



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

**Aiken, South Carolina**

**SRNS-RP-2017-00567**

**Redline Revision 01**

**December 2017July 2018**

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**Prepared for  
U.S. Department of Energy  
and  
Savannah River Nuclear Solutions, LLC  
Aiken, South Carolina**

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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. The eleven 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.

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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.
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### Five-Year Review Summary Form

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

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

<b>PROTECTIVENESS STATEMENT(S)</b>		
<b>Operable Unit:</b> 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	<b>Protectiveness Determination:</b> Protective	<b>Addendum Due Date (if applicable):</b> N/A
<b>Protectiveness Statement:</b> The remedy at the ABRP/MCB/MBP is protective of human health and the environment.		
<b>Operable Unit:</b> A-Area Miscellaneous Rubble Pile (731-6A) (AMRP) OU, CERCLIS #30	<b>Protectiveness Determination:</b> Protective	<b>Addendum Due Date (if applicable):</b> N/A
<b>Protectiveness Statement:</b> The remedy at the AMRP is protective of human health and the environment.		
<b>Operable Unit:</b> A/M-Area Groundwater OU, CERCLIS #36	<b>Protectiveness Determination:</b> Short-Term Protective	<b>Addendum Due Date (if applicable):</b> N/A
<b>Protectiveness Statement:</b> 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.		
<b>Operable Unit:</b> C-Area Burning/Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) (CBRP) OU, CERCLIS #31	<b>Protectiveness Determination:</b> Protective	<b>Addendum Due Date (if applicable):</b> N/A
<b>Protectiveness Statement:</b> The remedy at the CBRP is protective of human health and the environment.		
<b>Operable Unit:</b> D-Area Operable Unit (DAOU), CERCLIS #63	<b>Protectiveness Determination:</b> Protective	<b>Addendum Due Date (if applicable):</b> N/A
<b>Protectiveness Statement:</b> The remedy at the DAOU is protective of human health and the environment.		
<b>Operable Unit:</b> F-Area Groundwater OU, CERCLIS #8	<b>Protectiveness Determination:</b> Protective	<b>Addendum Due Date (if applicable):</b> N/A
<b>Protectiveness Statement:</b> The remedy at the F-Area Groundwater OU is protective of human health and the environment.		

**Table of Contents**

<b>Section</b>	<b>Page</b>
<b>Executive Summary .....</b>	<b>ES-1</b>
<b>List of Figures.....</b>	<b>ii</b>
<b>List of Tables .....</b>	<b>ii</b>
<b>List of Appendices.....</b>	<b>ii</b>
<b>List of Acronyms and Abbreviations .....</b>	<b>iii</b>
<b>I. Introduction.....</b>	<b>1</b>
<b>II. Site Chronology.....</b>	<b>4</b>
<b>III. Background .....</b>	<b>5</b>
<b>IV. Remedial Actions .....</b>	<b>8</b>
<b>V. Progress Since Last Review.....</b>	<b>10</b>
<b>VI. Five-Year Remedy Review Process .....</b>	<b>11</b>
<b>VII. Technical Assessment .....</b>	<b>13</b>
<b>VIII. Issues .....</b>	<b>15</b>
<b>IX. Recommendations and Follow-Up Actions.....</b>	<b>15</b>
<b>X. Protectiveness Statement(s).....</b>	<b>16</b>
<b>XI. Next Review .....</b>	<b>17</b>
<b>XII. OU-Specific Five-Year Remedy Review Reports.....</b>	<b>17</b>
<b>XIII. References.....</b>	<b>18</b>

**LIST OF FIGURES**

<b>Figure</b>	<b>Page</b>
<b>Figure 1. Location Map for SRS OUs with Groundwater Remedies .....</b>	<b>21</b>

**LIST OF TABLES**

<b>Table</b>	<b>Page</b>
<b>Table 1. SRS OUs with Groundwater Remedies .....</b>	<b>23</b>
<b>Table 2. Operation and Maintenance Cost Comparison for SRS OUs with Groundwater Remedies.....</b>	<b>25</b>

**LIST OF APPENDICES**

<b>Appendices</b>	<b>Pages</b>
<b>Appendix A Fifth Five-Year Remedy Review Report Phased Reviews .....</b>	<b>A-1</b>
<b>Appendix B Evaluation of Changes in Standards and Toxicity .....</b>	<b>B-1</b>
<b>Appendix <del>D</del>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).....</b>	<b>C-1</b>
<b>Appendix <del>C</del>D A/M-Area Groundwater.....</b>	<b>D-1</b>
<b>Appendix E A-Area Miscellaneous Rubble Pile (731-6A) .....</b>	<b>E-1</b>
<b>Appendix F C-Area Burning/Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) .....</b>	<b>F-1</b>
<b>Appendix G D-Area Operable Unit .....</b>	<b>G-1</b>
<b>Appendix H F-Area Groundwater .....</b>	<b>H-1</b>
<b>Appendix I H-Area Groundwater .....</b>	<b>I-1</b>
<b>Appendix J M-Area Operable Unit .....</b>	<b>J-1</b>
<b>Appendix K M-Area Settling Basin Inactive Process Sewer Lines to Manhole 1 (081-M).....</b>	<b>K-1</b>
<b>Appendix L P-Area Burning/Rubble Pit (131-P) .....</b>	<b>L-1</b>
<b>Appendix M TNX Area Operable Unit .....</b>	<b>M-1</b>

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”

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(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 ~~primary mission of 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 ~~has been to produce tritium, plutonium, and other special nuclear materials for our nation's defense programs.~~ Production of nuclear materials for the defense program was discontinued in 1988. SRS has provided nuclear materials for the space program, as well as for medical, industrial, and research efforts up to the present. Chemical and radioactive wastes are by-products of nuclear material production processes. These wastes have been treated, stored, and in some cases, disposed of at SRS. Past disposal practices (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<sup>2</sup> (310 mi<sup>2</sup>) 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. Virtually all 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 is pumped 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. ~~There is no current or projected future use of surface water or shallow aquifer groundwater as a drinking water source at the SRS.~~

### **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

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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. ~~Remedial goal~~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.
-

- 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 ~~are scheduled to~~ performed their site inspections of OUs with operating equipment with issued RODs or IRODs ~~in January 2018~~ on March 26, 2018. The Revision 0 report will be submitted on or before December 21, 2017. USDOE will address any comments received from USEPA and SCDHEC and provide 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 ~~in Aiken, Columbia, Barnwell, and Allendale, South Carolina, and in Augusta, Georgia.~~ 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.

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### 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 Remedial goals (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 ~~remedial goal~~ 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 remedial goal 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.

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### **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

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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 <sup>a</sup>	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	<del>30</del> 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	<del>36</del> 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 <sup>a</sup>	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

<sup>a</sup> OUs may include subunits with contaminants in building material or groundwater that are also addressed by the remedy decision document.  
NBN – No Building Number

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,

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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

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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	
<i>Submittal Date<sup>a</sup></i>	<i>Issuance Year</i>	<i>Submittal Date<sup>a</sup></i>	<i>Issuance Year</i>	<i>Submittal Date<sup>a</sup></i>	<i>Issuance Year</i>	<i>Submittal Date<sup>a</sup></i>	<i>Issuance Year</i>	<i>Submittal Date<sup>a</sup></i>	<i>Issuance Year</i>
2014	2015	2015	2017	2016	2018	2016	2018	2017	2019
C-Area Operable Unit <sup>b</sup>		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 <sup>d</sup>		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	
<i>Submittal Date<sup>a</sup></i>	<i>Issuance Year</i>	<i>Submittal Date<sup>a</sup></i>	<i>Issuance Year</i>	<i>Submittal Date<sup>a</sup></i>	<i>Issuance Year</i>	<i>Submittal Date<sup>a</sup></i>	<i>Issuance Year</i>	<i>Submittal Date<sup>a</sup></i>	<i>Issuance Year</i>
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 <sup>c</sup>						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 ~~approved in 2014~~ issued in 2018, but document has not been issued. This OU is ~~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 (*continued/end*)**

<b>Document Title<sup>a</sup></b>	<b>Document Number</b>	<b>Rev</b>	<b>Issuance Date<sup>b</sup></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
<b>D-Area Operable Unit EAROD</b>	<b>SRNS-RP-2010-00162</b>	<b>1.2</b>	<b>September 26, 2011</b>
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
<b>TNX Area Operable Unit (Second ESD to the ROD)</b>	<b>SRNS-RP-2012-00205</b>	<b>1</b>	<b>June 12, 2013</b>
F-Area Tank Farm (Tanks 18 and 19) ESD to the IROD)	SRR-CWDA-2013-00007	1.1	September 23, 2013
<b>Fourth Five-Year Remedy Review</b>	<b>SRNS-RP-2012-00011</b>	<b>1.1</b>	<b>February 4, 2014</b>
<del>Wetland Area at Dunbarton Bay in Support of Steel Creek IOU ROD</del>	<del>SRNS-RP-2013-00730</del>	<del>+</del>	<del>April 21, 2014<sup>d</sup></del>
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
<b>Fifth Five-Year Remedy Review for SRS OUs with Native Soil Covers and/or LUCs</b>	<b>SRNS-RP-2014-00902</b>	<b>1</b>	<b>November 30, 2015</b>
H-Area Tank Farm (Waste Tank 16) IROD	SRR-CWDA-2015-00157	1	August 16, 2016
<b>Fifth Five-Year Remedy Review for SRS OUs with Groundwater Remedies</b>	<b>SRNS-RP-2015-00419</b>	<b>1</b>	<b>February 2, 2017</b>
H-Area Tank Farm (Waste Tank 12) ESD to the IROD	SRR-CWDA-2016-00107	0	April 20, 2017
<b>Fifth Five-Year Remedy Review for SRS OUs with Engineered Covers</b>	<b>SRNS-RP-2016-00609</b>	<b>1</b>	<b>TBD<sup>e</sup> February 21, 2018</b>
<b>Fifth Five-Year Remedy Review for SRS OUs with Geosynthetic or S/S Cover Systems</b>	<b>SRNS-RP-2016-00610</b>	<b>1</b>	<b>TBD<sup>e</sup> March 27, 2018</b>
<u>Wetland Area at Dunbarton Bay in Support of Steel Creek IOU ROD</u>	<u>SRNS-RP-2013-00730</u>	<u>1</u>	<u>June 20, 2018</u>

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.

d ~~Redline Revision 1 ROD for the Wetland Area at Dunbarton Bay in Support of Steel Creek Integrator Operable Unit was approved on April 11, 2014 by SCDHEC and April 21, 2014 by USEPA. Date shown is for the last approval date because the ROD has not been issued.~~

e ~~Issuance dates will be added when the reports are issued to the public.~~

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

<b>Operable Unit</b>	<b>Remedial Action</b>
<b><i>No Action/No Further Action</i></b>	
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
<b><i>No Action/No Further Action OUs Associated with OUs Requiring Remedial Action</i></b>	
108-4R Overflow Basin (108-4R) <sup>1</sup>	No Further Action
Central Shops Burning/Rubble Pit (631-5G) <sup>2</sup>	No Action
ECODS B-3 and B-5 (NBN) <sup>3</sup>	No Further Action
ECODS G-3 (Adjacent to Gunsite 012) (NBN) <sup>4</sup>	No Action
L-Area Acid/Caustic Basin (904-79G) <sup>5</sup>	No Action
Rubble Pile Across from Gunsite 012 (NBN) <sup>4</sup>	No Action
<b><i>RCRA Units that are No Further Action under CERCLA</i></b>	
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 <sup>a,b</sup>	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 <sup>a,b</sup>	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 <sup>c</sup>	89
	H-Area Tank Farm, Waste Tank 16 <sup>c</sup>	
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	<del>L-Area Burning/Rubble Pit, 131-L</del>	56
3534	L-Area Oil Chemical Basin, 904-83G	17
3635	L-Area Reactor Seepage Basin, 904-64G	65
3736	L-Area Southern Groundwater, NBN	77
3837	M-Area Hazardous Waste Management Facility: Lost Lake, 904-112G	1
	M-Area Hazardous Waste Management Facility: M-Area Settling Basin, 904-51G	
3938	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 <sup>a,b</sup>	CERCLIS #
4039	Inactive Clay Process Sewer Lines (Including Potential Release of TCT, TET, TCE, HNO <sub>3</sub> , 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	
404	Metallurgical Laboratory Hazardous Waste Management Facility (904-110G)	2
4241	Mixed Waste Management Facility, 643-28E	33
4342	Old F-Area Seepage Basin, 904-49G	16
4443	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)	
4544	P-Area Burning/Rubble Pit, 131-P	59
4645	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	
4746	P-Area Reactor Seepage Basin, 904-61G	66
	P-Area Reactor Seepage Basin, 904-62G	
	P-Area Reactor Seepage Basin, 904-63G	
4847	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	
4948	R-Area Burning/Rubble Pit, 131-1R	43
	R-Area Burning/Rubble Pit, 131-R	
	R-Area Rubble Pit, 631-25G	
5049	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 <sub>2</sub> SO <sub>4</sub> 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 <sup>a,b</sup>	CERCLIS #
5450	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	
5251	Silverton Road Waste Unit, 731-3A	13
5352	SRL Seepage Basin, 904-53G1	47
	SRL Seepage Basin, 904-53G2	
	SRL Seepage Basin, 904-54G	
	SRL Seepage Basin, 904-55G	
5453	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	
5554	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)	
5655	Wetland Area at Dunbarton Bay <sup>d</sup>	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 ~~Redline Revision 1 ROD for the Wetland Area at Dunbarton Bay in Support of Steel Creek Integrator Operable Unit was approved on April 11, 2014 by SCDHEC and April 21, 2014 by USEPA. Date shown is for the last approval date because the ROD has not been issued.~~ 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.

