCE results at TBG 3 and TVM 1M that came close to exceeding the greater than75 ppb increase sustained for one year. Although the trigger criteria were not exceeded, additional edible oil was injected to take advantage of the high water table and to prevent future increases in TCE concentration. Results from the 2015 injections indicate reductive conditions are being created and VOC concentrations are decreasing. In 2016, there were no monitoring wells in the treatment area that exceeded the MCL for TCE. It is estimated that edible oil has removed 93% of the TCE mass from the secondary source area and TCE concentrations may be less than the MCL in 2021 (Figure M-8).

The combination of the cover system, pump-and-treat with air-stripping, passive SVE and edible oil has had a positive impact on TCE concentrations by reducing the footprint of the TCE plume (Figure M-9). In addition, the 5 µg/L isocontour no longer intercepts the X8 ditch, which intersects the water table; thus, having a channeling effect on groundwater flow, as was projected in Figure M-4. The 2013 TCE and PCE data from the X-008C National Pollutant Discharge Elimination System sampling location confirm that TCE and PCE are not present in the outfall (SRNS 2013b). X-008C was rendered incapable of discharge in November 2013 and has not been sampled since 2013 (SRNS 2014b). PCE, carbon tetrachloride and cis-1,2-dichloroethene are detected within the footprint of the TCE plume and were removed via the T-1 Air-Stripper, edible oils, and passive SVE. The T-1 Air Stripper was permanently removed from service in 2013. The remaining RCOCs (Table M-3) are localized with no discernible plumes.

1,4-Dioxane analysis for groundwater samples was initiated in 2013, based on comments on the Fourth Five Year Remedy Review Report. Results for 1,4-dioxane indicate that there is no discernable groundwater plume at the TNX Area OU. Only one monitoring well (i.e., TBG 5) has had detectable concentrations of 1,4-dioxane. A reduced monitoring well network was proposed in the 2016 annual report (SRNS 2017a) to provided continued monitoring of 1,4-dioxane. The reduced monitoring well network includes TBG 5 and adjacent downgradient monitoring wells (i.e., TBG 3, TBG 4, TBG 5, and TNX 3D).

Summary of Inspections and Interviews

Interviews were conducted with Richard Feagin, O&M staff member, on October 11, 2017 and George Joyner, O&M Site Manager, on October 12, 2017 at the O&M organization offices. No issues were identified for the TNX Area OU during these interviews.

The TNX Area OU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) and USDOE personnel on November 27, 2017. No issues were identified for the TNX Area OU during this inspection.

A site inspection will be conducted by USEPA and SCDHEC personnel, accompanied by USDOE and SRNS personnel, prior to submittal of the Revision 1 of this document. It is anticipated that no significant problems regarding this OU will be identified during the inspection.

Scheduled annual site inspections conducted from FY2012 through FY2017 identified the presence of ant mounds and minor erosion of the soil cover, a crack in the drain cleanout plug, debris in the drainage ditches resulting from an ice storm, and damage from hogs. These findings were documented on the field inspection checklist and resolved soon after discovery.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The remedy is functioning as intended as demonstrated below:

- The removal of PTSM soils associated with the OTSB and the sumps has achieved the remedial objectives to remove or treat contamination exceeding PTSM criteria in subsurface soils.

- The removal and consolidation under a geosynthetic cover system is effective in protecting future industrial and ecological receptors from exposure to contaminants (SRNS 2017b). Additionally, the TAOU cover system has the effect of decreasing contaminant loading by reducing surface water loading and transport through the contaminated vadose zone directly under the cover to the groundwater; thus, positively impacting groundwater treatment.
- The combined groundwater treatment approaches of pump-and-treat (ceased) and passive SVE (ongoing) are effective in decreasing the volume of contaminants in the groundwater and vadose zone, eliminating the 500 µg/L TCE contour, and facilitating a receding of the distal portion of the TCE plume. The application of the edible oil had further reduced the mass of TCE in the system by 93% and the results indicate TCE concentrations may be less than the MCL by 2021.

The Land Use Control Implementation Plan for TNX Area OU governs LUC implementation, maintenance, monitoring, reporting, and enforcement (WSRC 2004a). The LUCs that are in place include physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), use restrictions to prevent unauthorized contact, removal or excavation of contaminated soils, restrictions to prevent unauthorized access to or use of groundwater until cleanup levels are met, and restrictions to prevent disturbance of the engineered cover system. Warning signs are in good condition, and no activities were observed that would have violated the LUCs. All LUC objectives are being met.

Are Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still valid?

The exposure assumptions, toxicity data, and cleanup levels used at the time of remedy selection are still valid. There have been no changes in standards or to-be-considered guidance identified in the ROD that call into question the protectiveness of the remedy.

The USEPA standards and toxicity values have been updated since the last five-year remedy review as shown in Appendix B. The changes to the values for COCs at the TNX OU were not significant, and the RAOs continue to be met by the remedial action. No new standards or to-be-considered guidance have been identified that call into question the protectiveness of the remedy.

Fact sheets provided on the USEPA webpage regarding emerging contaminants were reviewed for applicability to this site. None of the listed emerging contaminants were identified as applicable to this OU.

Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No new information has come to light that could call into question the protectiveness of the remedy.

VIII. Issues

No issues have been identified for the TNX Area OU.

IX. Recommendations and Follow-up Actions

There are no recommendations or follow-up actions concerning TNX Area OU for this review period.

X. Protectiveness Statements

The remedy at the TNX Area OU is protective of human health and the environment.

Exposure pathways that could result in unacceptable risks are being controlled by removing TCE from the most concentrated portion of the contaminated plume and through institutional controls (i.e., LUCs). LUCs include physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain this site for industrial use only (SRS is a secured government facility with land use restrictions), and warning signs and use restrictions via the SRS Site Use/Site Clearance Program.

XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS

OUs with Operating Equipment is scheduled for January 2024.

