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Sixth Five-Year Remedy Review Report for Savannah River Site Operable Units with Groundwater Remedies (U)

Aiken, South Carolina

SEMS Number: 00

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DISCLAIMER

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EXECUTIVE SUMMARY

This document presents the results of a technical evaluation of environmental remedies that implemented groundwater remediation at Savannah River Site (SRS). The remedies are evaluated to determine whether they are functioning as designed and whether they remain 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 into a single document all SRS operable units (OUs) that had implemented a remedial action. The Fourth Five-Year Remedy Review Report, issued in February 2014, reviewed 52 SRS remedy decision documents. 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. Beginning with the Fifth Five-Year Remedy Review Report, technical evaluations are conducted in five phases, approximately one year apart, with OUs grouped by the following remedy types: (1) native soil covers and/or land use controls (LUCs); (2) groundwater; (3) engineered cover systems; (4) geosynthetic or stabilization/solidification cover systems; and (5) operating equipment. The Sixth Five-Year Remedy Review Report will be conducted in five phases based on the remedy type with this report evaluating SRS OUs that have groundwater remediation as a final remedy.

According to the data reviewed and the site inspections, the 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 remedies have been determined to still protective of human health and the environment. No issues or recommendations resulted from the remedy review.

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LIST OF ACRONYMS AND ABBREVIATIONS

ac	acre or acres
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BHC	benzene hexachloride
BPRG	Building Preliminary Remediation Goal
BRA	Baseline Risk Assessment
CA	contamination area
CAGW	C-Area Groundwater
CBRP	C-Area Burning/Rubble Pit (131-C)
CCl_4	carbon tetrachloride
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
Ci	curie or curies
cDCE	cis-1,2-dichloroethylene
cm	centimeter or centimeters
CM	contaminant migration
cm/sec and cm/s	centimeter per second
CMCOC	contaminant migration constituent of concern
CMP Pits	Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G)
CMS/FS	Corrective Measures Study/Feasibility Study
CO_2	carbon dioxide
COC	constituent of concern
CPT	cone penetrometer technology
CRSB	C-Area Reactor Seepage Basins
+D	plus daughter
DCE	dichloroethene
DCM	dichloromethane
DDD	p,p’-dichlorodiphenyldichloroethane
DDE	p,p’-dichlorodiphenyldichloroethylene
DDT	p,p’-dichlorodiphenyltrichloroethane
DO	dissolved oxygen
DOSB	D-Area Oil Seepage Basin (631-G)
DNAPL	dense non-aqueous phase liquid
EAROD	Early Action Record of Decision
EC&ACP	Environmental Compliance and Area Completion Projects
ECO	ecological
ECODS	Early Construction and Operational Disposal Site

LIST OF ACRONYMS AND ABBREVIATIONS *(continued)*

EE/CA	Engineering Evaluation/Cost Analysis
EIS	Environmental Impact Statement
EMP	Effectiveness Monitoring Plan
EMR	Effectiveness Monitoring Report
ERH	electrical resistance heating
ESD	Explanation of Significant Differences
FFA	Federal Facility Agreement
FONSI	Finding of No Significant Impact
FY	fiscal year
ft	foot or feet
ft^3	cubic foot or cubic feet
ft^3/min	cubic feet per minute
GA	Gordon Aquifer
gal	gallon
GAU	Gordon Aquifer Unit
GMZA	Groundwater Mixing Zone Application
GWMZ	Groundwater Mixing Zone
ha	hectare or hectares
HH	human health
ICA	Isolated Contamination Area
in	inch or inches
IRA	interim remedial action
IROD	Interim Record of Decision
ISD	in situ decommissioning
KBRP	K-Area Burning/Rubble Pit and Rubble Pile (131-K and 631-20G)
km	kilometer or kilometers
km^2	square kilometer or square kilometers
L	liter or liters
LADB	L-Area Disassembly Basin
LAERB	L-Area Emergency Retention Basin
LAHS	L-Area Hot Shop
LAOCB	L-Area Oil and Chemical Basin
LASG	L-Area Southern Groundwater
LAZ	Lower Aquifer Zone
lbs	pound or pounds
LBRP	L-Area Burning/Rubble Pit (131-L)
LLC	Limited Liability Company
LRSB	L-Area Reactor Seepage Basin
LUCAP	Land Use Controls Assurance Plan
LUCIP	Land Use Controls Implementation Plan
LUC	land use control
m	meter or meters