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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, ~~the “plus daughters” (+D) isotopes were removed from the radionuclide selection list and the secular equilibrium PRG calculation was identified as the preferred (i.e., default) value~~ 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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(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.

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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.

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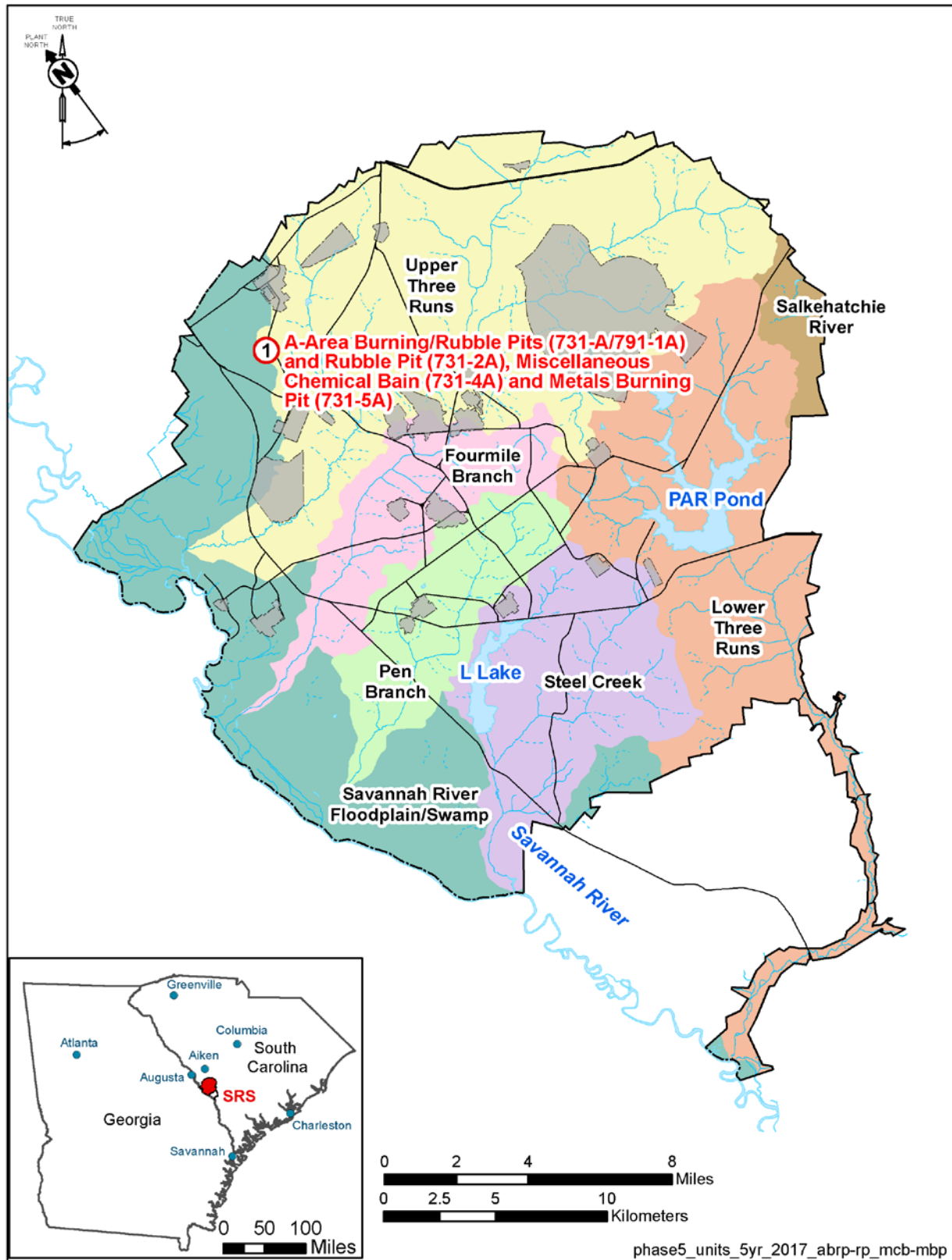


Figure C-1. Location of ABRP/MCB/MBP OU at SRS

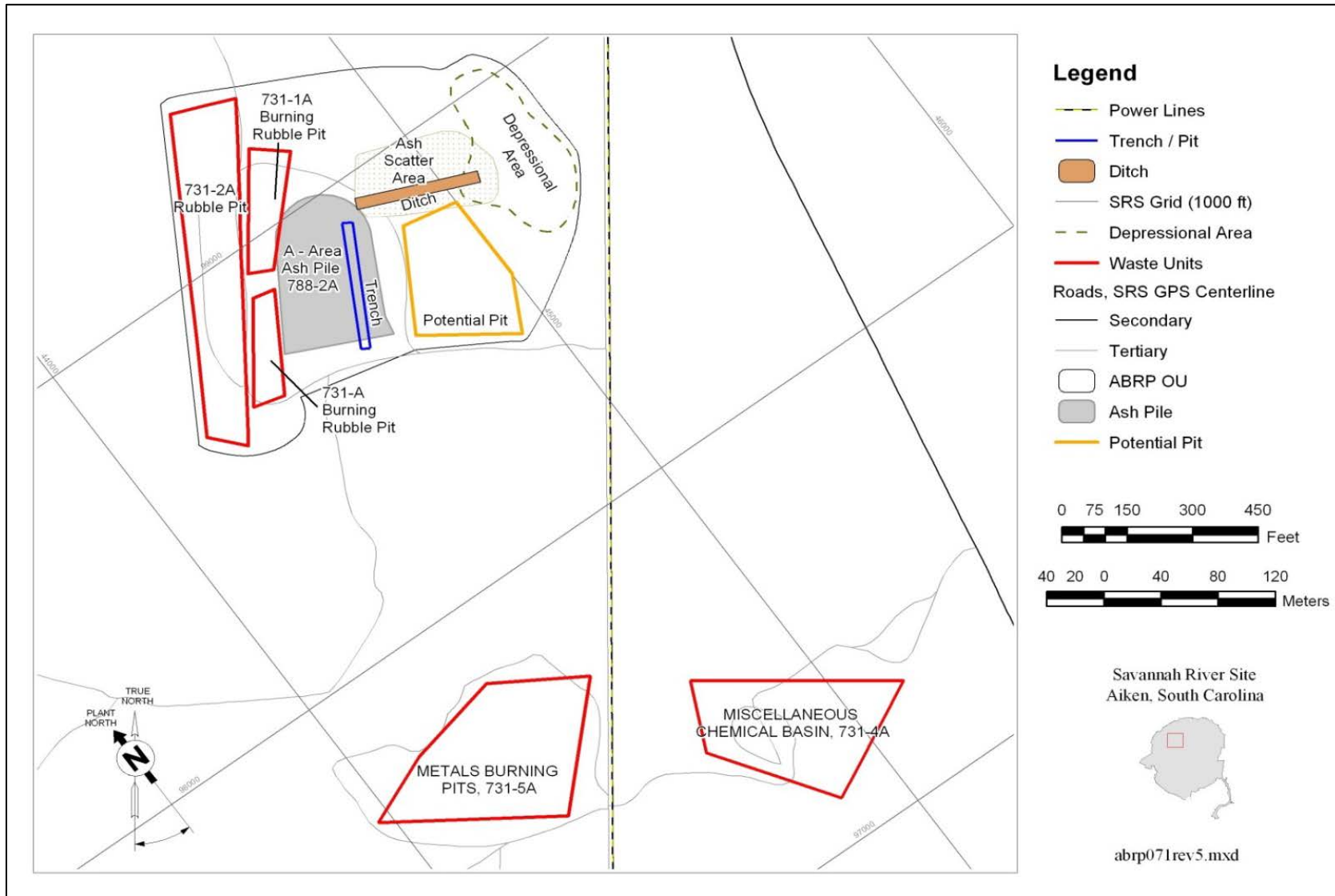


Figure C-2. ABRP/MCB/MBP OU Subunits Layout

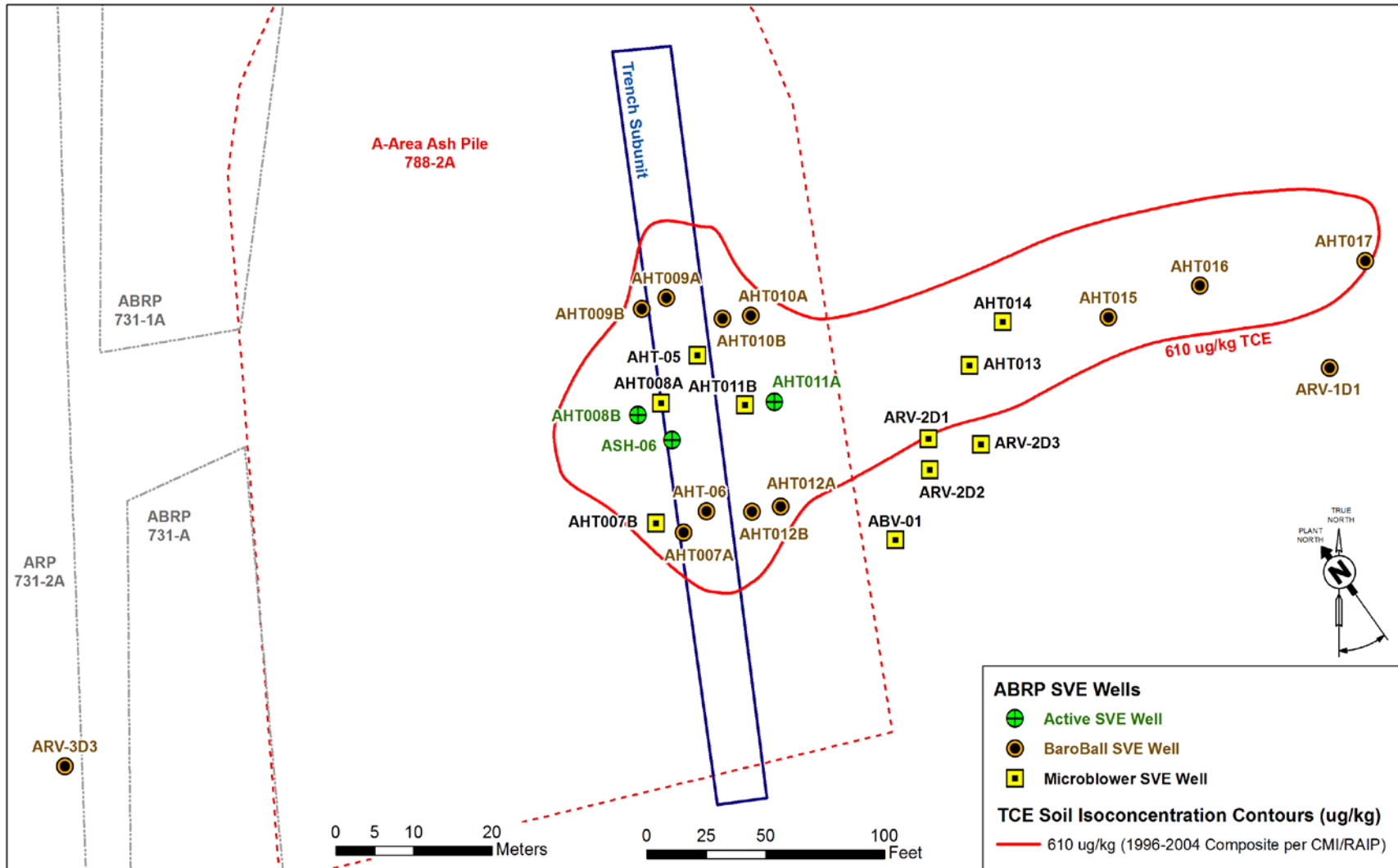


Figure C-3. ABRP Trench Subunit (current) SVE System



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~~After Halting 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)