XII. Documents Reviewed

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

SRNS, 2010b. *Enhanced Attenuation Technologies: Passive Soil Vapor Extraction*, SRNL-STI-2009-00571, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2012a. *Treatability Study for Edible Oil Deployment for Enhanced cVOC Attenuation for T-Area*, SRNL-STI-2012-00290, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2012b. *Second Explanation of Significant Differences (ESD) for the Revision 1 TNX Area Operable Unit Record of Decision (U)*, SRNS-RP-2012-00205, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2013a. *2012 Comprehensive TNX Area Annual Groundwater and Effectiveness Monitoring Strategy Report (U),* SRNS-RP-2013-00286, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2013b. *Savannah River Site Environmental Report for 2014*, SRNS-RP-2014-00006, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2014a. *2013 Comprehensive TNX Area Annual Groundwater and Effectiveness Monitoring Strategy Report (U),* SRNS-RP-2014-00469, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2014b. *Savannah River Site Environmental Report for 2014*, SRNS-RP-2015-00008, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2015a. *2014 Comprehensive TNX Area Annual Groundwater and Effectiveness Monitoring Strategy Report (U),* SRNS-RP-2015-00396, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2015b. *Second Corrective Measures Implementation/Remedial Action Implementation Plan (CMI/RAIP) for the TNX Operable Unit (U)*, SRNS-RP-2015-00266, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2016. *2015 Annual Comprehensive TNX Area Groundwater Monitoring and Remedial Action Effectiveness Interim Report (U),* SRNS-RP-2016-00394, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2017a. *2016 Annual Comprehensive TNX Area Groundwater Monitoring and Remedial Action Effectiveness Interim Report (U),* SRNS-RP-2017-00302, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2017b. *Fifth Five-Year Remedy Review Report for Savannah River Site Operable Units with Geosynthetic or Stabilization/Solidification Cover Systems (U)*, SRNS-RP-2016-00610, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 1994. *Interim Action Record of Decision, Remedial Alternative Selection - TNX Groundwater Operable Unit (U)*, WSRC-TR-94-0375, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1997. *Explanation of Significant Differences for the TNX Area Groundwater Operable Unit (U),* WSRC-RP-97-169, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1999. *Land Use Control Assurance Plan for the Savannah River Site*, WSRC-RP-98-4125, Revision 1.1, latest revision, Savannah River Nuclear Solutions, LLC Savannah River Site, Aiken, SC

WSRC, 2001. *Explanation of Significant Differences (ESD) to the Revision 1 Interim Record of Decision (IROD) for the TNX Area Operable Unit Groundwater (U)*, WSRC-RP-2001-00764, Revision 0, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2004a. *Land Use Control Implementation Plan (LUCIP) for the TNX Area Operable Unit (U)*, WSRC-RP-2003-4173, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2004b. *Record of Decision Remedial Alternative Selection for the TNX Area Operable Unit (U)*, WSRC-RP-2003-4017, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2005. *Explanation of Significant Differences (ESD) to the Record of Decision for the TNX Area Operable Unit (U)*, WSRC-RP-2005-4030, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2007a. *Post-Construction Report (PCR) for the TNX Area Operable Unit (U)*, WSRC-RP-2005-4007, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

Various - Inspection Data Sheets – *Field Inspection Checklist, T-Area Operable Unit (U)*, ER-IDS-019-032, Inspection Period 2012 to 2017 (annually)