LIST OF ACRONYMS AND ABBREVIATIONS *(continued)*

m^3	cubic meter or cubic meters
MCL	maximum contaminant level
mi	mile or miles
mi^2	square mile or square miles
mV	milliVolt
µg/kg	microgram per kilogram
µg/L	microgram per Liter
mg/kg	milligrams per kilogram
MAZ	Middle Aquifer Zone
MNA	monitored natural attenuation
msl	mean sea level
MZ	mixing zone
MZCL	mixing zone concentration limit
N/A	not applicable
NBN	no building number
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	No Further Action
NPL	National Priorities List
NRDC	National Resource Defense Council
NTCR	non-time critical removal
O&M	operation and maintenance
ORP	oxidation reduction potential
OU	operable unit
PAR	P and R
PBRP	P-Area Burning/Rubble Pit (131-P)
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
ρCi/g	picoCuries per gram
ρCi/mL	picoCuries per milliliter
ρCi/L	picoCuries per liter
PCR	Post Construction Report
PRG	Preliminary Remediation Goal
PSA	Potential Source Area
PSL	process sewer line
PTSM	principal threat source material
RAGW	R-Area Groundwater
RAO	remedial action objective
RAOU	R Area Operable Unit
RCOC	refined constituent of concern
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RG	remedial goal

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

RGO	remedial goal option
RI	Remedial Investigation
ROD	Record of Decision
RPSL	R-Area Process Sewer Line
RRSB	R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin
RSER	Removal Site Evaluation Report
RSL	regional screening level
RUNK	R-Area Unknown
SARA	Superfund Amendments and Reauthorization Act of 1986
SCDHEC	South Carolina Department of Health and Environmental Control
SEMS	Superfund Enterprise Management System
SPRG	surface preliminary remediation goal
SRS	Savannah River Site
SRNS	Savannah River Nuclear Solutions, LLC
SSHASP	Site-Specific Health and Safety Plan
SVE	soil vapor extraction
TBD	to be determined
TCE	trichloroethylene
TCCZ	Tan Clay Confining Zone
TZ	Transmissive Zone
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
UST	underground storage tanks
UTRA	Upper Three Runs Aquifer
VC	vinyl chloride
VOC	volatile organic compound
WADB	Wetland Area at Dunbarton Bay
WSRC	Washington Savannah River Company
WSRC	Westinghouse Savannah River Company
yd	yard or yards
yd^3	cubic yard or cubic yards

SAVANNAH RIVER SITE SUMMARY

I. INTRODUCTION

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

The U.S. Department of Energy (USDOE) prepared this sixth five-year remedy review for Savannah River Site (SRS) OUs that had groundwater remediation selected as a remedial action pursuant to CERCLA Section 121 and as amended by SARA and the NCP. During implementation of the five-year remedy review process at the SRS, the U.S. Environmental Protection Agency (USEPA), the South Carolina Department of Health and Environmental Control (SCDHEC), and the USDOE recognized that remedial action decision document(s) would be issued for multiple OUs. Rather than generate individual five-year remedy review reports for each OU, the USDOE and regulatory agencies determined that it would be more cost effective to conduct a remedy review for all applicable OUs on the same five-year cycle. The First Five-Year Remedy Review was issued in August 1997

(WSRC 1997); the Second Five-Year Remedy Review was issued in February 2004 (WSRC 2003); the Third Five-Year Remedy Review was issued in January 2009 (WSRC 2008b); the Fourth Five-Year Remedy Review was issued in February 2014 (SRNS 2014); and the Fifth Five-Year Remedy Review was issued in December 2018 (SRNS 2015, SRNS 2017a, SRNS 2018a, SRNS 2018b, and SRNS 2018c).

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

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

The trigger date for submittal of the next five-year remedy review report to the regulatory agencies is based on the USEPA signature date of the previous report. Therefore, the final signature for the last grouping of Sixth Five-Year Remedy Review Report is due no later than January 21, 2024. A more detailed discussion of the phased reviews and transition schedule are provided in Appendix A.