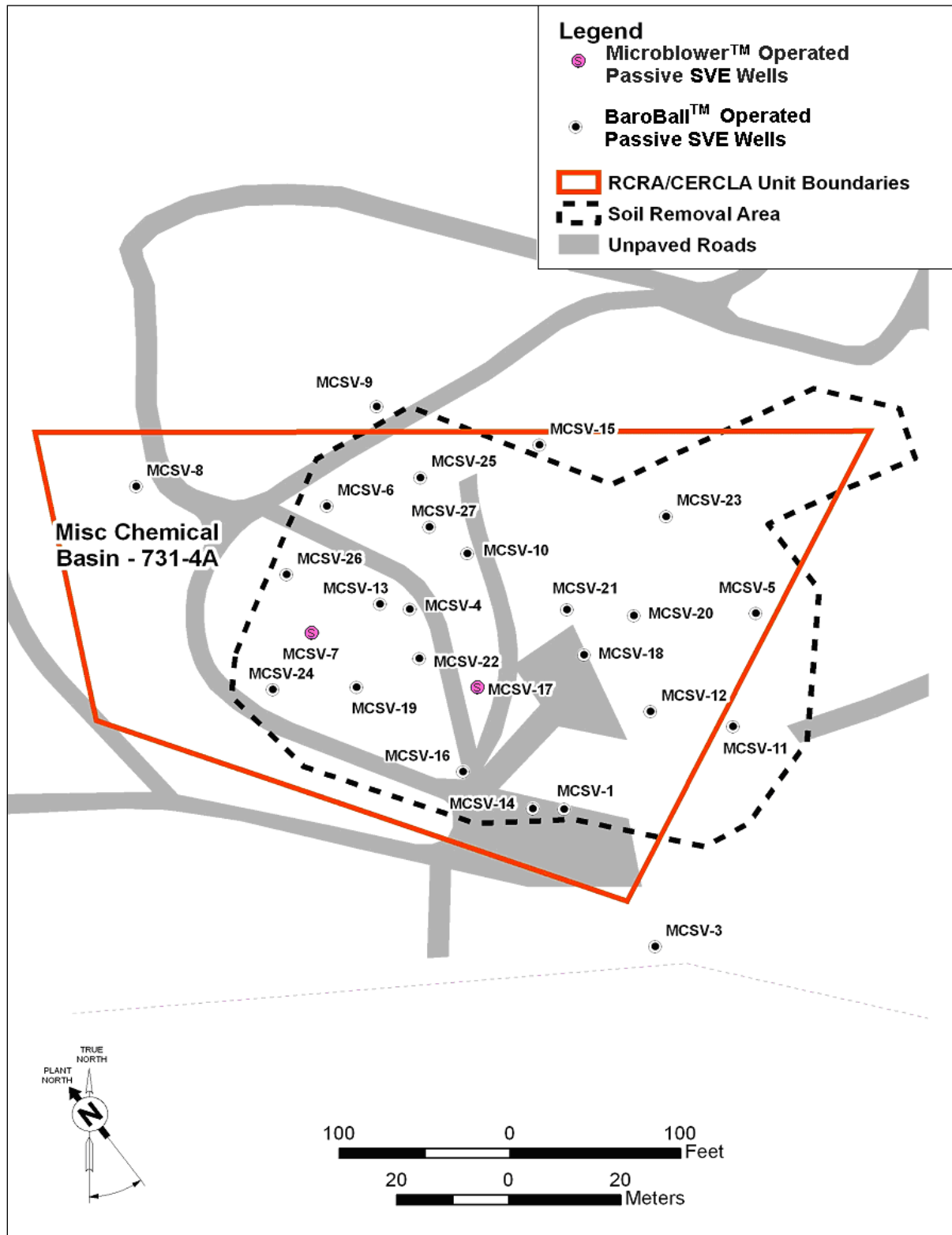


Figure C-10. MCB Subunit SVE System

**Table C-1. Chronology of OU Events**

<b>Event</b>	<b>Date</b>
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		
<b>MCB Vadose Zone</b>  <b>Remedial Action Objectives</b> <ul style="list-style-type: none"> <li>Prevent migration of TCE and PCE contamination in soil to groundwater at a concentration above its MCL</li> </ul>	TCE		X			344 µg/kg	Contaminant Migration Final RG – WSRC 1999
	PCE		X			344 µg/kg	Contaminant Migration Final RG – WSRC 1999
<b>ABRP Trench Subunit</b>  <b>Remedial Action Objectives</b> <ul style="list-style-type: none"> <li>Prevent migration of TCE contamination in soil to groundwater at a concentration above its MCL.</li> </ul>	TCE		X			610 µg/kg	Contaminant Migration
<b>A-Area Ash Pile Subunit</b>  <b>Remedial Action Objectives</b> <ul style="list-style-type: none"> <li>Prevent human exposure to COCs that present a risk to future industrial workers</li> <li>Prevent ecological exposure to COCs that present a hazard to ecological receptors</li> </ul>	Arsenic			X	X	9,753 µg/kg	Background <sup>1</sup>
	Selenium				X	15,280 µg/kg	Background <sup>1</sup>
	Potassium-40			X		1.60 pCi/g	Background <sup>1</sup>
	Radium-226			X		0.0255 pCi/g	HH-industrial
	Radium-228			X		1.83 pCi/g	Background <sup>1</sup>
	Thorium-228			X		1.69 pCi/g	Background <sup>1</sup>
	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

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:

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- 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™ 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 ~~implemented through the following activities:~~

- ~~• Removing the dissolved plume contaminants using a recovery well system connected to an air stripper, designated the M-1 Air Stripper (Figures D-2 and D-4). This system was designed to hydraulically contain and capture the high~~

~~concentration VOC plume. The original recovery well network (eleven wells) began operations 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. The recovery wells are screened predominantly in the Lost Lake Aquifer Unit, 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.~~

- ~~• Conducting an evaluation of off-gas treatment options for the air strippers.~~
- ~~• Monitoring of air stripper off-gas and treated water discharge, recovery well flow rates and concentrations, and groundwater concentrations in nearby monitoring wells to evaluate the effectiveness of the system.~~
- ~~• In addition, multiple remediation strategies and technologies have been implemented in response to discussion provided in the A/M Area Groundwater IROD, along with the collection of further characterization data.~~

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™.

~~In addition to the M-1 Air Stripper and recovery well system, other groundwater remediation activities were undertaken to reduce the dissolved contaminant mass and reduce the spread of the groundwater plume in other portions of A/M Area. The northern~~

~~portion of the VOC groundwater plume 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 shallow aquifer system, thereby preventing future downward migration into the deeper aquifer system. The A-2 Air Stripper began operations in 1996 and operated at a rate of approximately 1,135 L/min (300 gpm). The six recovery wells are screened in the Lost Lake Aquifer Zone and the Middle Sand Aquifer Zone of the Crouch Branch Confining Unit. Both the M-1 and A-2 Air Strippers currently comply with their air emissions permit without treatment.~~

~~As mass removal rates diminished 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.~~

~~In addition, two process water production wells (PW 20A and PW 53A) located in the deeper aquifer system are operated to provide mass removal and plume control.~~

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), ~~is~~ 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~~provide information on the amount of VOCs removed.~~
- 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).

A-1,4-dioxane contaminant plume was identified below the M Area Settling Basin and ABRP Subunit 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 \$13,235,807. RCRA documentation does not require estimated project costs to be prepared. Therefore, a cost comparison cannot be provided in this remedy review.

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**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.
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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

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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 Land Use Control Implementation Plan OU-specific LUCIP is not required for ~~this~~ the A/M Area Groundwater OU. As discussed in the RCRA Permit Renewal, ~~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 warning signs~~ 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.

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**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 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)

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-Area 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*

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Department of Health and Environmental Control, Office of Environmental Quality Control, Bureau of Land and Waste Management, Columbia, SC

SCDHEC, 2016a. Letter, D. Scaturro (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 Scaturro 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)*

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*Post-closure*, WSRC-IM-98-30, Volume III, Revision 1, Washington Savannah River  
Company, Savannah River Site, Aiken, SC

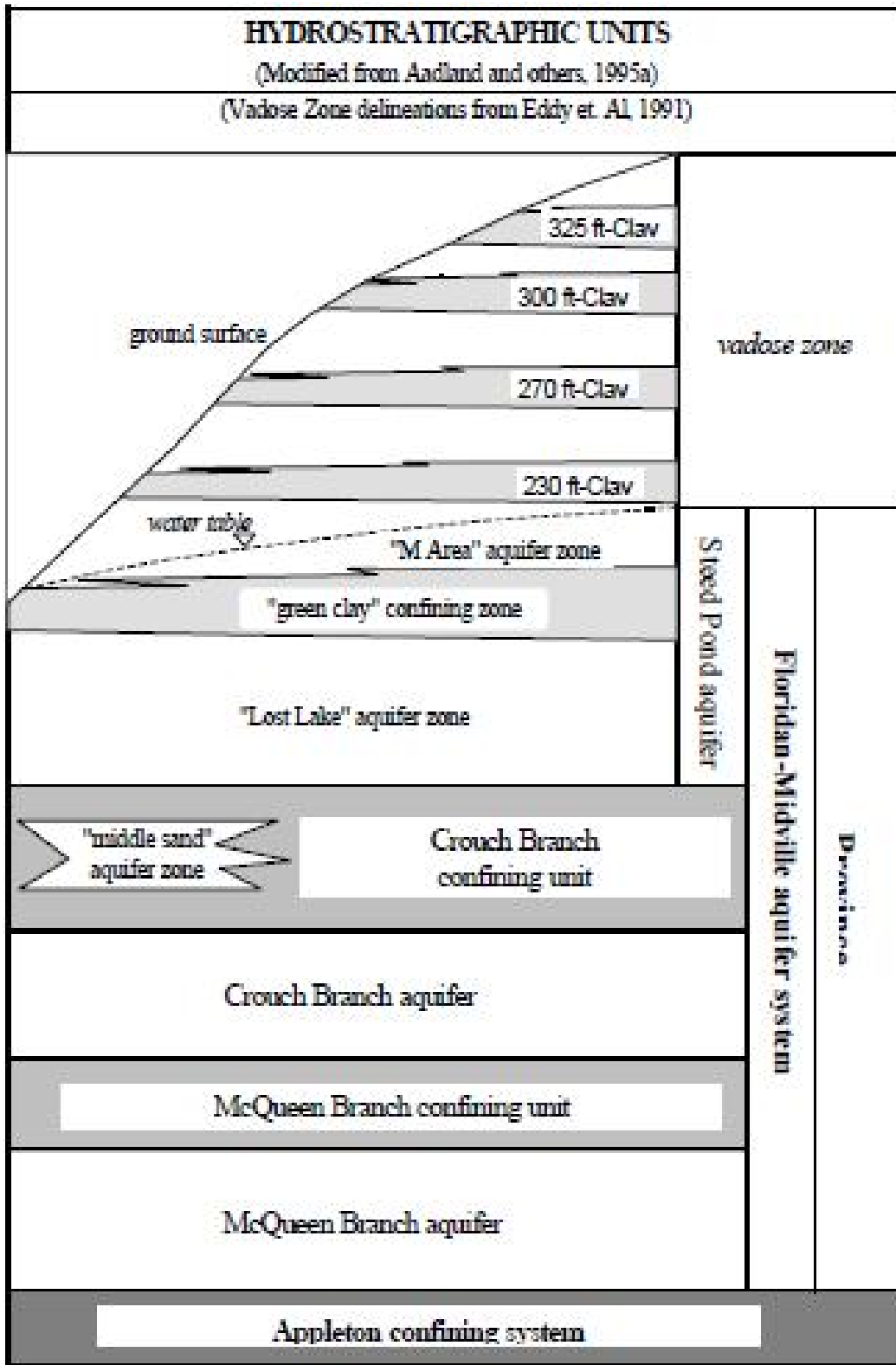


Figure D-3. A/M-Area Groundwater OU General Hydrostratigraphy



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

<b>III. ONSITE DOCUMENTS &amp; RECORDS VERIFIED (Continued)</b>			
<b>2. Health and Safety Plans (HASPs):</b>			
<input type="checkbox"/> Site-Specific Health and Safety Plans	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input type="checkbox"/> Contingency Plan/Emergency Response Plan	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks: <u>Routine O&amp;M activities do not require a SSHASP under 29 CFR 1910.120.HAZWOPER. A SSHASP is prepared if needed.</u>			
<b>3. O&amp;M and OSHA Training Records:</b>			
	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
Remarks: <u>Training Records are complete and up to date per ACP training matrix.</u>			
<b>4. Permits and Service Agreements:</b>			
<input checked="" type="checkbox"/> Air Discharge Permit	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
<input checked="" type="checkbox"/> Effluent Discharge	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
<input type="checkbox"/> Waste Disposal; POTW	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input checked="" type="checkbox"/> Other Permits	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
Remarks: <u>Underground injection control permits, RCRA Permit Renewal for SRS</u>			
<b>5. Gas Generation Records:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks: _____			
<b>6. Settlement Monument Records:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks: _____			
<b>7. Groundwater Monitoring Records:</b>			
	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
Remarks: _____			
<b>8. Leachate Extraction Records:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks: _____			
<b>9. Discharge Compliance Records:</b>			
<input checked="" type="checkbox"/> Air	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
<input checked="" type="checkbox"/> Water (Effluent)	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
Remarks: _____			
<b>10. Daily Access/Security Logs:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks: _____			

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

IV. O&M COSTS			
<b>1. O&amp;M Organization:</b>			
<input type="checkbox"/> State In-House	<input type="checkbox"/> Contractor for State		
<input type="checkbox"/> PRP In-House	<input type="checkbox"/> Contractor for PRP		
<input checked="" type="checkbox"/> Other: <u>SRS</u>			
<b>2. O&amp;M Cost Records:</b>			
<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input type="checkbox"/> Funding mechanism/agreement in place	
<input checked="" type="checkbox"/> Other: <u>Project cost data is summarized in Section IV of this OU-specific review</u>			
<b>Total annual cost by year for review period, if available</b>			
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
<b>3. Unanticipated or Unusually High O&amp;M Costs During Review Period</b>			
Describe costs and reasons: _____			
_____			
_____			
_____			
V. ACCESS AND INSTITUTIONAL CONTROLS <input checked="" type="checkbox"/> Applicable <input type="checkbox"/> N/A			
<b>A. Fencing</b>			
<b>1. Fencing Damage:</b> <input type="checkbox"/> Location shown on site map <input type="checkbox"/> Gates secured <input checked="" type="checkbox"/> N/A			
Remarks: <u>OU-specific perimeter fencing is not required by the interim remedial action.</u>			
_____			
<b>B. Signs</b>			
<b>1. Signs and Other Security Measures:</b> <input type="checkbox"/> Location shown on site map <input checked="" type="checkbox"/> N/A			
Remarks: <u>Signs are in good condition.</u>			
_____			

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

XI. OVERALL OBSERVATIONS	
<b>A. Implementation of the Remedy</b>	<p>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.).</p> <p>The remedies at the A/M Area Groundwater OU currently protects human health and the environment because <u>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.</u></p>
<b>B. Adequacy of O&amp;M</b>	<p>Describe issues and observations related to the implementation and scope of O&amp;M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.</p> <p><u>The O&amp;M procedures consisting of site inspections and site maintenance and site controls (SRS Site Use and Site Clearance Programs) have been implemented. O&amp;M programs are well established and functioning to ensure that the remedial systems remain in effective service and the condition of the warning signs is good.</u></p>
<b>C. Early Indicators of Potential Remedy Failure</b>	<p>Describe issues and observations such as unexpected changes in the cost or scope of O&amp;M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.</p> <p>N/A</p>
<b>D. Opportunities for Optimization</b>	<p>Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.</p> <p><u>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.</u></p>

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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 COCs ~~is~~ are arsenic and benzo[a]pyrene. ~~Both~~ This COCs ~~are~~ 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:

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### **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.