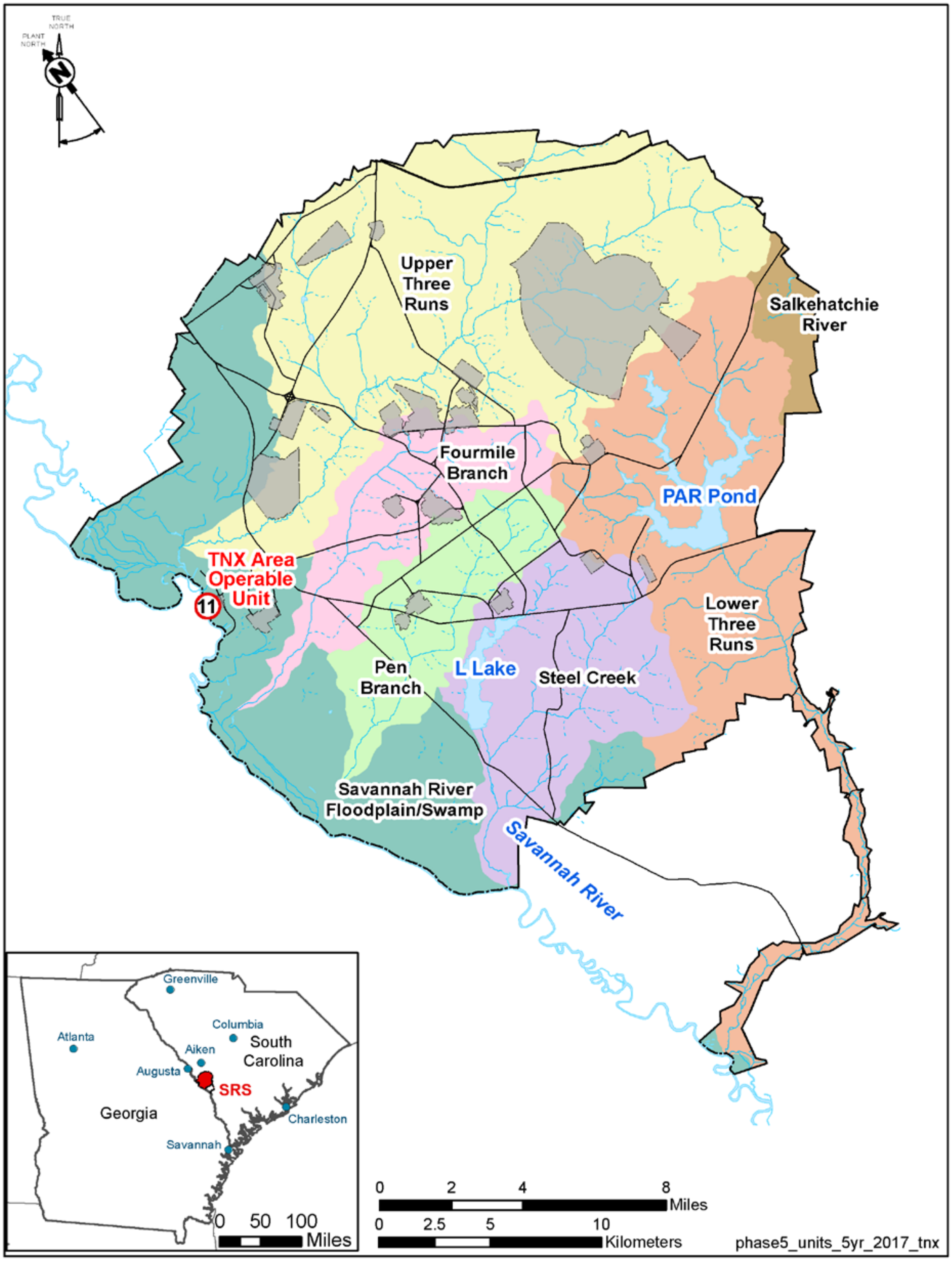

Figure M-1. Location of TNX Area OU at Savannah River Site

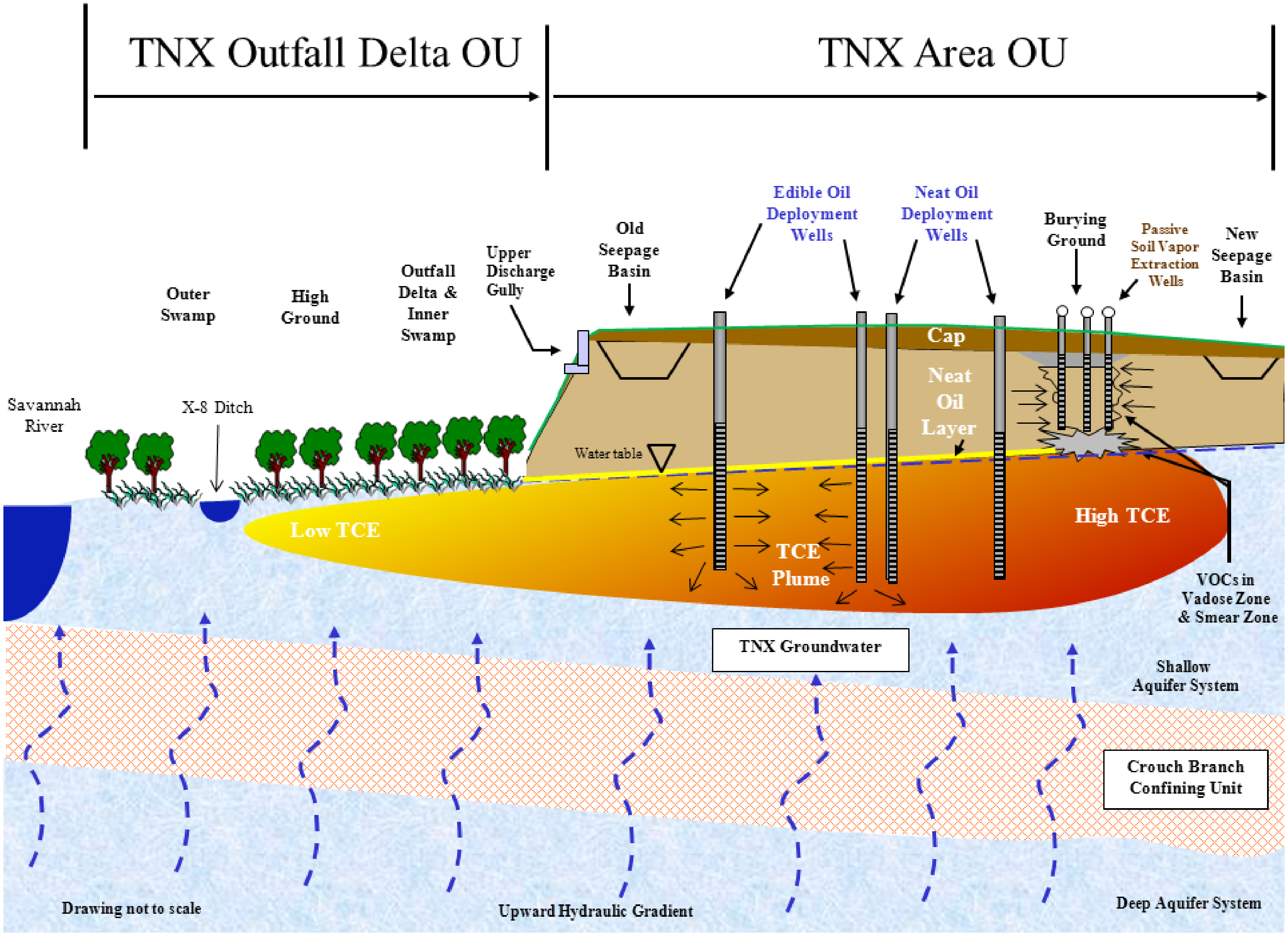

Figure M-2. Schematic Cross Section of TNX Area OU and Interim Action

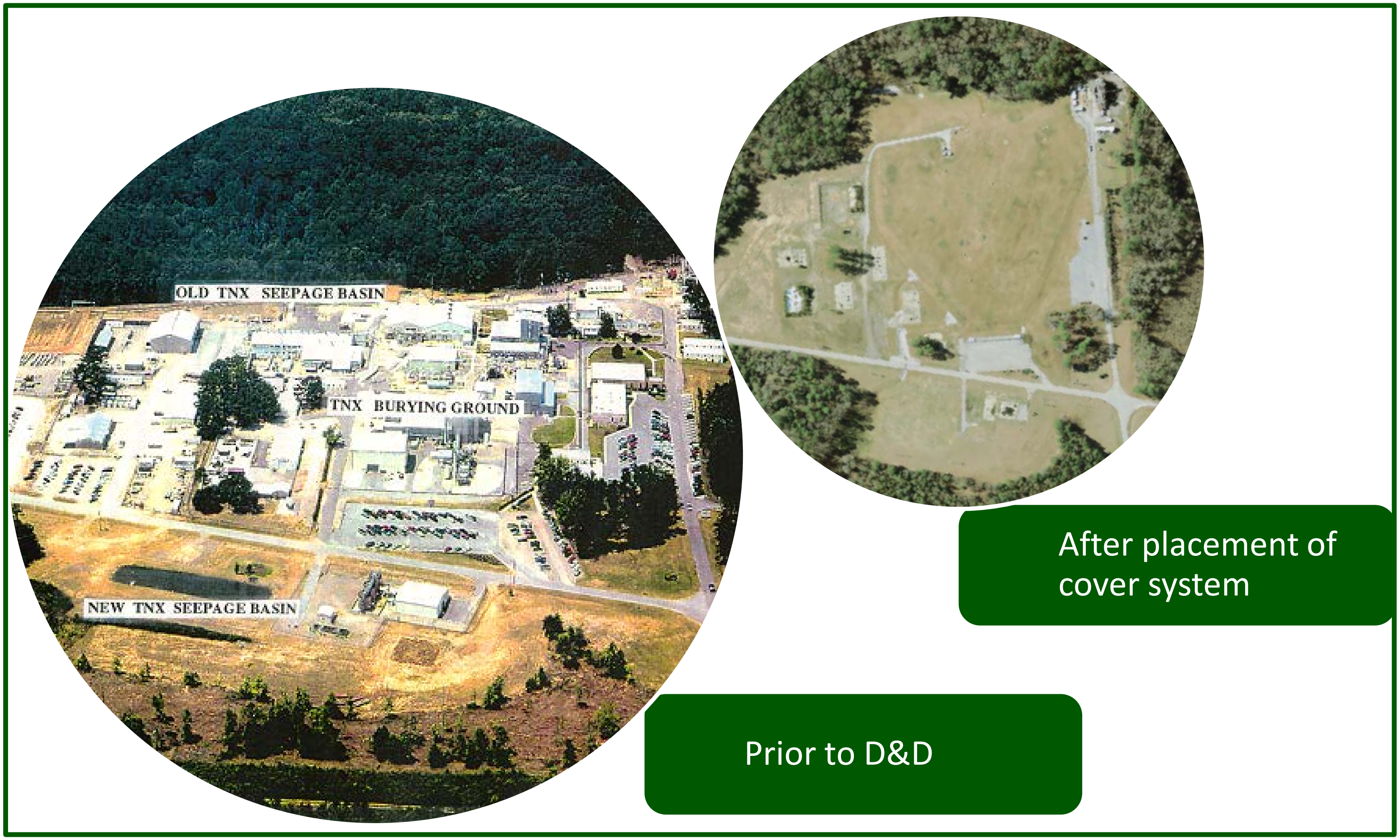