This report documents the Sixth Five-Year Remedy Review for OUs with groundwater remediation selected as the final remedy and includes a review of remedy decision documents for six USEPA Superfund Enterprise Management System (SEMS) units at the SRS. SEMS 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 SEMS unit and/or SRS OU.

The SRS OUs evaluated in this document were grouped together because of similar groundwater monitoring activities associated with Monitored Natural Attenuation (MNA) or a Groundwater Mixing Zone permit. Figure 1 identifies the location of the SRS OUs evaluated in this document. The data evaluation and visual inspections for the SRS OUs with groundwater remedies were conducted from August 2019 through November 2019.

This report was prepared using the *Comprehensive Five-Year Review Guidance* (USEPA 2001) and is supplemented by the *Recommended Evaluation of Institutional Controls: Supplement to the "Comprehensive Five-Year Review Guidance"* (USEPA 2011), *Clarifying the Use of Protectiveness Determinations for Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Reviews* (USEPA 2012), and *Five-Year Review Recommendation Template* (USEPA 2016). This report summarizes common elements for the entire SRS. The remedy reviews are included as Appendix C through Appendix H.

Site Chronology

A summary of the regulatory history of the SRS is provided below beginning with the 1988 National Resource 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 Basins (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 the 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 (RFI) 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 is the Five-Year Summary Review Form, which provides a summary status of SRS. Table 2 provides a chronology of the decision documents for the SRS OUs with groundwater remedies 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 H).

Background

The SRS was constructed during the 1950s to produce the basic materials used in the fabrication of nuclear weapons, primarily tritium and plutonium, in support of our nation’s defense programs. Production of nuclear materials for the defense program was discontinued in 1988. SRS has provided nuclear materials for the space program, as well as for medical, industrial, and research efforts up to the present. Chemical and radioactive wastes are by-products of nuclear material production processes. These wastes have been treated, stored, and in some cases, disposed of at SRS. Past disposal practices (e.g., seepage basins, pits and piles, landfills, etc.) have resulted in soil and groundwater contamination.

Hazardous waste materials handled at SRS are managed under RCRA, a comprehensive law requiring responsible management of hazardous waste. Certain SRS activities require SCDHEC operating or post-closure permits under RCRA. SRS received a RCRA hazardous waste permit from the SCDHEC, which was most recently renewed on February 11, 2014. Module VIII of the Hazardous and Solid Waste Amendments portion of the RCRA permit mandates corrective action requirements for non-regulated solid waste management units subject to RCRA 3004(u).

Physical Characteristics

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

SRS is located on the Atlantic Coastal Plain. Subsurface and groundwater contamination associated with OUs is 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 of the 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 the remedial action will prohibit residential use of the area.

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

History of Contamination

During the early 1950s, SRS began to produce materials used in nuclear weapons, primarily tritium, plutonium-239, and other special nuclear materials for national defense and the space program. Chemical and radioactive wastes are by-products of nuclear material production processes. These wastes have been treated, stored, and in some cases disposed of at SRS. Hazardous substances, as defined by the CERCLA, are currently present in the environment at SRS, with past disposal practices (e.g., seepage basins, pits and piles, landfills, etc.) resulting in soil and groundwater contamination.

II. RESPONSE ACTION SUMMARY

Initial Response

After SRS was placed on the NPL in 1989, the SRS Site Evaluation program was initiated to identify potential release sites present 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 not already completed.

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 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 analyses, 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.

Table 3 provides a summary of the LUC objectives for the OUs with groundwater remedies.

Basis for Taking Action

Groundwater contaminant plumes associated with SRS OUs cover approximately 2,023 hectares (5,000 acres) of the SRS. The lateral extent of these plumes is indicated on Figure 2. The primary contaminants in groundwater are volatile organic compounds (VOCs) and tritium. Strontium-90, iodine-129, and metals are present in groundwater above drinking water standards to a lesser extent. VOCs are present in the vadose zone between the source unit and the groundwater at a number of OUs and act as a secondary source of contamination to the groundwater.

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 H).

Remedial Actions

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

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

Additionally, LUCs are part of all 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 land use control implementation plan (LUCIP) are described in Section VII of the OU-specific appendices LUCs are defined for individual OUs, but in general, LUC objectives at SRS are:

- Prevent exposure to, or ingestion of, contaminated media.
- Prohibit residential use.
- Prevent unauthorized access.
- Prevent unauthorized intrusive activity.