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## **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 ~~DE~~-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

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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:

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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, Savannah 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, Savannah 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, Savannah 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

**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**

Subunit	Refined COCs	Type of COC			RG (mg/kg)	Basis
		ARAR	HH	CM		
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
<u>Soil</u> RGs have likely been achieved and operation of the passive SVE system may no longer be needed for future protectiveness.	In accordance with the <i>Sampling and Analysis Plan for the A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit (U)</i> (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 <u>soil</u> 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													
<b>Site Name:</b>	<b>A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit</b>	<b>Date of Inspection:</b>	<b>08/9/2017</b>										
<b>Location and Region</b>	<b>SRS, USEPA Region 4</b>	<b>EPA ID:</b>	<b>CERCLIS #4830</b>										
<b>Agency, Office, or Company leading the Five-Year Review</b>	<b>USDOE</b>	<b>Weather/ Temperature</b>	<b>80°F and Cloudy</b>										
<b>Remedy Includes:</b> (Click all that apply) <table style="width: 100%; border: none;"> <tr> <td><input checked="" type="checkbox"/> Landfill Cover / Containment</td> <td><input type="checkbox"/> Surface Water Pump and Treatment</td> </tr> <tr> <td><input checked="" type="checkbox"/> Access Controls</td> <td><input type="checkbox"/> Monitored Natural Attenuation</td> </tr> <tr> <td><input checked="" type="checkbox"/> Institutional Controls</td> <td><input type="checkbox"/> Groundwater Containment</td> </tr> <tr> <td><input type="checkbox"/> Groundwater Pump and Treatment</td> <td><input type="checkbox"/> Vertical Barriers</td> </tr> <tr> <td colspan="2"><input checked="" type="checkbox"/> Other <u>Excavation, Soil Vapor Extraction</u></td> </tr> </table>				<input checked="" type="checkbox"/> Landfill Cover / Containment	<input type="checkbox"/> Surface Water Pump and Treatment	<input checked="" type="checkbox"/> Access Controls	<input type="checkbox"/> Monitored Natural Attenuation	<input checked="" type="checkbox"/> Institutional Controls	<input type="checkbox"/> Groundwater Containment	<input type="checkbox"/> Groundwater Pump and Treatment	<input type="checkbox"/> Vertical Barriers	<input checked="" type="checkbox"/> Other <u>Excavation, Soil Vapor Extraction</u>	
<input checked="" type="checkbox"/> Landfill Cover / Containment	<input type="checkbox"/> Surface Water Pump and Treatment												
<input checked="" type="checkbox"/> Access Controls	<input type="checkbox"/> Monitored Natural Attenuation												
<input checked="" type="checkbox"/> Institutional Controls	<input type="checkbox"/> Groundwater Containment												
<input type="checkbox"/> Groundwater Pump and Treatment	<input type="checkbox"/> Vertical Barriers												
<input checked="" type="checkbox"/> Other <u>Excavation, Soil Vapor Extraction</u>													
<b>Attachments:</b> <input type="checkbox"/> Inspection team roster attached <input type="checkbox"/> Inspection team roster attached													
II. INTERVIEWS (Click all that apply)													
<b>1. O&amp;M Site Manager:</b> <u>George Joyner</u> <u>Post Closure Manager</u> <u>10/12/2017</u> (Name)    (Title)    (Date)													
<b>Interviewed:</b> <input type="checkbox"/> At Site <input checked="" type="checkbox"/> At Office <input type="checkbox"/> By Phone    Phone No.: <u>803-952-3324</u>													
<b>Problems/Suggestions:</b> <input type="checkbox"/> Report Attached    _____													
<hr/>													
<b>2. O &amp; M Staff</b> <u>Richard Feagin</u> <u>EC&amp;ACP Post-Closure Waste Site</u> (Name)    (Title) <u>Inspector/Maintenance Coord.</u> <u>10/11/2017</u> (Date)													
<b>Interviewed:</b> <input type="checkbox"/> At Site <input checked="" type="checkbox"/> At Office <input type="checkbox"/> By Phone    Phone No. <u>952-4416</u>													
<b>Problems, suggestions:</b> <input type="checkbox"/> Report Attached    _____													

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

II. INTERVIEWS ( <i>Click all that apply</i> )( <i>Continued</i> )			
<b>2. Local Regulatory Authorities and Response Agencies</b> (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: <input type="checkbox"/> Report Attached	_____		
_____			
Agency: _____			
Contact: _____	_____		
(Name)	(Title)		
_____	_____		
(Date)	(Phone No.)		
Problems/Suggestions: <input type="checkbox"/> Report Attached	_____		
_____			
Agency: _____			
Contact: _____	_____		
(Name)	(Title)		
_____	_____		
(Date)	(Phone No.)		
Problems/Suggestions: <input type="checkbox"/> Report Attached	_____		
_____			
<b>3. Other Interviews (<i>Optional</i>):</b> <input type="checkbox"/> Report Attached _____			
_____			
_____			
_____			
III. ONSITE DOCUMENTS & RECORDS VERIFIED ( <i>Click all that apply</i> )			
<b>1. O&amp;M Documents:</b>			
<input type="checkbox"/> O&M Manual	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
<input checked="" type="checkbox"/> As-Built Drawings	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
<input type="checkbox"/> Maintenance Logs	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
Remarks: <u>See Waste Unit Inspection and Maintenance, ER-SOP-019 and Field Inspection Checklist for A-Area Miscellaneous Rubble Pile OU, ER-IDS-019-029</u>			
_____			
_____			

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

<b>III. ONSITE DOCUMENTS &amp; RECORDS VERIFIED (Continued)</b>			
<b>2. Health and Safety Plans (HASPs):</b>			
<input type="checkbox"/> Site-Specific Health and Safety Plans	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input type="checkbox"/> Contingency Plan/Emergency Response Plan	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks: Routine O&M activities do not require an SSHASP under 29 CFR 1910.120, HAZWOPER. An SSHASP is prepared if needed.			
<b>3. O&amp;M and OSHA Training Records:</b>			
	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
Remarks: Training Records are complete and up to date per ACP training matrix			
<b>4. Permits and Service Agreements:</b>			
<input checked="" type="checkbox"/> Air Discharge Permit	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
<input type="checkbox"/> Effluent Discharge	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input type="checkbox"/> Waste Disposal; POTW	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input type="checkbox"/> Other Permits	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks:			
<b>5. Gas Generation Records:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks:			
<b>6. Settlement Monument Records:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks:			
<b>7. Groundwater Monitoring Records:</b>			
	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
Remarks:			
<b>8. Leachate Extraction Records:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks:			
<b>9. Discharge Compliance Records:</b>			
<input checked="" type="checkbox"/> Air	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
<input type="checkbox"/> Water (Effluent)	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks:			
<b>10. Daily Access/Security Logs:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks:			

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

IV. O&M COSTS			
<b>1. O&amp;M Organization:</b>			
<input type="checkbox"/> State In-House	<input type="checkbox"/> Contractor for State		
<input type="checkbox"/> PRP In-House	<input type="checkbox"/> Contractor for PRP		
<input checked="" type="checkbox"/> Other: <u>SRS</u>			
<b>2. O&amp;M Cost Records:</b>			
<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input type="checkbox"/> Funding mechanism/agreement in place	
<input checked="" type="checkbox"/> Other: <u>Project cost data is summarized in Section IV of this OU-specific review</u>			
<b>Total annual cost by year for review period, if available</b>			
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
<b>3. Unanticipated or Unusually High O&amp;M Costs During Review Period</b>			
Describe costs and reasons: _____			
_____			
_____			
_____			
V. ACCESS AND INSTITUTIONAL CONTROLS <input checked="" type="checkbox"/> Applicable <input type="checkbox"/> N/A			
<b>A. Fencing</b>			
<b>1. Fencing Damage:</b> <input type="checkbox"/> Location shown on site map <input type="checkbox"/> Gates secured <input checked="" type="checkbox"/> N/A			
Remarks: <u>OU-specific fencing is not required by the remedial action.</u>			
_____			
<b>B. Signs</b>			
<b>1. Signs and Other Security Measures:</b> <input type="checkbox"/> Location shown on site map <input type="checkbox"/> N/A			
Remarks: <u>Signs are in good condition.</u>			
_____			

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

V. ACCESS AND INSTITUTIONAL CONTROLS (Continued)									
<b>C. Institutional Controls</b>									
<b>1. Implementation and Enforcement</b>									
Site conditions imply ICs are not properly implemented:	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A								
Site conditions imply ICs are not being fully enforced:	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A								
Type of monitoring (e.g., self-reporting, drive-by, etc.) <u>Walkdown</u>									
Frequency: <u>Once in 5 years</u>									
Responsible Party/Agent: <u>USDOE Savannah River Field Office</u>									
Contact:	<table style="width: 100%; border: none;"> <tr> <td style="text-align: center; width: 30%;"><u>Karen Adams</u></td> <td style="text-align: center; width: 30%;"><u>Federal Project Director</u></td> <td style="text-align: center; width: 15%;"><u>12/15/17</u></td> <td style="text-align: center; width: 25%;"><u>803-952-7871</u></td> </tr> <tr> <td style="text-align: center; font-size: small;">(Name)</td> <td style="text-align: center; font-size: small;">(Title)</td> <td style="text-align: center; font-size: small;">(Date)</td> <td style="text-align: center; font-size: small;">(Phone No.)</td> </tr> </table>	<u>Karen Adams</u>	<u>Federal Project Director</u>	<u>12/15/17</u>	<u>803-952-7871</u>	(Name)	(Title)	(Date)	(Phone No.)
<u>Karen Adams</u>	<u>Federal Project Director</u>	<u>12/15/17</u>	<u>803-952-7871</u>						
(Name)	(Title)	(Date)	(Phone No.)						
Reporting is up-to-date:	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A								
Reports are verified by the lead agency:	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A								
Specific requirements in deed or decision documents have been met:	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A								
Violations have been reported:	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> N/A								
Problems/Suggestions: <input type="checkbox"/> Report Attached									
<hr/> <hr/>									
<b>2. Adequacy:</b>	<input checked="" type="checkbox"/> ICs are adequate <input type="checkbox"/> ICs are inadequate <input type="checkbox"/> N/A								
Remarks: <u>Survey markers were located and are in good condition.</u>									
<hr/> <hr/>									
<b>D. General</b>									
<b>1. Vandalism/Trespassing:</b>	<input type="checkbox"/> Location shown on site map <input checked="" type="checkbox"/> No vandalism is evident								
Remarks: _____									
<hr/> <hr/>									
<b>2. Land use changes onsite:</b>	<input checked="" type="checkbox"/> N/A								
Remarks: _____									
<hr/> <hr/>									
<b>3. Land use changes offsite:</b>	<input checked="" type="checkbox"/> N/A								
Remarks: _____									
<hr/> <hr/>									

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

VI. GENERAL SITE CONDITIONS	
<b>A. Roads</b>	<input checked="" type="checkbox"/> Applicable <input type="checkbox"/> N/A
<b>1. Roads damaged:</b>	<input type="checkbox"/> Location shown on site map <input checked="" type="checkbox"/> Roads adequate <input type="checkbox"/> N/A
Remarks: _____ _____	
<b>B. Other Site Conditions</b>	
Remarks: <u>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 findings were resolved soon after discovery.</u> _____ _____	
VII. LANDFILL COVER /CONTAINMENT <input checked="" type="checkbox"/> Applicable <input type="checkbox"/> N/A	
<b>A. Landfill Surface</b>	
<b>1. Settlement (Low spots):</b>	<input type="checkbox"/> Location shown on site map <input checked="" type="checkbox"/> Settlement not evident
Areal extent _____      Depth _____	
Remarks: _____ _____	
<b>2. Cracks:</b>	<input type="checkbox"/> Location shown on site map <input checked="" type="checkbox"/> Cracking not evident
Lengths _____      Widths _____      Depths _____	
Remarks: _____ _____	
<b>3. Erosion:</b>	<input type="checkbox"/> Location shown on site map <input checked="" type="checkbox"/> Erosion not evident
Areal extent _____      Depth _____	
Remarks: _____ _____	
<b>4. Holes:</b>	<input type="checkbox"/> Location shown on site map <input checked="" type="checkbox"/> Holes not evident
Areal extent _____      Depth _____	
Remarks: _____ _____	
<b>5. Vegetative Cover:</b>	<input checked="" type="checkbox"/> Grass <input checked="" type="checkbox"/> Cover properly established <input type="checkbox"/> No signs of stress
Areal extent _____      Depth _____	
Remarks: <u>Vegetative cover is mowed routinely</u> _____	

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

VII. LANDFILL COVER/CONTAINMENT (Continued)		
<b>6. Alternative Cover (armored rock, concrete, etc.):</b> <input checked="" type="checkbox"/> N/A Remarks: _____ _____		
<b>7. Bulges:</b> <input type="checkbox"/> Location shown on site map <input checked="" type="checkbox"/> Bulges not evident Areal extent _____                      Depth _____ Remarks: _____ _____		
<b>8. Wet Areas / Water Damage:</b> <input checked="" type="checkbox"/> Wet areas/water damage not evident <input type="checkbox"/> Wet areas <input type="checkbox"/> Location shown on site map                      Areal extent _____ <input type="checkbox"/> Ponding <input type="checkbox"/> Location shown on site map                      Areal extent _____ <input type="checkbox"/> Seeps <input type="checkbox"/> Location shown on site map                      Areal extent _____ <input type="checkbox"/> Soft subgrade <input type="checkbox"/> Location shown on site map                      Areal extent _____ Remarks: _____ _____		
<b>9. Slope Instability:</b> <input type="checkbox"/> Slides <input type="checkbox"/> Location shown on site map <input checked="" type="checkbox"/> No evidence of slope instability Areal extent _____ Remarks: _____ _____		
<b>B. Benches</b> <input type="checkbox"/> Applicable <input checked="" type="checkbox"/> 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)		
<b>C. Letdown Channels</b> <input type="checkbox"/> Applicable <input checked="" type="checkbox"/> 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 DE-1. Five-Year Review Site Inspection Checklist – A-Area Miscellaneous Rubble Pile (731-6A) Operable Unit (continued)**