Figure M-3. **Layout of the TNX Area OU before (pre-2004) and after D&D and remedial actions (post-2006)**

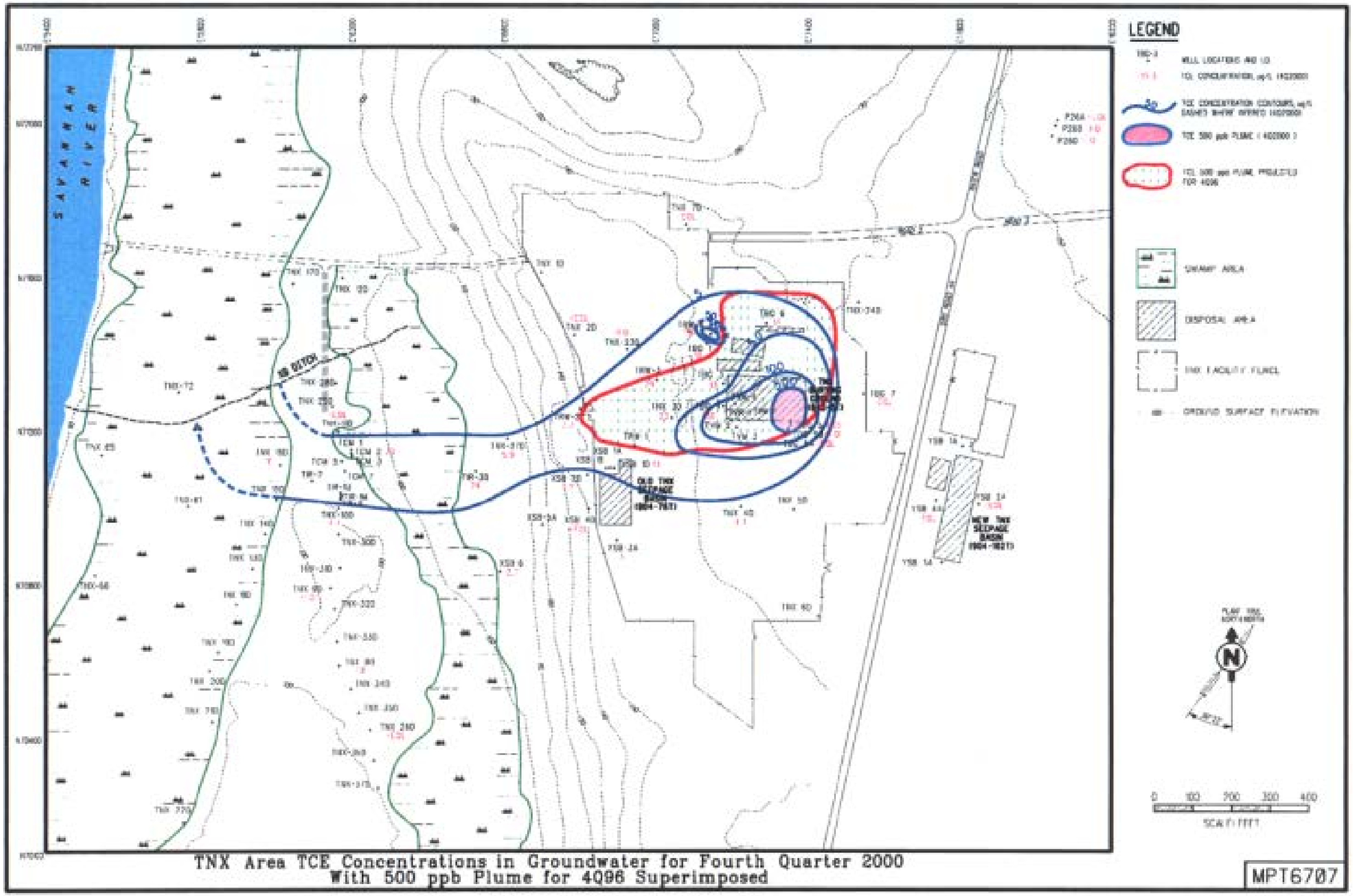

Figure M-4. 2000 TCE Contours with 4Q96 500 µg/L TCE Contour

Figure M-5. Photograph of a MicroBlower™ Field Setup powered by a Solar Panel (2007)