Table 2 lists the remedial actions for each of the OUs in this five-year remedy review report. The remedial actions are described in greater detail in the OU-specific appendices (Appendix C through Appendix H). Table 3 provides a summary of the LUC objectives for the OUs with groundwater remedies.

Status of Implementation

The remedial actions listed in Table 2 have been implemented. Except for C-Area Groundwater OU, LUCs are ongoing at all OUs discussed in this five-year remedy review report. Because the remedy for the C-Area Groundwater (CAGW) OU is an interim remedy, LUCs will be addressed (if needed) as a component of the remedy in the final Record of Decision (ROD). The status of all response actions or remedial actions for each of the groundwater remedies is discussed in greater detail in the OU-specific appendices (Appendix C through Appendix H). These actions include removal and remedial actions conducted prior to a final ROD.

Systems Operation and Maintenance

A site-wide maintenance program is in place to care for cover systems, signs, monitoring wells, and other infrastructure associated with environmental remediation. Groundwater monitoring networks require maintenance. Identifying signs must be legible and locks and wells covers must be operational. Access to the wells must be maintained. Pumps and fittings periodically require repair or replacement, and sometimes wells are refurbished, redeveloped, or abandoned.

Groundwater monitoring is an important component of operation and maintenance (O&M) at SRS. Groundwater monitoring includes installing monitoring wells, collecting water samples, analysis of samples at laboratories, data management, data interpretation, and document production. Groundwater monitoring reports are produced and submitted to USEPA and SCDHEC for individual OUs where monitoring and reporting are required. Enhancements to the groundwater sampling systems are part of a continual groundwater monitoring well O&M improvement program. For example, Purge Water Management System (PWMS) units were installed at wells that require containerization to decrease the amount of purge water requiring treatment, thus lowering O&M (sampling) costs. As reported in Table 4, Operation and Maintenance Cost Comparison for SRS OUs with Groundwater Remedies, any cost savings from the PWMS units are captured in the actual costs.

The costs of the O&M activities for the individual OUs have been compiled as part of this five-year remedy review. As part of the process of selecting the most appropriate action for each OU, the cost of implementing each of the remedies was estimated and reported in the respective remedy decision documents. Table 4 compares the actual costs incurred at SRS OUs with groundwater remedies over the period from fiscal year (FY) 2015 to FY2019 to the estimated costs from the remedy decision documents over the same period. The review for the actual costs incurred (i.e., FY2015 to FY2019) is based on the time-period since the last review five-year remedy review. Specific details concerning costs incurred are included for each OU in Appendix C through Appendix H.

III. PROGRESS SINCE LAST REVIEW

For the OUs evaluated in this review, the previous protectiveness statements from the Fifth Five-Year Remedy Review Report (SRNS 2017a) concluded that all OUs were found to be protective (Table 5).

The recommendation from the Fifth Five-Year Remedy Review Report that impact the OUs with groundwater remedies evaluated in this report are as follows (Table 6):

- SRS recommended continued monitoring of 1,4-dioxane for two OUs and reporting of the results in the OU-specific groundwater reports. Based on the monitoring results, the USEPA, SCDHEC, and USDOE will determine whether 1,4-dioxane should be permanently added to the list of monitored constituents. For this report, this recommendation pertains to the D-Area Oil Seepage Basin (631-G) (DOSB) OU and R-Area Operable Unit (RAOU). Based on comprehensive sampling, 1,4-dioxane was added to the annual groundwater monitoring at the DOSB. Monitoring is no longer required at RAOU as agreed to by the approved *R-Area Groundwater (NBN)*

Effectiveness Monitoring Report in Support of the R-Area Operable Unit (U) January 2015 through December 2015 (SRNS 2016) and subsequent comment responses.