VII. LANDFILL COVER / CONTAINMENT (Continued)			
<b>D. Cover Penetrations</b>		<input checked="" type="checkbox"/> Applicable	<input type="checkbox"/> N/A
<b>1. Gas Vents:</b>	<input checked="" type="checkbox"/> Active	<input checked="" type="checkbox"/> Passive	
<input checked="" type="checkbox"/> Properly secured/locked	<input checked="" type="checkbox"/> Functioning	<input checked="" type="checkbox"/> Routinely sampled	<input checked="" type="checkbox"/> Good Condition
<input type="checkbox"/> Evidence of leakage at penetration		<input type="checkbox"/> Needs maintenance	<input type="checkbox"/> N/A
Remarks: <u>SVE wells</u>			
<hr/>			
<b>2. Gas Monitoring Probes:</b>	<input checked="" type="checkbox"/> Properly secured/locked	<input checked="" type="checkbox"/> Functioning	<input checked="" type="checkbox"/> Routinely sampled
<input checked="" type="checkbox"/> Properly secured/locked	<input checked="" type="checkbox"/> Functioning	<input checked="" type="checkbox"/> Routinely sampled	<input checked="" type="checkbox"/> Good Condition
<input type="checkbox"/> Evidence of leakage at penetration		<input type="checkbox"/> Needs maintenance	<input type="checkbox"/> N/A
Remarks: <u>Monitoring wells</u>			
<hr/>			
<b>3. Monitoring Wells:</b>	<input type="checkbox"/> Properly secured/locked	<input type="checkbox"/> Functioning	<input type="checkbox"/> Routinely sampled
<input type="checkbox"/> Properly secured/locked	<input type="checkbox"/> Functioning	<input type="checkbox"/> Routinely sampled	<input type="checkbox"/> Good Condition
<input type="checkbox"/> Evidence of leakage at penetration		<input type="checkbox"/> Needs maintenance	<input checked="" type="checkbox"/> N/A
Remarks: _____			
<hr/>			
<b>4. Leachate Extraction Wells:</b>	<input type="checkbox"/> Properly secured/locked	<input type="checkbox"/> Functioning	<input type="checkbox"/> Routinely sampled
<input type="checkbox"/> Properly secured/locked	<input type="checkbox"/> Functioning	<input type="checkbox"/> Routinely sampled	<input type="checkbox"/> Good Condition
<input type="checkbox"/> Evidence of leakage at penetration		<input type="checkbox"/> Needs maintenance	<input checked="" type="checkbox"/> N/A
Remarks: _____			
<hr/>			
<b>5. Settlement Monuments:</b>	<input type="checkbox"/> Located	<input type="checkbox"/> Routinely Surveyed	<input checked="" type="checkbox"/> N/A
Remarks: _____			
<hr/>			
<b>E. Gas Collection and Treatment</b>		<input type="checkbox"/> Applicable	<input checked="" type="checkbox"/> N/A
<b>F. Cover Drainage Layer</b>		<input type="checkbox"/> Applicable	<input checked="" type="checkbox"/> N/A
<b>G. Detention/Sedimentation Ponds</b>		<input type="checkbox"/> Applicable	<input checked="" type="checkbox"/> N/A
<b>H. Retaining Walls</b>		<input type="checkbox"/> Applicable	<input checked="" type="checkbox"/> N/A
<b>I. Perimeter Ditches/Offsite Discharge</b>		<input type="checkbox"/> Applicable	<input checked="" type="checkbox"/> N/A

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

<b>VIII. VERTICAL BARRIER WALLS</b>	<input type="checkbox"/> Applicable	<input checked="" type="checkbox"/> N/A
<b>IX. GROUNDWATER/SURFACE WATER REMEDIES</b>	<input type="checkbox"/> Applicable	<input checked="" type="checkbox"/> N/A
<b>X. OTHER REMEDIES</b>		
<p>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.</p>		
<b>A. Soil Vapor Extraction System</b>	<input checked="" type="checkbox"/> Applicable	<input type="checkbox"/> N/A
<p><b>1. Blowers, Wellhead Plumbing, and Electrical:</b></p> <p><input checked="" type="checkbox"/> Good Condition    <input checked="" type="checkbox"/> All required wells located    <input type="checkbox"/> Needs maintenance    <input type="checkbox"/> N/A</p> <p>Remarks: <u>SVE system is in service</u></p> <p>_____</p> <p>_____</p>		
<p><b>2. Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances:</b></p> <p><input checked="" type="checkbox"/> Good Condition    <input type="checkbox"/> Needs maintenance</p> <p>Remarks: _____</p> <p>_____</p>		
<p><b>3. Spare Parts and Equipment:</b></p> <p><input checked="" type="checkbox"/> Readily Available    <input checked="" type="checkbox"/> Good Condition    <input type="checkbox"/> Requires Upgrade    <input type="checkbox"/> Needs to be provided</p> <p>Remarks: _____</p> <p>_____</p>		

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

<b>XI. OVERALL OBSERVATIONS</b>	
<b>A. Implementation of the Remedy</b>	<p>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.).</p> <p><u>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.</u></p>
<b>B. Adequacy of O&amp;M</b>	<p>Describe issues and observations related to the implementation and scope of O&amp;M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.</p> <p><u>The O&amp;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&amp;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.</u></p>
<b>C. Early Indicators of Potential Remedy Failure</b>	<p>Describe issues and observations such as unexpected changes in the cost or scope of O&amp;M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.</p> <p>N/A</p>
<b>D. Opportunities for Optimization</b>	<p>Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.</p> <p><u>Recommendations are provided in the OU-specific review report (Table E-4).</u></p>

**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.

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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 to 12 ft). It had a volume of approximately 2,477 m<sup>3</sup> (3,240 yd<sup>3</sup>).
  - 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-34 and F-45 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 seepines 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 through 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.
-

- 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™ SVE ~~system~~ 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™ 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.

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integrity of the cover system. The annual inspection reports indicate no significant deficiencies.

- The MicroBlower™ system and cover system have been effective in preventing the migration of VOCs to the groundwater and surface water above MCLs. The MicroBlower™ 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.

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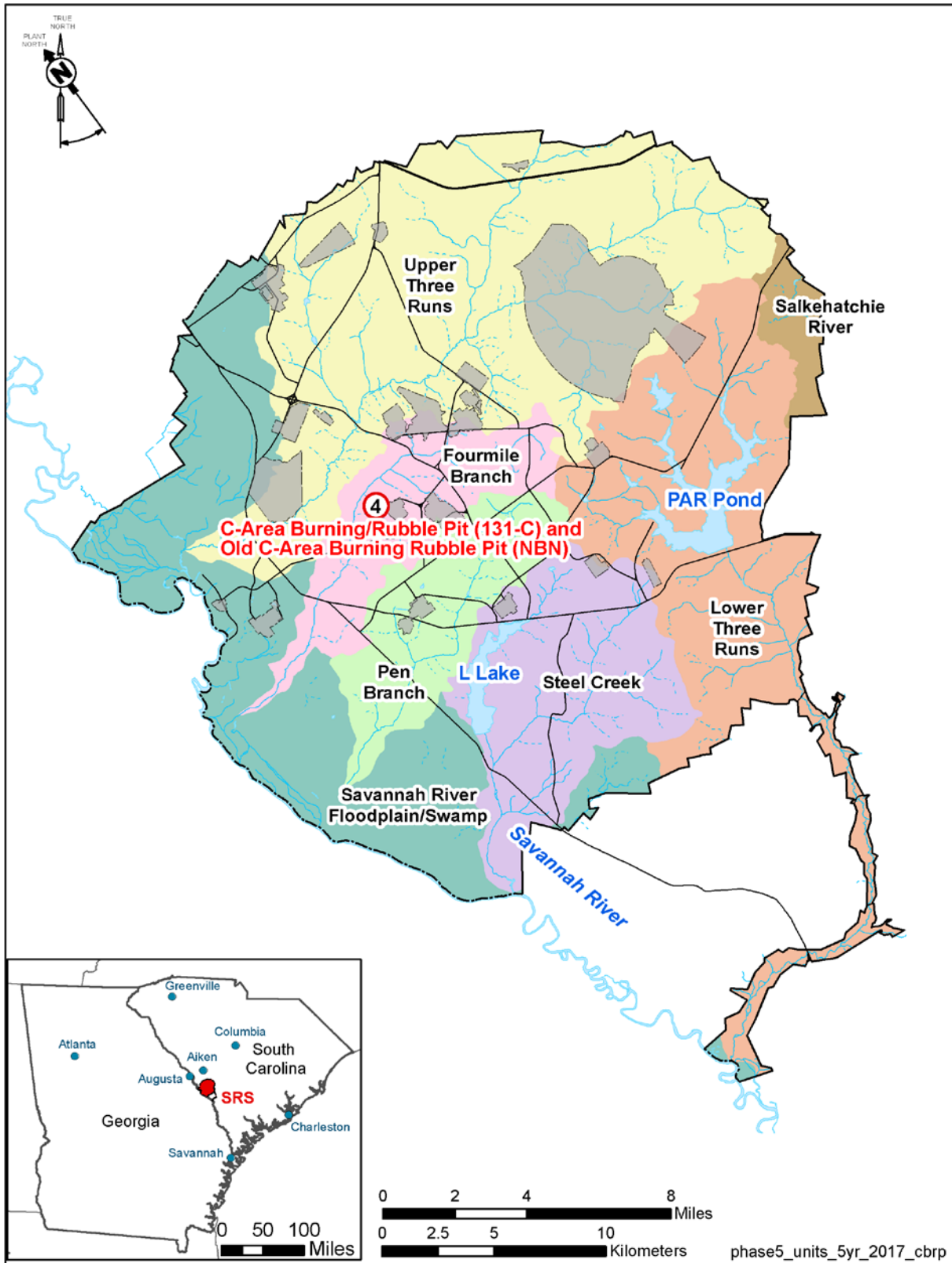
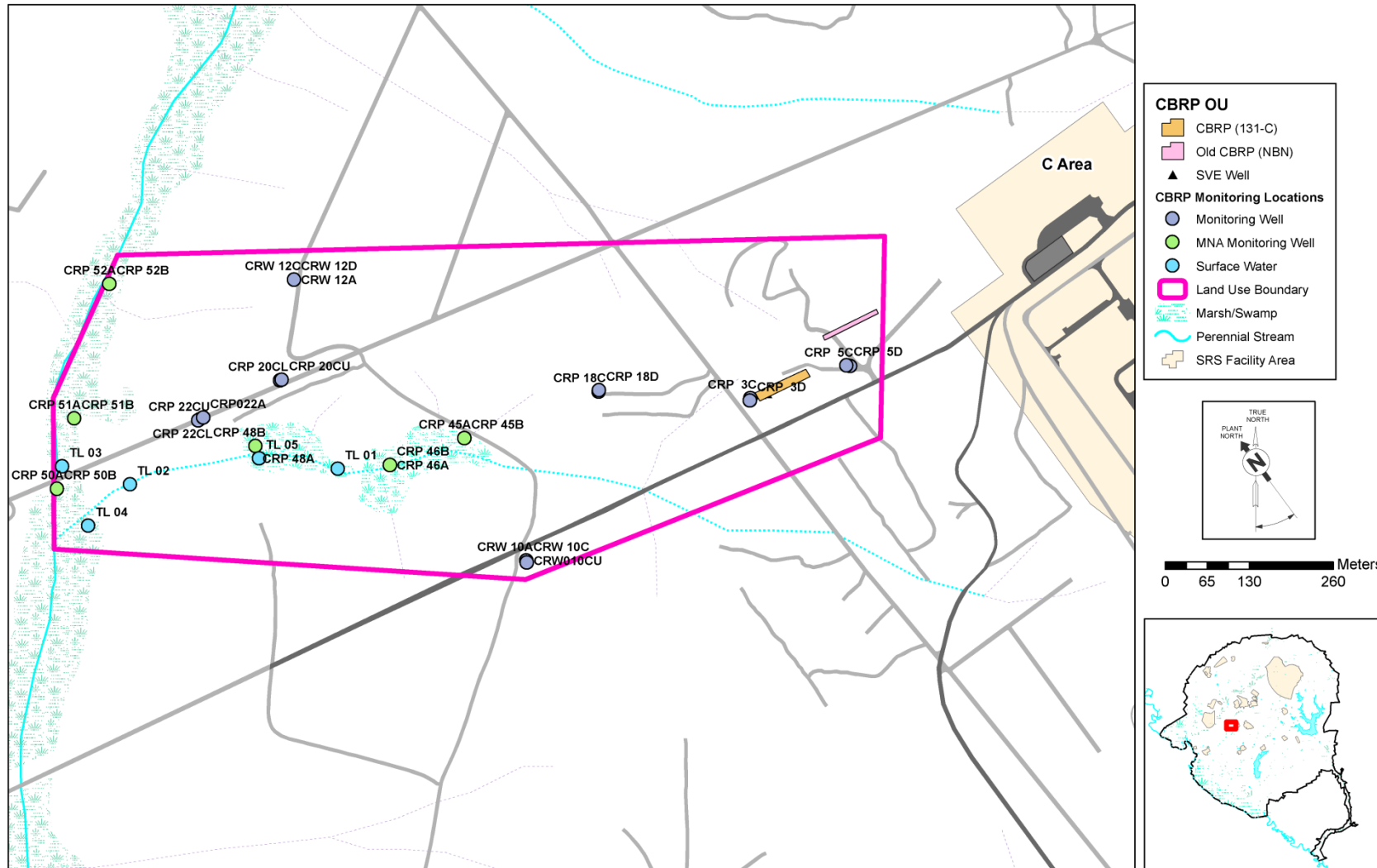
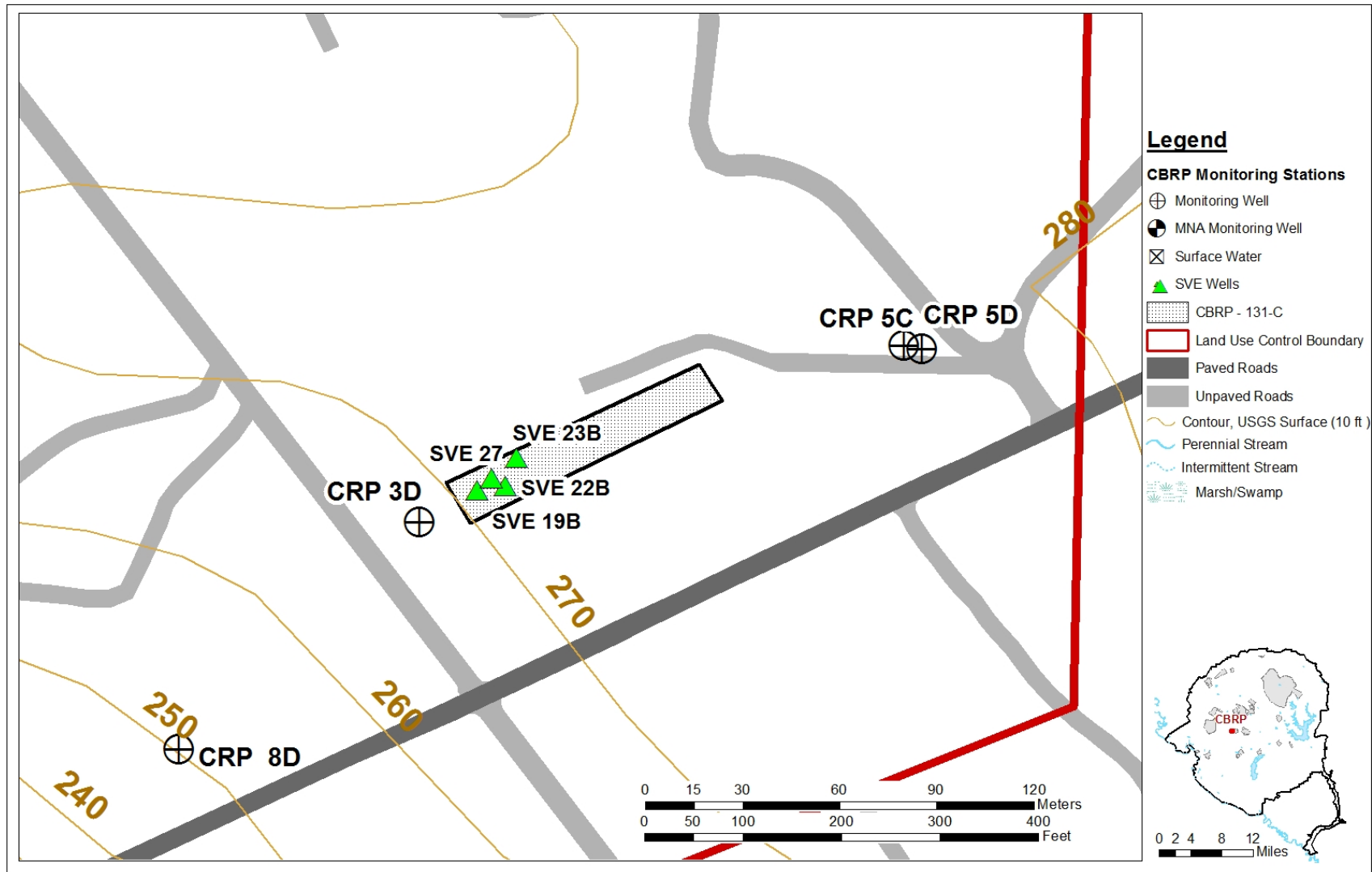