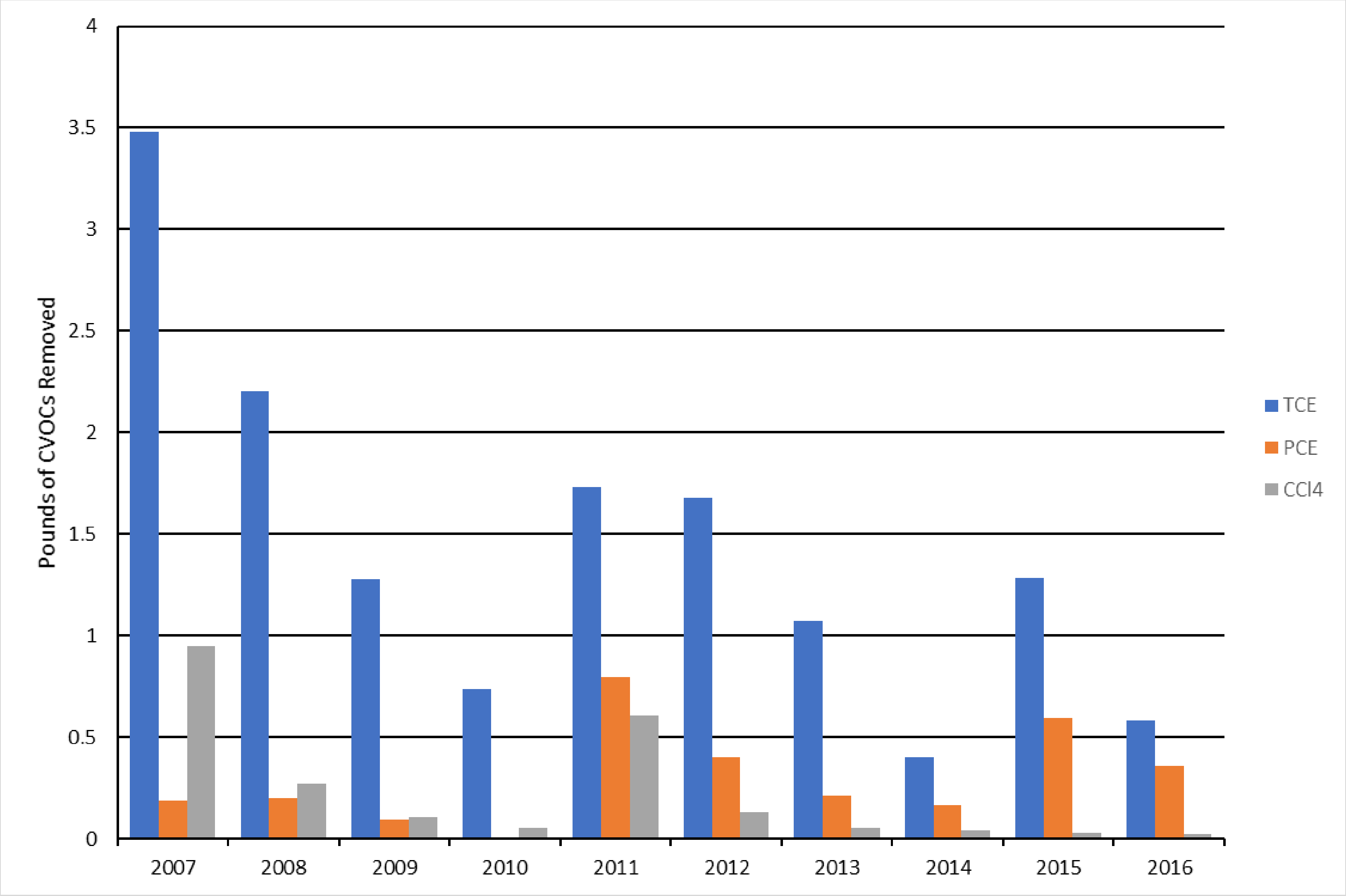

Figure M-6. **Mass Removal Rates by Year for the TNX Area OU Passive SVE (MicroBlower™) System**