The *K-Area Burning/Rubble Pit and Rubble Pile (131-K and 631-20G) (KBRP), L-Area Burning/Rubble Pit and Rubble Pile (131-L, 131-1L, and 131-2L) (LBRP), and P-Area Burning/Rubble Pit (131-P) (PBRP) Operable Units (OUs) Detailed Combined Groundwater Monitoring Report* (SRNS 2017b) included data and a recommendation to discontinue monitoring and reporting at the LBRP OU (SEMS #56). As stated in the report, the LBRP OU ROD (WSRC 2002) selected Groundwater Mixing Zone with institutional controls (i.e., LUCs) as the remedial action until the maximum contaminant level for carbon tetrachloride is no longer exceeded for groundwater. The USEPA and SCDHEC agreed with the recommendation to discontinue monitoring and reporting at the LBRP OU in letters dated October 3, 2017 and October 25, 2017, respectively. Since monitoring and reporting have been discontinued at the LBRP OU, the institutional controls (i.e., LUCs) are no longer required because remedial goals for unrestricted land use have been achieved. The LBRP unit has been identified as a No Action site in Appendix A.

Groundwater monitoring at the RAOU will focus on the most mobile constituents (carbon-14, chlorine-36, iodine-129, and tritium) every five years at ten in situ decommissioning wells based on regulatory approved recommendations in the *Addendum to the Effectiveness Monitoring Plan (EMP) for the R-Area Operable Unit.* In addition, carbon-14 was detected in on sample in 2017. Monitoring for 1,4-dioxane is no longer required at RAOU based on monitoring results and regulatory agreement. Starting in 2018, the reporting requirements for RAOU were revised from annually to biennially.

IV. FIVE-YEAR REMEDY REVIEW PROCESS

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

- Submitted a scoping summary to USDOE, USEPA, and SCDHEC on August 15, 2019. The USDOE, USEPA, and SCDHEC agreed to the scope and schedule of the remedy review report, which is discussed in the scoping summary;
- Published an announcement on October 10, 2019 that the USDOE is conducting the Sixth Five-Year Remedy Review in phases. The announcement stated that the second phased submittal will focus on OUs with groundwater remedies. The public was notified through mailings of *The Savannah River Site 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 [ESDs], ROD Amendments), 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 H;
- 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 H;
- 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 Section V (Technical Assessment) and Section VI (Issues/ Recommendations) of the OU-specific appendices; and

- Submitted draft Fact Sheet to USEPA and SCDHEC for review with Revision 0 of the Sixth Five-Year Remedy Review Report for SRS OUs with Groundwater Remedies.

Community Notification and Involvement

USDOE will address any comments received from USEPA and SCDHEC and provide a Revision 1 report, if necessary, for USEPA and SCDHEC approval. After the USEPA and SCDHEC approve this report and USDOE, USEPA, and SCDHEC sign this report, a notice of its availability will be published in the *Aiken Standard* (Aiken, SC), *The Augusta Chronicle* (Augusta, GA), *The People Sentinel* (Allendale and Barnwell, SC), and *The State* (Columbia, SC) newspapers. Additionally, the availability of the report will be announced in *The Savannah River Site Environmental Bulletin*, which will be sent to the SRS mailing list. The report will be made available to the public at four information repositories.

Data Review, Site Inspections, and Interviews

According to the data review, 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 the 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.

The Revision 0 report was submitted on December 19, 2019. USEPA and SCDHEC performed site inspections of OUs with groundwater remedies with issued decision documents on February 27, 2020.

V. 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 Appendix H) is described by answers to the following three questions posed by the USEPA guidance.

- 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?

Answer: Yes. SRS groundwater remedies and related activities are functioning as intended as demonstrated below.

- Passive and Low Energy soil vapor extraction (SVE) Systems, solar powered MicroBlowers™ and barometric pressure operated BaroBalls™ continue to remove contaminants from subsurface soils contaminated by low concentrations of VOCs.
- Thermal technologies (e.g., electrical resistance heating [ERH]) have been successful in removing very high concentrations of VOCs from subsurface zones.
- Groundwater data at MNA remedy plumes indicates that groundwater concentrations are generally decreasing, and plumes are not expanding.
- None of the expected timeframes to achieve RGs in groundwater as identified in the respective RODs have been exceeded.
- Contaminated material has been excavated and consolidated or left in place under protective cover systems breaking the pathway for worker exposure. The remedial actions associated with the RAOU (in situ decommissioning) and the R-Area Reactor Seepage Basins (RRSB) (asphalt and concrete covers) also serve to mitigate the migration of contaminants to groundwater. No other units in this five-year remedy review report with groundwater remedies have an engineered low permeability cap.