Figure F-1. Location of C-Area Burning/Rubble Pit Operable Unit (131-C) at SRS



**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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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. ~~administrative controls that maintain this site for industrial use only (SRS is a secured government facility with land use restrictions), and warning signs and LUCs (SRS Site Use/Site Clearance Program). The Early Action Land Use Control Implementation Plan for DAOU governs LUC implementation, maintenance, monitoring, reporting, and enforcement (SRNS 2011b).~~ 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.

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## **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

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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

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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)

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**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 <u>and operation of the SVE system may no longer be needed for future protectiveness if the soil RG has been achieved.</u>	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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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

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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 seep lines 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, ~~r~~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, ~~r~~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, ~~r~~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, rReduce 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, rReduce 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 barrier depth is approximately 20 m (65 ft) and 0.75 m (2.5 ft) thick. 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, ~~and will continue to monitor and observe the effects of treatment.~~
- ~~Awarded approval on submission of Revision 2 to the 2000 RCRA Permit Renewal Application, Volume IV, that a~~ 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

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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 seepage 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 seepages. Table H-5 provides a summary of constituents from the seepage 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 seepage 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. 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 seep lines 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 seepage line. However, aluminum, barium, and mercury are potential threats to wildlife in Fourmile Branch in the area impacted by F-Area operations. 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

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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 ~~warning signs 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.

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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), ~~and information devices such as warning signs~~. Protectiveness of the remedial action will be verified by continued groundwater monitoring.

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## **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*

**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 <sup>1</sup>	Maximum Concentration (µg/L) [# of samples]			
			2 <sup>nd</sup> Remedy Review (1997-2001)	3 <sup>rd</sup> Remedy Review (2002–2006)	4 <sup>th</sup> Remedy Review (2007–2011)	5 <sup>th</sup> 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] <sup>3</sup>
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] <sup>2</sup>	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] <sup>4</sup>

<sup>1</sup> The more conservative of the MCL or GWPS was used for comparison.

<sup>2</sup> Of the 11 records, 7 were non-detects and 4 were estimated values.

<sup>3</sup> All other records were below the MCL.

<sup>4</sup> 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 5<sup>th</sup> 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 Seepine Groundwater Detected Above Standards**

Constituent	Unit	GWPS or MCL <sup>1</sup>	Maximum Concentration (µg/L) [# of samples]			
			2 <sup>nd</sup> Remedy Review (1997-2001)	3 <sup>rd</sup> Remedy Review (2002-2006)	4 <sup>th</sup> Remedy Review (2007-2011)	5 <sup>th</sup> 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.

<sup>1</sup> 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 <sup>1</sup> (µg/L)	MCL <sup>2</sup> (µg/L)
Arsenic	50	10

<sup>1</sup> GWPS as set forth in the SRS RCRA Permit Renewal (SCDHEC 2017)

<sup>2</sup> EPA MCLs

**Attachment H-1. Five-Year Review Site Inspection Checklist – F-Area Groundwater Operable Unit (continued)**

<b>III. ONSITE DOCUMENTS &amp; RECORDS VERIFIED (Continued)</b>			
<b>2. Health and Safety Plans (HASPs):</b>			
<input type="checkbox"/> Site-Specific Health and Safety Plans	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input type="checkbox"/> Contingency Plan/Emergency Response Plan	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.120.HAZWOPER. A SSHASP is prepared if needed.			
<b>3. O&amp;M and OSHA Training Records:</b>			
	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
Remarks: Training Records are complete and up to date per ACP training matrix			
<b>4. Permits and Service Agreements:</b>			
<input type="checkbox"/> Air Discharge Permit	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input type="checkbox"/> Effluent Discharge	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input type="checkbox"/> Waste Disposal; POTW	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input checked="" type="checkbox"/> Other Permits	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
Remarks: RCRA Permit Renewal for SRS, Underground Injection Control Permits			
<b>5. Gas Generation Records:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks:			
<b>6. Settlement Monument Records:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks:			
<b>7. Groundwater Monitoring Records:</b>			
	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
Remarks:			
<b>8. Leachate Extraction Records:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks:			
<b>9. Discharge Compliance Records:</b>			
<input type="checkbox"/> Air	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input type="checkbox"/> Water (Effluent)	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks:			
<b>10. Daily Access/Security Logs:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks:			

**Attachment H-1. Five-Year Review Site Inspection Checklist – F-Area Groundwater Operable Unit (continued)**

IV. O&M COSTS			
<b>1. O&amp;M Organization:</b>			
<input type="checkbox"/> State In-House	<input type="checkbox"/> Contractor for State		
<input type="checkbox"/> PRP In-House	<input type="checkbox"/> Contractor for PRP		
<input checked="" type="checkbox"/> Other: <u>SRS</u>			
<b>2. O&amp;M Cost Records:</b>			
<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input type="checkbox"/> Funding mechanism/agreement in place	
<input checked="" type="checkbox"/> Other: <u>Project cost data is summarized in Section IV of this OU-specific review.</u>			
<b>Total annual cost by year for review period, if available</b>			
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
<b>3. Unanticipated or Unusually High O&amp;M Costs During Review Period</b>			
Describe costs and reasons: _____			
_____			
_____			
_____			
V. ACCESS AND INSTITUTIONAL CONTROLS <input checked="" type="checkbox"/> Applicable <input type="checkbox"/> N/A			
<b>A. Fencing</b>			
<b>1. Fencing Damage:</b> <input type="checkbox"/> Location shown on site map <input type="checkbox"/> Gates secured <input checked="" type="checkbox"/> N/A			
Remarks: <u>OU-specific perimeter fencing is not required by the remedial action.</u>			
_____			
<b>B. Fencing</b>			
<b>1. Signs and Other Security Measures:</b> <input type="checkbox"/> Location shown on site map <input checked="" type="checkbox"/> N/A			
Remarks: <u>Signs are in good condition.</u>			
_____			

- 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

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948 m (3,160 ft) ~~of low permeability wall.~~ 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 seepines.

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 seepine. 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

address the potential ecological impacts at the seep lines 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).

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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 ~~warning signs 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

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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 ~~warning signs 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

**Attachment I-1. Five-Year Review Site Inspection Checklist – H-Area Groundwater Operable Unit (continued)**

<b>III. ONSITE DOCUMENTS &amp; RECORDS VERIFIED (Continued)</b>			
<b>2. Health and Safety Plans (HASPs):</b>			
<input type="checkbox"/> Site-Specific Health and Safety Plans	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input type="checkbox"/> Contingency Plan/Emergency Response Plan	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks: <u>Routine O&amp;M activities do not require a SSHASP under 29 CFR 1910.120 HAZWOPER. A SSHASP is prepared if needed.</u>			
<b>3. O&amp;M and OSHA Training Records:</b>			
	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
Remarks: <u>Training Records are complete and up to date per ACP training matrix.</u>			
<b>4. Permits and Service Agreements:</b>			
<input type="checkbox"/> Air Discharge Permit	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input type="checkbox"/> Effluent Discharge	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input type="checkbox"/> Waste Disposal; POTW	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input checked="" type="checkbox"/> Other Permits	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
Remarks: <u>RCRA Permit Renewal for the SRS</u>			
<b>5. Gas Generation Records:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks: _____			
<b>6. Settlement Monument Records:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks: _____			
<b>7. Groundwater Monitoring Records:</b>			
	<input checked="" type="checkbox"/> Readily Available	<input checked="" type="checkbox"/> Up to Date	<input type="checkbox"/> N/A
Remarks: _____			
<b>8. Leachate Extraction Records:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks: _____			
<b>9. Discharge Compliance Records:</b>			
<input type="checkbox"/> Air	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
<input type="checkbox"/> Water (Effluent)	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks: _____			
<b>10. Daily Access/Security Logs:</b>			
	<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input checked="" type="checkbox"/> N/A
Remarks: _____			

**Attachment I-1. Five-Year Review Site Inspection Checklist – H-Area Groundwater Operable Unit (continued)**

IV. O&M COSTS			
<b>1. O&amp;M Organization:</b>			
<input type="checkbox"/> State In-House	<input type="checkbox"/> Contractor for State		
<input type="checkbox"/> PRP In-House	<input type="checkbox"/> Contractor for PRP		
<input checked="" type="checkbox"/> Other: <u>SRS</u>			
<b>2. O&amp;M Cost Records:</b>			
<input type="checkbox"/> Readily Available	<input type="checkbox"/> Up to Date	<input type="checkbox"/> Funding mechanism/agreement in place	
<input checked="" type="checkbox"/> Other: <u>Project cost data is summarized in Section IV of this OU-specific review.</u>			
<b>Total annual cost by year for review period, if available</b>			
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
From: _____ (Date)	To: _____ (Date)	_____ (Total Cost)	<input type="checkbox"/> Breakdown attached
<b>3. Unanticipated or Unusually High O&amp;M Costs During Review Period</b>			
Describe costs and reasons: _____			
_____			
_____			
_____			
V. ACCESS AND INSTITUTIONAL CONTROLS <input checked="" type="checkbox"/> Applicable <input type="checkbox"/> N/A			
<b>A. Fencing</b>			
<b>1. Fencing Damage:</b> <input type="checkbox"/> Location shown on site map <input type="checkbox"/> Gates secured <input checked="" type="checkbox"/> N/A			
Remarks: <u>OU-specific perimeter fencing is not required by the remedial action.</u>			
_____			
<b>B. Signs</b>			
<b>1. Signs and Other Security Measures:</b> <input type="checkbox"/> Location shown on site map <input checked="" type="checkbox"/> N/A			
Remarks: <u>Signs are in good condition.</u>			
_____			

- 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:

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- 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

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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 MIPS L 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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### **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

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(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.
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### **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™ 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-2-3 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™, 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;
-

## **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.

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**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)



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
	Trichloroethylene (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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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.
  - Seepage subunit - No waste was placed along the seepage line. The seepage line 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, seepage, 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 ~~health~~ receptors as it is contaminated with polyaromatic hydrocarbons (PAHs) (~~Table L-2~~). 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<sup>3</sup> (3,500 yd<sup>3</sup>) 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 seepage line 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™) 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.