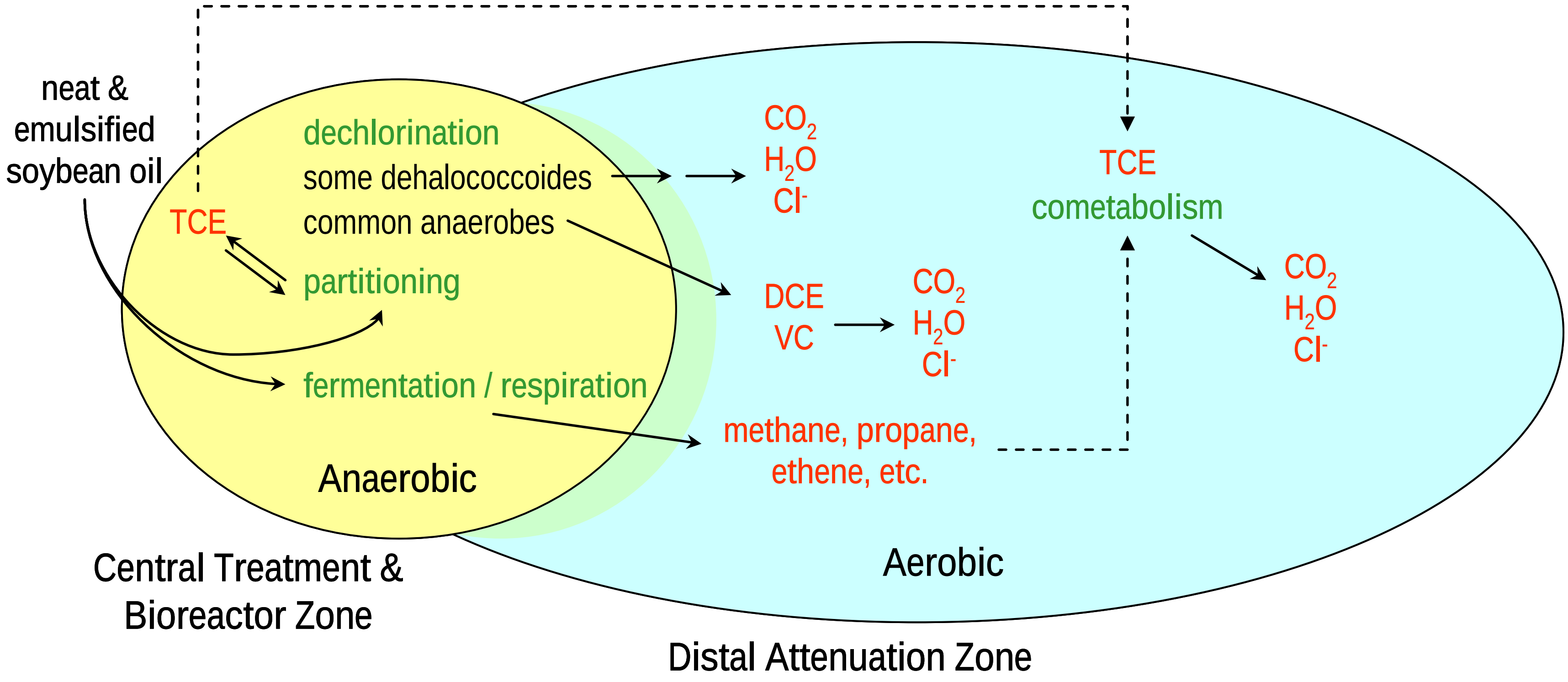

Figure M-7. **Schematic of Edible Oil Reduction Processes (SRNS 2012a)**

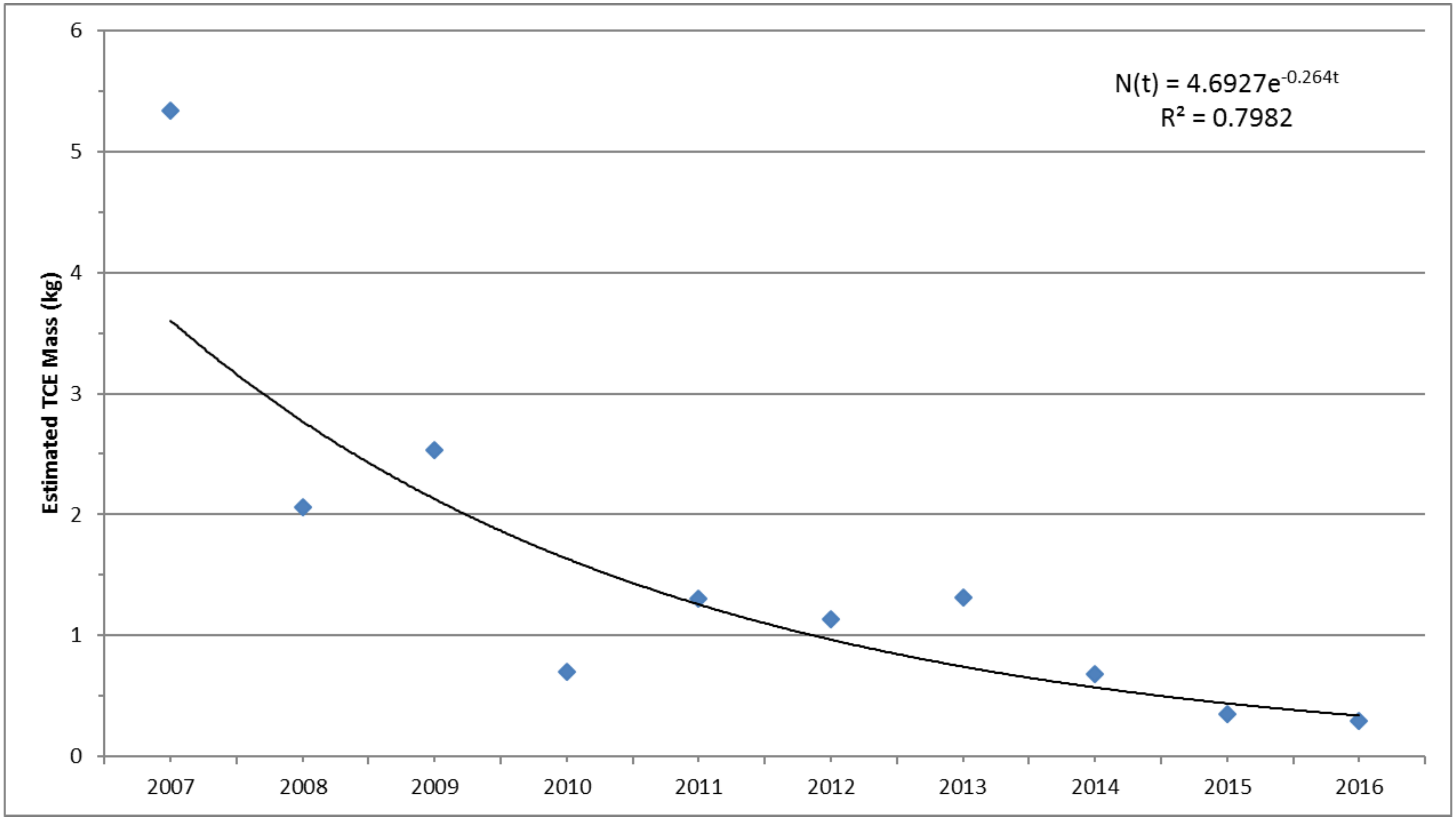

Figure M-8. Estimate of TCE Plume Mass Reduction and Rate (SRNS 2012a)