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

Answer: Yes. The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection are still valid for all the 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 2015 to the current 2019 standards 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?

Answer: No. No other information that could call into question the protectiveness of the selected remedies and no outstanding issues have been identified in this Sixth Five-Year Remedy Review.

For all OUs, current and reasonably anticipated future land use at SRS remains consistent with assumptions in the respective decision documents.

VI. ISSUES/RECOMMENDATIONS

Remedial actions evaluated in this Five-Year Remedy Review for SRS remain protective of human health and the environment and are functioning as intended. No issues were identified for the remedies evaluated (Table 7).

There are no recommendations or follow-up actions (Table 8).

VII. PROTECTIVENESS STATEMENT(S)

The protectiveness statements for each remedy are based on the recommended language from the *Comprehensive Five-Year Review Guidance* (USEPA 2001), *Clarifying the Use* *of Protectiveness Determinations for Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Reviews* (USEPA 2012), and *Five-Year Review Recommended Template* (USEPA 2016).

For OUs evaluated in this Five-Year Remedy Review, the groundwater remedies were determined to be protective of human health and the environment (Table 9). The ERH with SVE interim remedy for the CAGW OU was determined to be protective of human health and the environment in the short-term. However, for the remedy to be protective in the long-term, additional remedial actions, including LUCs (if needed), will need to be implemented. SRS facility security and administrative controls that restrict unauthorized access to the CAGW OU are not part of the interim remedy and therefore not recognized as long-term protective. SRS will include the CAGW OU in the FFA Annual Progress Report to demonstrate long-term protectiveness through the SRS facility security and administrative controls. The report is required by the FFA and includes an annual certification by the USDOE SRS Manager that the listed OUs are in compliance with land use requirements.

LUCs are part of all 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 OU-specific LUCIPs are 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 including LUCs with the exception of the CAGW OU. Because the remedy for the CAGW OU is an interim remedy, LUCs will be addressed (if needed) as a component of the remedy in the final ROD.

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 H.

VIII. 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 at the site above levels that allow for unlimited use and unrestricted exposure following the completion of all remedial actions. Barring a change in the governing laws, another review for the remedies in this report should be completed within five years from the signature date of this document. The final signature date for the last grouping of the Seventh Five-Year Remedy Review Report is due no later than January 21, 2029.

IX. 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 H.

X. REFERENCES

FFA, 1993. *Federal Facility Agreement for the Savannah River Site*, Administrative Docket Number 89-05-FF, WSRC-OS-94-52, Effective Date: August 16, 1993

SRNS, 2011. *Land Use Control Implementation Plan (LUCIP) for the R-Area Operable Unit (RAOU) (U)*, SRNS-RP-2010-01208, 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, 2015. *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

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

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SRNS, 2017b. *K-Area Burning/Rubble Pit and Rubble Pile (131-K and 631-20G) (KBRP), L-Area Burning/Rubble Pit and Rubble Pile (131-L, 131-1L, and 131-2L) (LBRP), and P-Area Burning/Rubble Pit (131-P) (PBRP) Operable Units (OUs) Detailed Combined Groundwater Monitoring Report*, SRNS-RP-2017-00356, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2017c. *Groundwater Flow and Solute Transport Model of the CMP Pits OU (U) Tetra Tech, Inc. Alpharetta, GA*, SRNS-TR-2017-00312, Revision 0, Savannah River Nuclear Solutions, LLC, 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, LLC, 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, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

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

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

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

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

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WSRC, 2004. *Land Use Control Implementation Plan (LUCIP) for the R-Area Reactor Seepage Basins Operable Unit (U),* WSRC-RP-2004-4032, Revision 1, Westinghouse Savanah River Company, Savannah River Site, Aiken, SC