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### *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™ 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.

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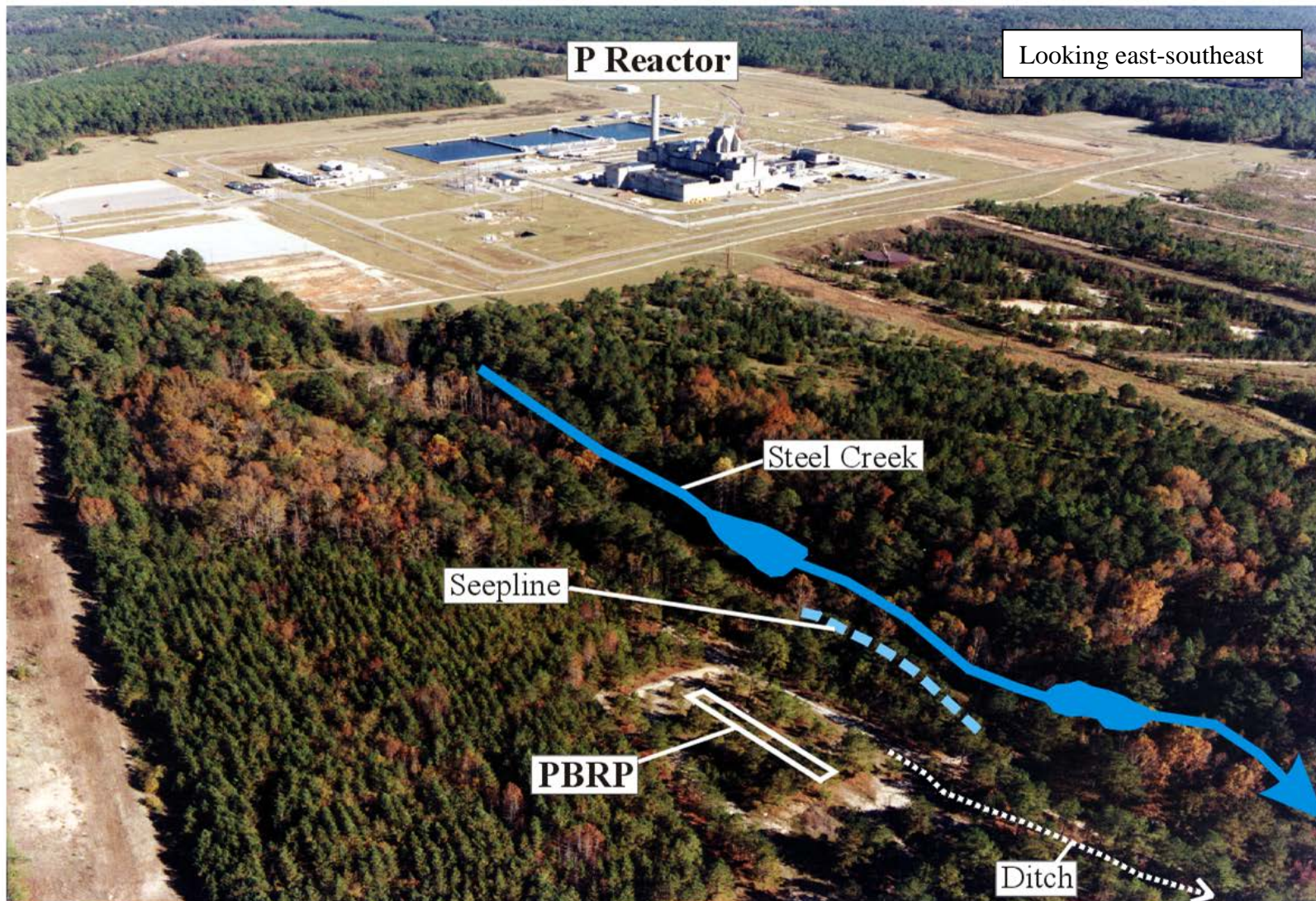


Figure L-2. Layout of the PBRP OU (1987)

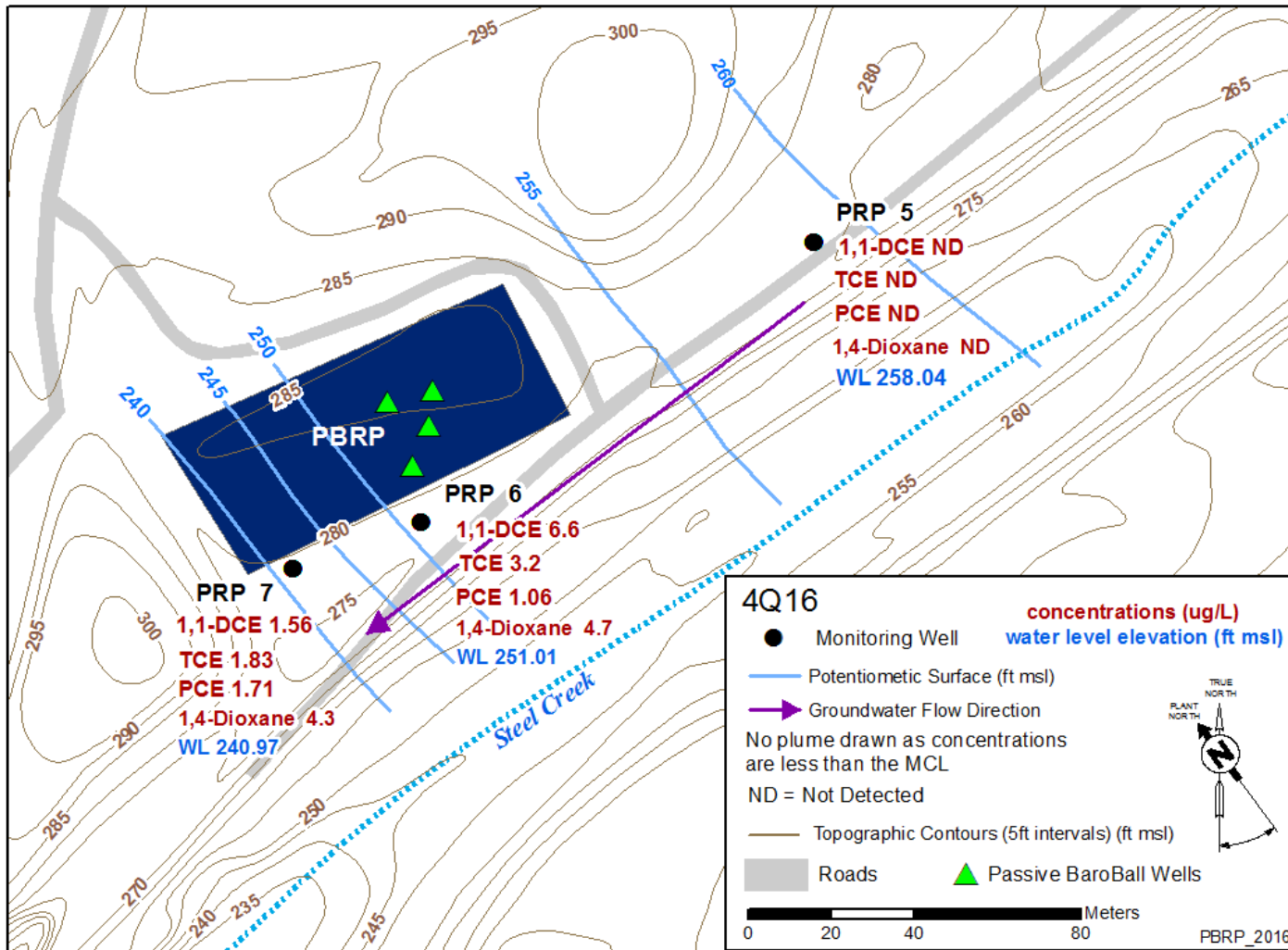


Figure L-3. 2016 1,1-DCE Plume and Potentiometric Surface at PBRP

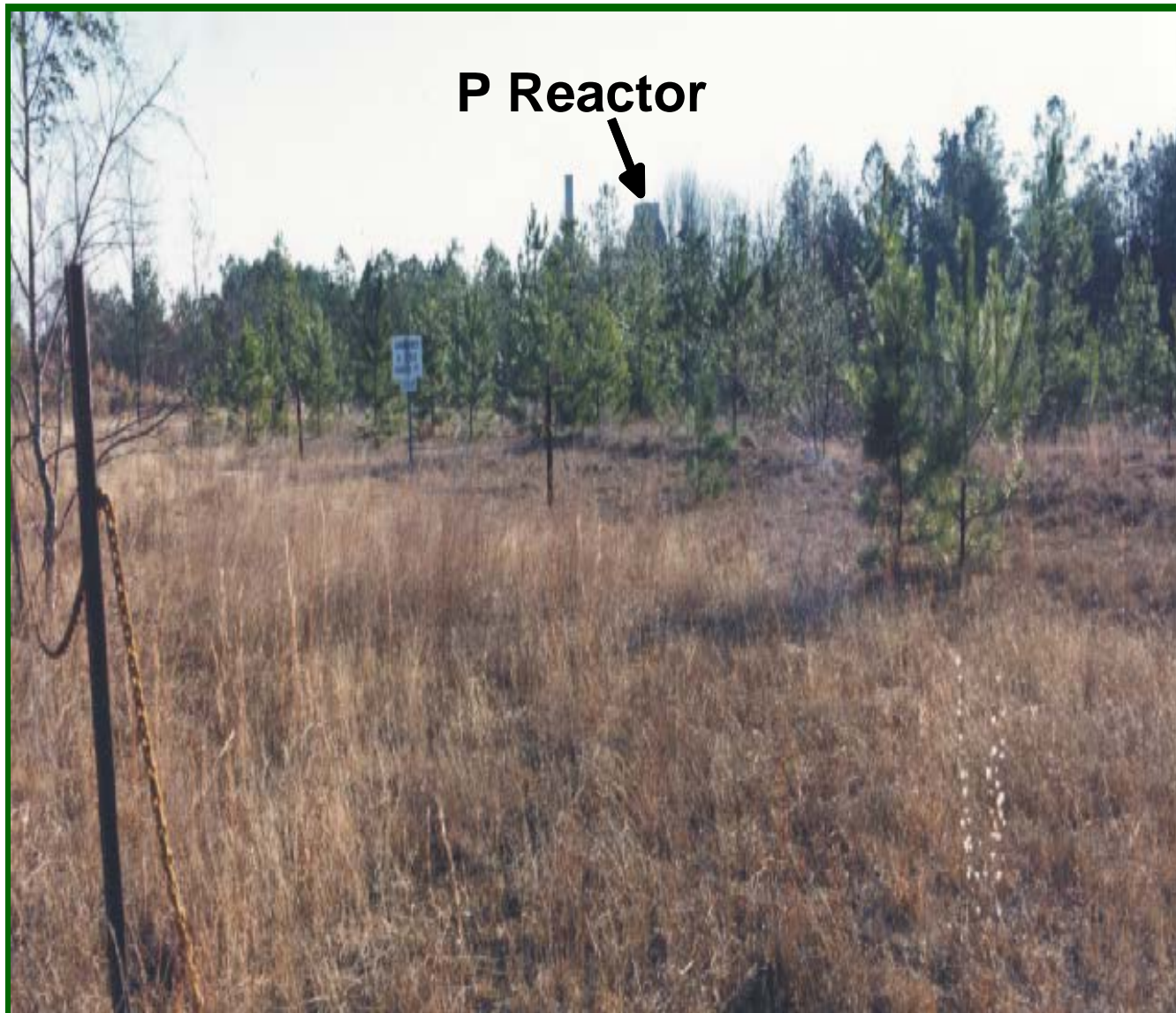


Figure L-4. Photo of PBRP Before Remediation Activities (~~December~~ 1987)



Figure L-5. Photo of PBRP Currently (2017)

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			<u>X<sub>Res, IW</sub></u>	2.56	<u>1E-06 risk level</u>
	Benzo[a]pyrene			<u>X<sub>Res, IW, CW</sub></u>	0.256	<u>1E-06 risk level</u>
	Benzo[b]fluoranthene			<u>X<sub>Res, IW</sub></u>	2.56	<u>1E-06 risk level</u>
	Benzo[k]fluoranthene			<u>X<sub>Res, IW</sub></u>	25.6	<u>1E-06 risk level</u>
	Chrysene			<u>X<sub>Res</sub></u>	256	<u>1E-06 risk level</u>
	Dibenzo[a,h]anthracene			<u>X<sub>Res, IW</sub></u>	0.256	<u>1E-06 risk level</u>
	Fluoranthene			<u>X<sub>Res</sub></u>	2670	<u>1E-06 risk level</u>
	Indeno[1,2,3-c,d] pyrene			<u>X<sub>Res, IW</sub></u>	2.56	<u>1E-06 risk level</u>
	Phenanthrene			<u>X<sub>Res</sub></u>	3270	<u>1E-06 risk level</u>
	Pyrene			<u>X<sub>Res</sub></u>	2000	<u>1E-06 risk level</u>
Soil – CM COC (mg/kg)	Antimony		<u>X</u>		4.588	<u>95<sup>th</sup> percentile background</u>
	Chromium		<u>X</u>		35.22	<u>95<sup>th</sup> percentile background</u>
	Copper		<u>X</u>		40.8	<u>CM soil clean up level</u>
	Nickel		<u>X</u>		11.432	<u>95<sup>th</sup> percentile background</u>
	Zinc		<u>X</u>		1110	<u>CM soil clean up level</u>
	Tetrachloroethylene (PCE)		<u>X</u>		0.00338	<u>CM soil clean up level</u>
	Trichloroethylene (TCE)		<u>X</u>		0.00153	<u>CM soil clean up level</u>
	Aroclor 1242		<u>X</u>		0.00843	<u>CM soil clean up level</u>
	Dibenzofuran		<u>X</u>		0.195	<u>CM soil clean up level</u>
Groundwater (µg/L)	1,1-Dichloroethylene	<u>X</u>		<u>X<sub>Res, IW</sub></u>	7.0	<u>MCL</u>
	Trichloroethylene	<u>X</u>		<u>X<sub>Res</sub></u>	5.0	<u>MCL</u>

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

RGØ – remedial goal option

Bkg – Background

NA – not applicable

**Table L-3. Actual versus Estimated O&M Costs**

	<b>FY2012</b>	<b>FY2013</b>	<b>FY2014</b>	<b>FY2015</b>	<b>FY2016</b>	<b>FY2017</b>	<b>5-Year Total</b>
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**

<b>RCOC</b>	<b>RG (MCL) (µg/L)</b>	<b>2016 Maximum Concentration (µg/L)</b>	<b>Well with Maximum Concentration</b>
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.