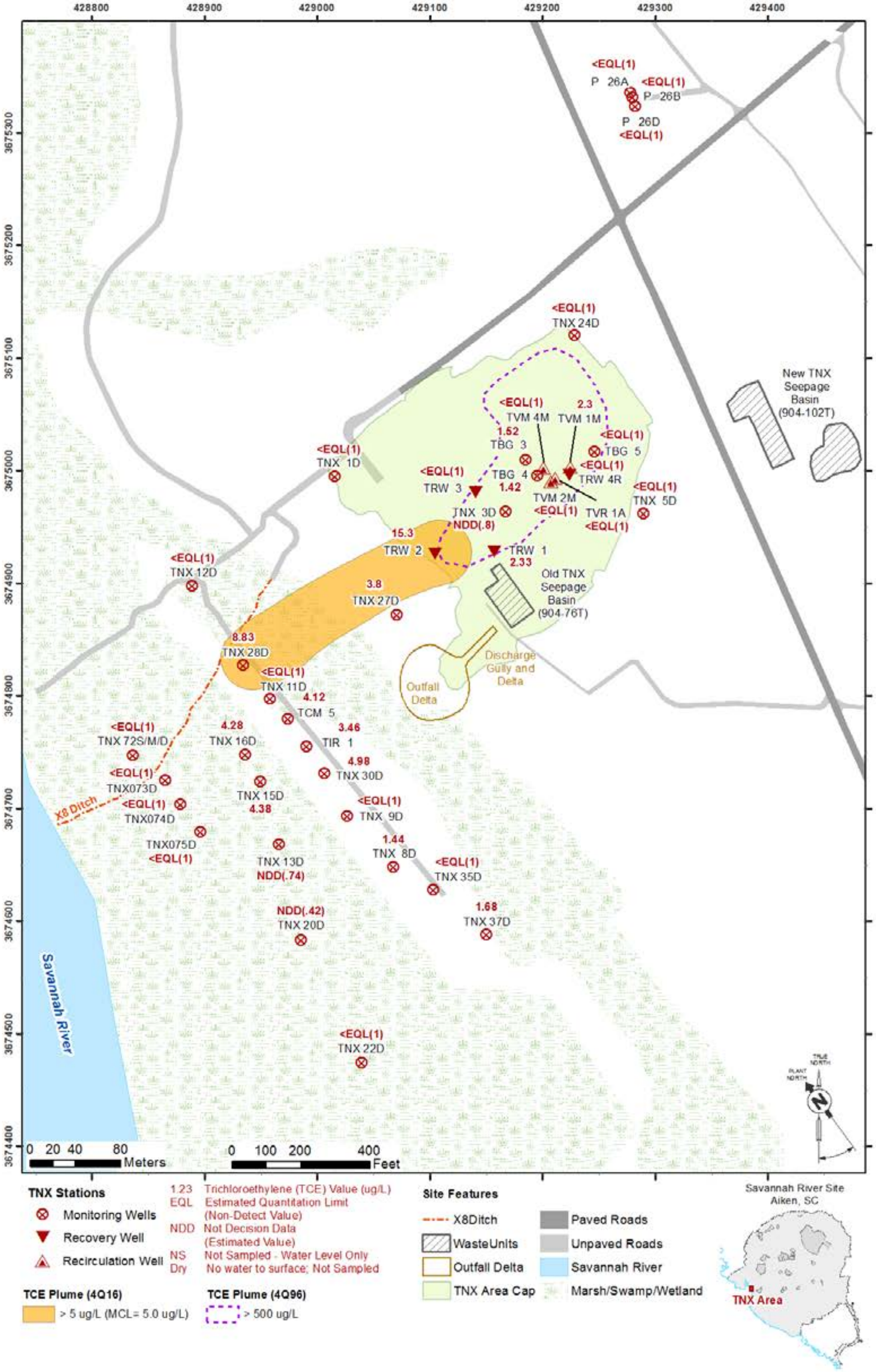

Figure M-9. **2016 TCE Plume (SRNS 2017a)**

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Table M-1. Chronology of OU Events

Event	Date
Interim Record of Decision (IROD) Issuance for TNX Area Groundwater OU	November 16, 1994
Interim Remedial Action start	September 16, 1996
Explanation of Significant Differences (ESD) Issuance for the TNX Area Groundwater OU	October 10, 1997
ESD Issuance to the Revision 1 IROD for the TNX Area Groundwater OU	May 19, 2003
ROD Issuance for TNX Area OU	April 7, 2004
ESD Issuance for TNX Area OU ROD	November 5, 2005
Remedial Action Start / Completion	August 12, 2004/May 4, 2006
ESD Issuance for TNX Area OU ROD	June 12, 2013
Edible Oil Deployments	April 2008 / October 2010 / August 2015
Previous Five-Year Reviews Issuance	June 30, 1997 / February 12, 2004 / February 4, 2009 / February 4, 2014

Table M-2. Soil and Sediment RCOCS and RGs

Media (subunit)	RCOC	Type of RCOC	RG
Sediment (NTSB)	Radium-226	HH-future worker	0.16 ρCi/g
	Arsenic	ECO	8.2 mg/kg
	Chromium	ECO	80 mg/kg
	Copper	ECO	70 mg/kg
	Lead	ECO	35 mg/kg
	Mercury	ECO	0.15 mg/kg
	Nickel	ECO	30 mg/kg
	Silver	ECO	1.0 mg/kg
	Zinc	ECO	150 mg/kg
Soil (OTSB/IPSL)	Mercury	CM	0.078 mg/kg
Soil (UDG)	Mercury	CM	0.13 mg/kg
Soil (LDG)	Uranium -233/234	CM	1.31 ρCi/g
	Uranium-235	CM	0.06 ρCi/g
	Uranium -238	CM	1.31 ρCi/g
	Actinium-228	HH-future worker	0.07 ρCi/g
	Cesium-137	HH-future worker	0.10 ρCi/g
	Lead-212	HH-future worker	0.73 ρCi/g
	Radium-228	HH-future worker	0.07 ρCi/g
	Thorium-228	HH-future worker	0.04 ρCi/g
	Thorium -234	HH-future worker	45.43 ρCi/g
	Uranium -233/234	HH-future worker	68.80 ρCi/g
	Uranium-235	HH-future worker	0.82 ρCi/g
	Uranium -238)	HH-future worker	3.13 ρCi/g

Table M-3. Groundwater RCOCs and RGs for Future Industrial Worker at TNX Area OU

RCOC	RG/MCL
Carbon tetrachloride	5 µg/L
Tetrachloroethylene	5 µg/L
Trichloroethylene	5 µg/L
Gross alpha	15 ρCi/L
Total uranium	30 µg/L
Total radium (226 + 228)	5 ρCi/L
Mercury	2 µg/L

Table M-4. Actual versus Estimated O&M Costs

	FY2012	FY2013	FY2014	FY2015	FY2016	FY2016	Five-Year Total
Total Actual O&M Costs ($)	462,638	281,490	235,053	65,717	131,015	175,071	1,350,984
Total ROD Estimated Direct O&M Costs ($)	278,769	238,845	238,845	238,845	238,845	278,769	1,512,918

Attachment M-1. Five-Year Review Site Inspection Checklist – TNX Area Operable Unit

I. SITE INFORMATION

Site Name:	**TNX Area Operable Unit**	**Date of Inspection:**	**08/31/2017**
Location and Region	**SRS, USEPA Region 4**	**CERCLIS #:**	**#21 and 29**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**74°F and overcast**

Remedy Includes: *(Click all that apply)*

☐ Landfill Cover / Containment
☒ Access Controls
☒ Institutional Controls
☒ Groundwater Pump and Treatment
☐ Surface Water Pump and Treatment
☐ Monitored Natural Attenuation
☐ Groundwater Containment
☐ Vertical Barriers
☐ Other ______________________________

Attachments: ☐ Inspection team roster attached ☐ Inspection team roster attached

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 10/12/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

Problems/Suggestions: ☐ Report Attached ______________________________

2. **O&M Staff:** Richard Feagin (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 10/11/2017 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.:803-952-4416

Problems/Suggestions: ☐ Report Attached ______________________________

Attachment M-1. Five-Year Review Site Inspection Checklist – TNX Area Operable Unit *(continued)*

II. INTERVIEWS *(Click all that apply)(Continued)*

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

Agency: ____________________

Contact: ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

Agency: ____________________

Contact: ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

Agency: ____________________

Contact: ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

Problems/Suggestions: ☐ Report Attached ____________________

4. **Other Interviews** *(Optional):* ☐ Report Attached ____________________

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Click all that apply)*

1. **O&M Documents:**

☒ O&M Manual	☒ Readily Available	☒ Up to Date	☐ N/A
☒ As-Built Drawings	☒ Readily Available	☒ Up to Date	☐ N/A
☒ Maintenance Logs	☒ Readily Available	☒ Up to Date	☐ N/A

Remarks: ____________________

Attachment M-1. Five-Year Review Site Inspection Checklist – TNX Area Operable Unit *(continued)*

III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)*

2. Health and Safety Plans (HASPs):

☐ Site-Specific Health and Safety Plans	☐ Readily Available	☐ Up to Date	☒ N/A
☐ Contingency Plan/Emergency Response Plan	☐ Readily Available	☐ Up to Date	☒ N/A

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.120.HAZWOPER. A SSHASP is prepared if needed.