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

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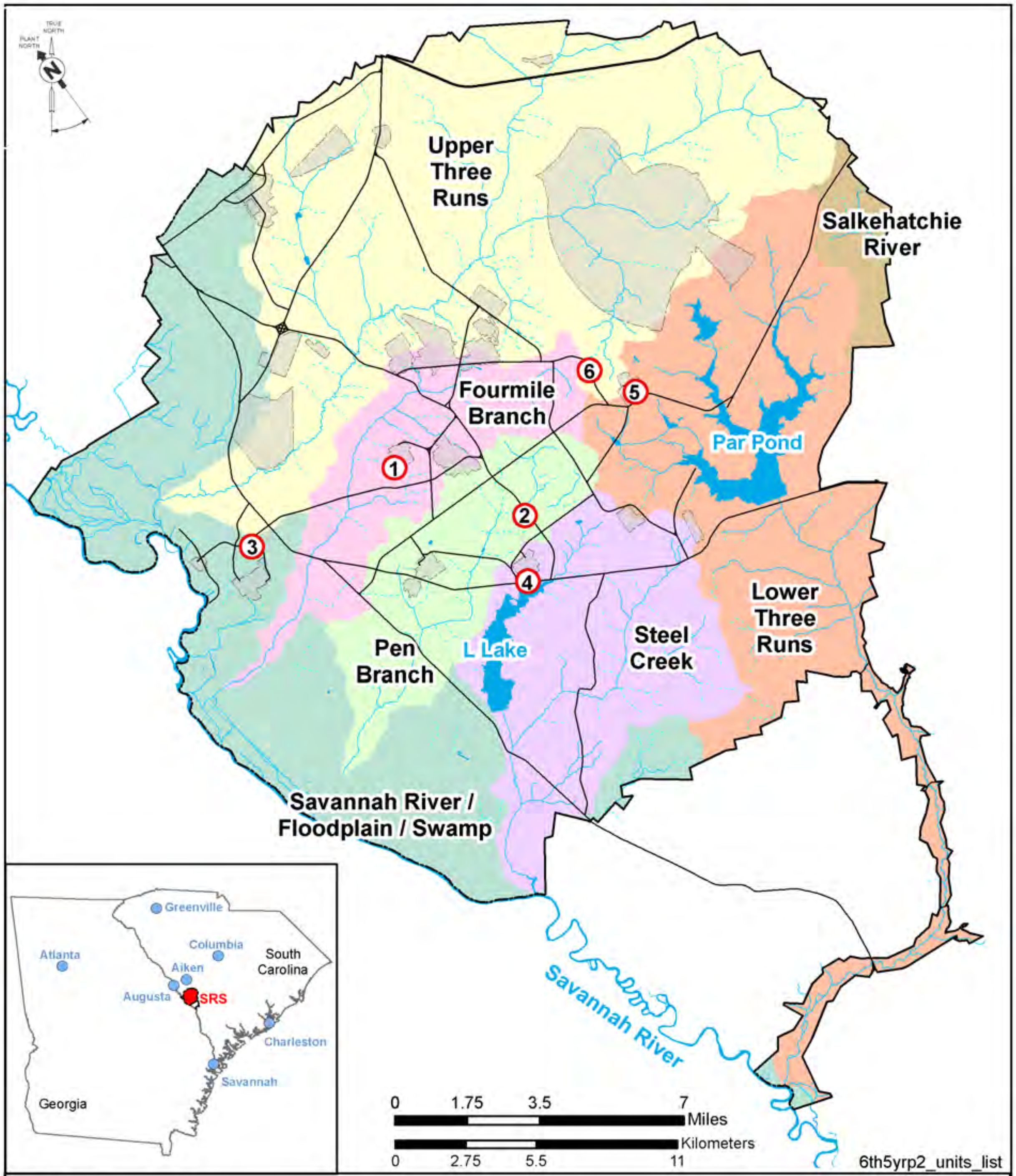
WSRC, 2008b. *Third Five-Year Remedy Review Report for the Savannah River Site (U)*, WSRC-RP-2007-4063, Revision 1.1, Washington Savannah River Company, Savannah River Site, Aiken, SC



1. C-Area Groundwater
2. Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G)
3. D-Area Oil Seepage Basin (631-G)
4. L-Area Southern Groudnwater
5. R-Area Operable Unit
6. R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin