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 provide 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

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

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WSRC, 2004a. *Land Use Control Implementation Plan (LUCIP) for the TNX Area Operable Unit (U)*, WSRC-RP-2003-4173017, 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)

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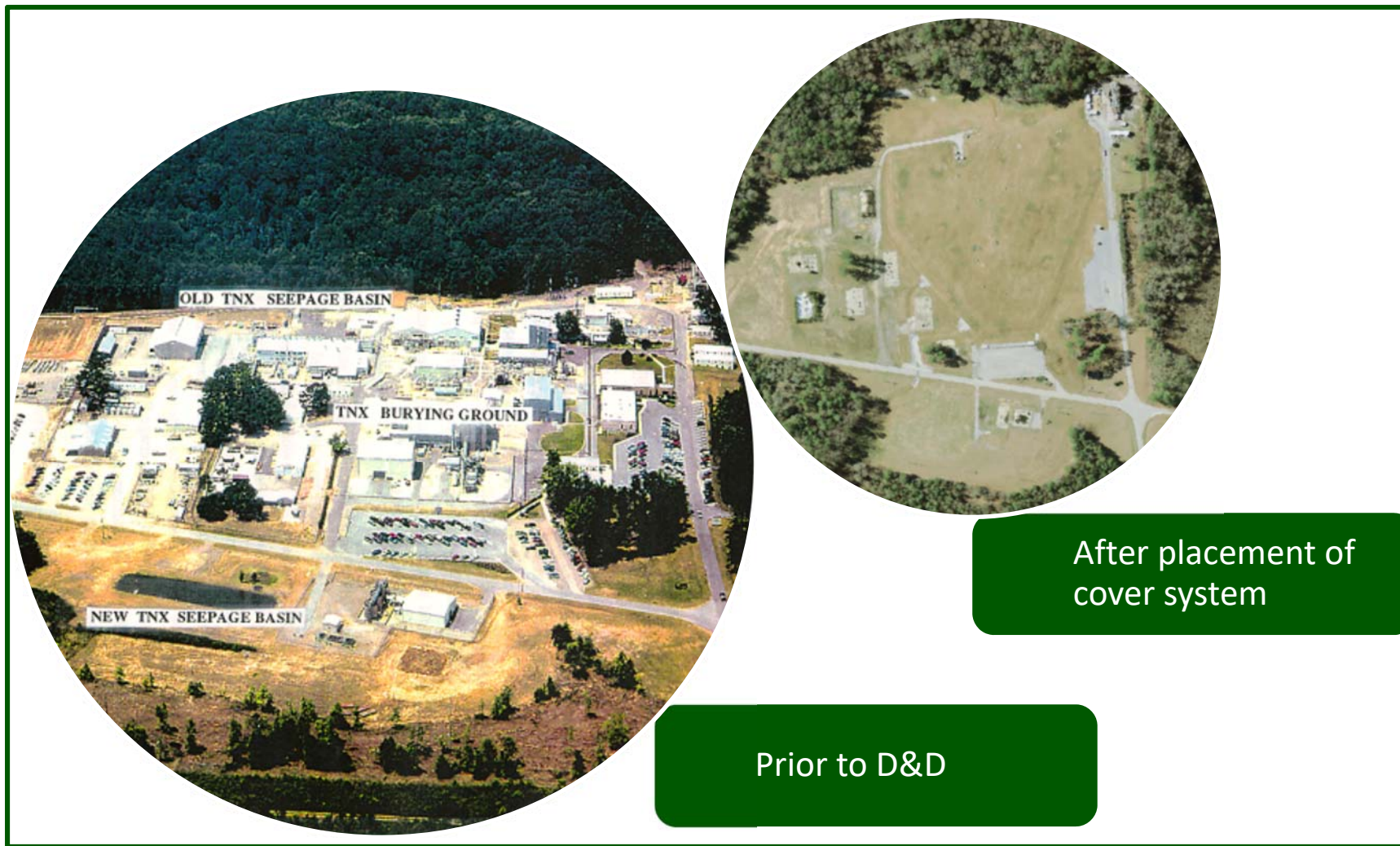


Figure M-3. Layout of the TNX Area OU before (pre-2004) and after D&D and remedial actions (post-2006)

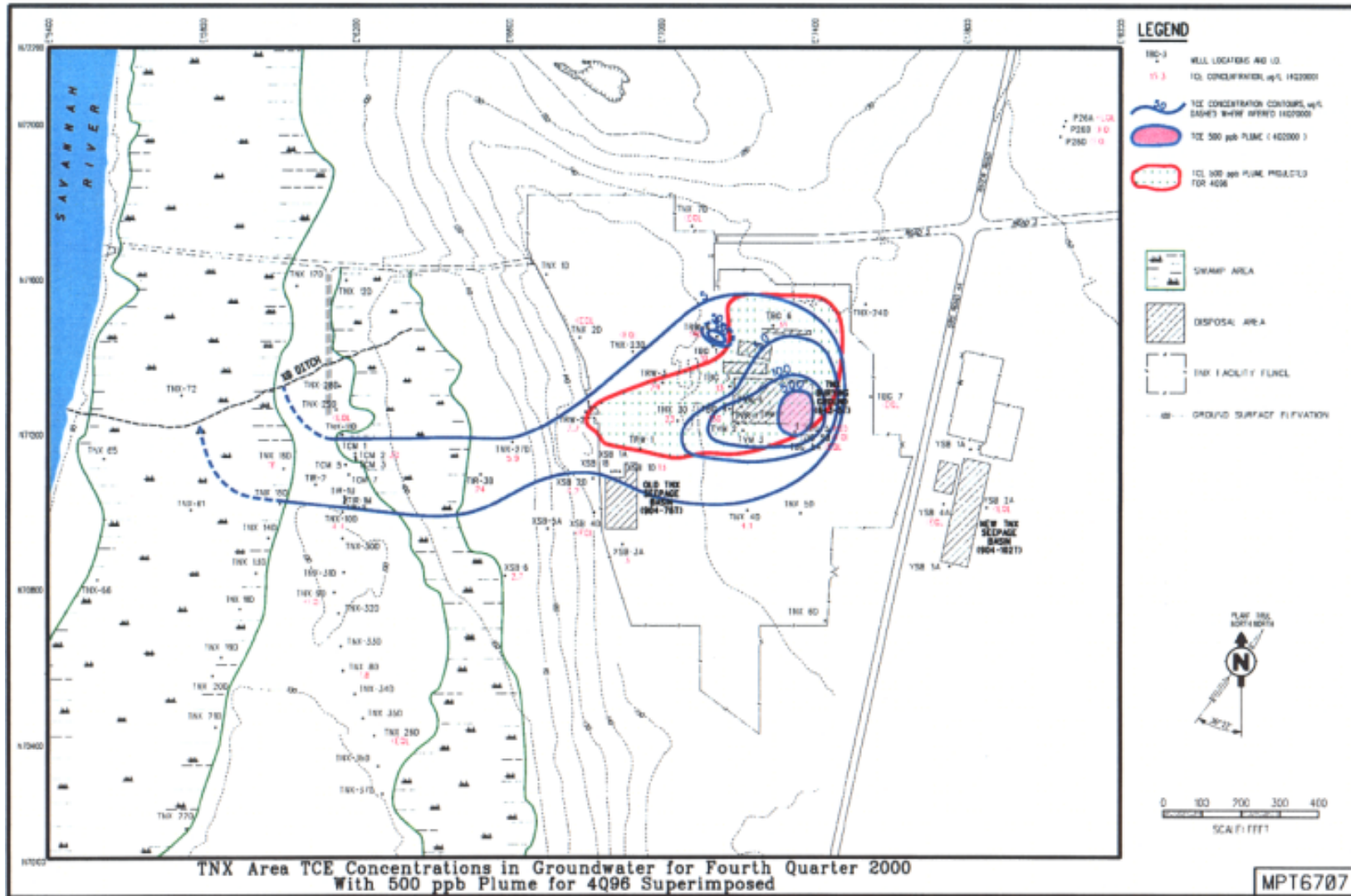


Figure M-4. 2000 TCE Contours with 4Q96 500  $\mu\text{g/L}$  TCE Contour



Figure M-5. Photograph of a MicroBlower™ Field Setup powered by a Solar Panel (2007)

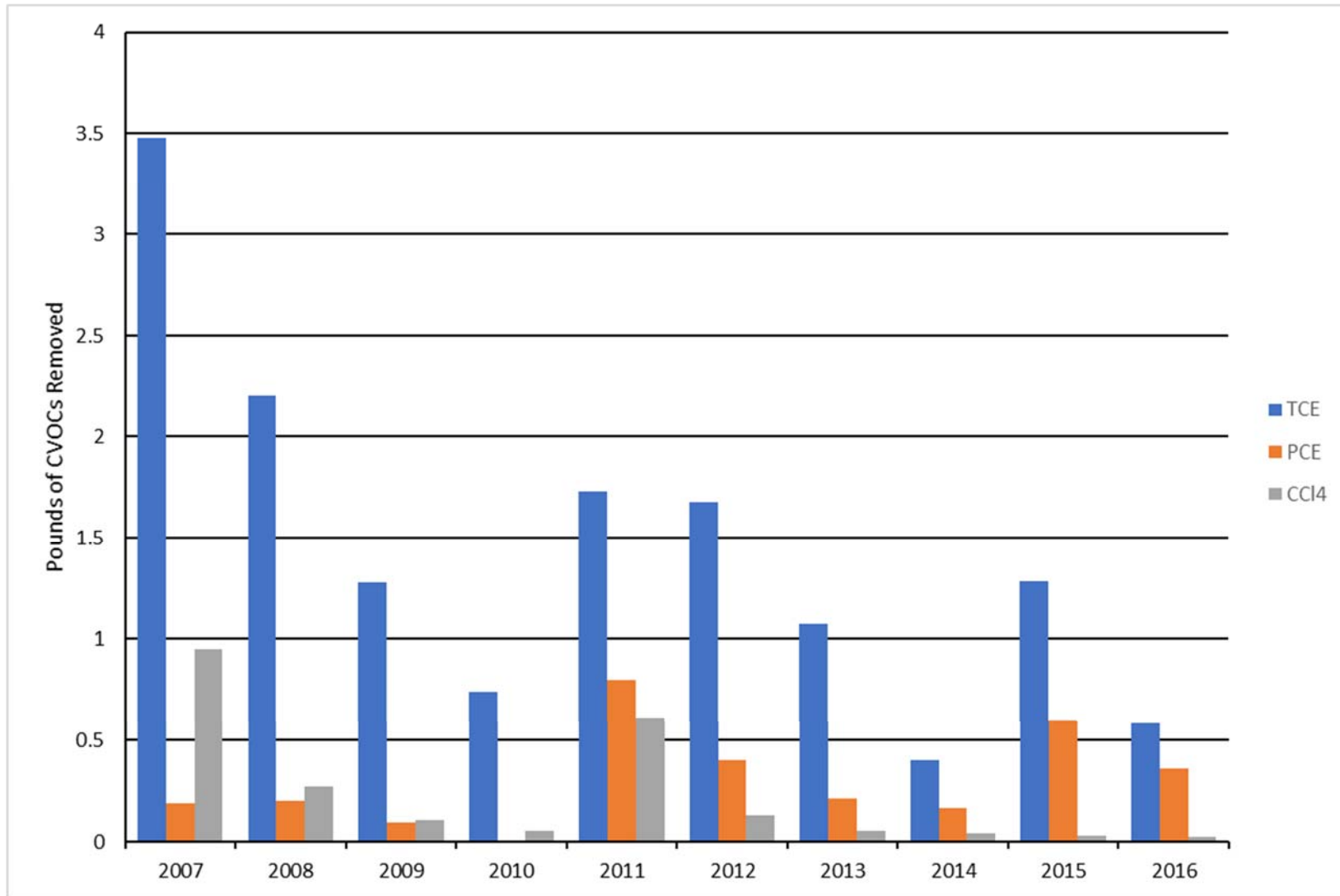


Figure M-6. Mass Removal Rates by Year for the TNX Area OU Passive SVE (MicroBlower™) System