3. O&M and OSHA Training Records: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix.

4. Permits and Service Agreements:

☐ Air Discharge Permit	☐ Readily Available	☐ Up to Date	☒ N/A
☒ Effluent Discharge	☒ Readily Available	☒ Up to Date	☐ N/A
☐ Waste Disposal; POTW	☐ Readily Available	☐ Up to Date	☒ N/A
☐ Other Permits	☐ Readily Available	☐ Up to Date	☒ N/A

Remarks: SCDHEC Title V Air Quality Permit

5. Gas Generation Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

6. Settlement Monument Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

7. Groundwater Monitoring Records: ☒ Readily Available ☒ Up to Date ☒ N/A

Remarks:

8. Leachate Extraction Records: ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

9. Discharge Compliance Records:

☒ Air	☒ Readily Available	☒ Up to Date	☐ N/A
☐ Water (Effluent)	☐ Readily Available	☐ Up to Date	☒ N/A

Remarks:

10. Daily Access/Security Logs: ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Daily operation logs

Attachment M-1. Five-Year Review Site Inspection Checklist – TNX Area Operable Unit *(continued)*

IV. O&M COSTS

1. O&M Organization:

☐ State In-House ☐ Contractor for State
☐ PRP In-House ☐ Contractor for PRP
☒ Other: SRS

2. O&M Cost Records:

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

Total annual cost by year for review period, if available

From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached
From:______ (Date) To:______ (Date) ______ (Total Cost) ☐ Breakdown attached

3. Unanticipated or Unusually High O&M Costs During Review Period

Describe costs and reasons: ______

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing Damage: ☐ Location shown on site map ☒ Gates secured ☐ N/A
Remarks: OU-specific perimeter fencing is not required by the remedial action.

B. Signs

1. Signs and Other Security Measures: ☐ Location shown on site map ☐ N/A
Remarks: Signs at this site are in good condition.

Attachment M-1. Five-Year Review Site Inspection Checklist – TNX Area Operable Unit *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Once in five years
Responsible Party/Agent: USDOE Savannah River Field Office
Contact: Phil Prater (Name) IACD Program Manager (Title) 11/27/17 (Date) 803-952-9333 (Phone No.)

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

2. Adequacy: ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks:

D. General

1. Vandalism/Trespassing: ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

2. Land use changes onsite: ☒ N/A
Remarks:

3. Land use changes offsite: ☒ N/A
Remarks:

Attachment M-1. Five-Year Review Site Inspection Checklist – TNX Area Operable Unit *(continued)*

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. Roads damaged: ☒ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks:

B. Other Site Conditions

Remarks: Scheduled annual site inspections conducted from FY2012 through FY2017 identified the presence of ant mounds and minor erosion of the soil cover, a crack in the drain cleanout plug, debris in the drainage ditches resulting from an ice storm, and damage from hogs. These findings were resolved soon after discovery.

VII. LANDFILL COVER / CONTAINMENT ☐ Applicable ☒ N/A

VIII. LANDFILL COVER / CONTAINMENT ☐ Applicable ☒ N/A

IX. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

X. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. Pumps, Wellhead Plumbing, and Electrical:
☒ Good Condition ☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks: TRW 1,2,3, and 4R

2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances:
☒ Good Condition ☐ Needs Maintenance
Remarks:

3. Spare Parts and Equipment:
☒ Readily Available ☒ Good Condition ☐ Requires Upgrade ☐ Needs to be provided
Remarks:

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

Attachment M-1. Five-Year Review Site Inspection Checklist – TNX Area Operable Unit *(continued)*

IX. GROUNDWATER/SURFACE WATER REMEDIES *(Continued)*

C. Treatment System ☒ Applicable ☐ N/A

1. Treatment Train (Check components that apply)**:**

☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☐ Carbon adsorbers
☐ Filters__________
☐ Additive (e.g., chelation agent, flocculent)__________
☐ Others__________
☐ Good Condition ☐ Needs maintenance
☐ Sampling ports properly marked and function
☐ Sampling/maintenance log displayed and up-to-date
☐ Equipment properly identified
☐ Quantity of groundwater treatment annually 100 gpm maximum, 75 gpm average
☐ Quantity of surface water treatment annually__________
Remarks:__________

2. Electrical Enclosures and Panels *(properly rated and function)***:**

☒ N/A ☐ Good Condition ☐ Needs maintenance
Remarks:__________

3. Tanks, Vaults, Storage Vessels:

☒ N/A ☐ Good Condition ☐ Proper secondary containment ☐ Needs maintenance
Remarks:__________

4. Discharge Structure Appurtenances:

☒ N/A ☐ Good Condition ☐ Needs maintenance
Remarks:__________

5. Treatment Building(s):

☒ N/A ☐ Good Condition (especially roof and doorways ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks:__________

Attachment M-1. Five-Year Review Site Inspection Checklist – TNX Area Operable Unit *(continued)*

IX. GROUNDWATER/SURFACE WATER REMEDIES *(Continued)*

6. Monitoring Wells *(pump and treatment remedy)***:**
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs maintenance ☐ N/A
Remarks:____

D. Monitoring Data ☒ Applicable ☐ N/A

1. Monitoring Data:
☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring Data:
☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

E. Monitored Natural Attenuation ☐ Applicable ☒ N/A

XI. OTHER REMEDIES

If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

A. Soil Vapor Extraction System ☒ Applicable ☐ N/A

1. Blowers, Wellhead Plumbing, and Electrical:
☐ Good Condition ☐ All required wells located ☐ Needs maintenance ☐ N/A
Remarks:____

2. Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances:
☐ Good Condition ☐ Needs maintenance
Remarks:____

3. Spare Parts and Equipment:
☐ Readily Available ☐ Good Condition ☐ Requires Upgrade ☐ Needs to be provided
Remarks:____

Attachment M-1. Five-Year Review Site Inspection Checklist – TNX Area Operable Unit *(continued/end)*

XII. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

The remedy included excavation of contaminated soil pump-and-treat of groundwater contaminants (ceased), SVE to attenuate the leachability of VOCs and radiological contaminants in soils, and LUCs to prevent exposure to contaminants in soil and groundwater. Edible oil injections have also been implemented. The remedy is fully established and functioning as designed and the results are reported in the annual Groundwater Monitoring and Remedial Action Effectiveness Interim Report for TNX Area OU.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The O&M procedures are adequately maintaining the integrity of the pump-and-treat and SVE systems, which in turn maintains the effectiveness of the systems to mitigate leaching. The O&M procedures consisting of annual site inspections and site maintenance (repair of erosion damage, cover maintenance, and warning signs) and site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the OU) have been implemented. There are no issues requiring corrective actions.

C. Early Indicators of Potential Remedy Failure

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

N/A

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