Figure 1. Location Map for SRS OUs with Groundwater Remedies

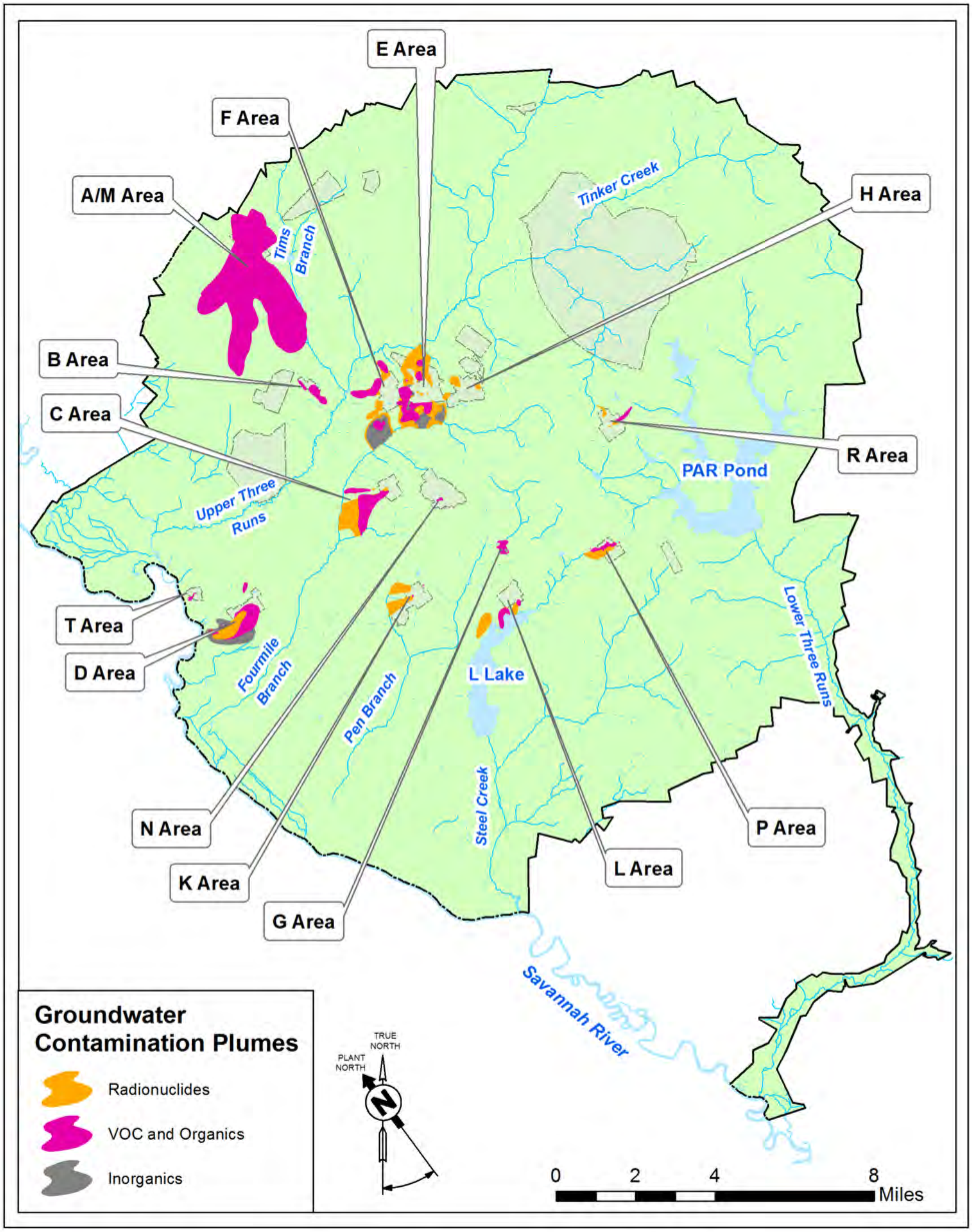


Figure 2. Groundwater Contamination at the Savannah River Site

Table 1. Five-Year Review Summary Form

SITE IDENTIFICATION			
Site Name:	Savannah River Site		
EPA ID:	SC1890008989		
Region:	**4**	**State: SC**	**City/County:** Aiken/Aiken
SITE STATUS			
NPL Status:	Final		
Multiple OUs?:	Yes	**Has the Site achieved Construction Completion?**	No
REVIEW STATUS			
Lead Agency: Other Federal Agency **If "Other Federal Agency" was selected above, enter Agency Name:** U.S. Department of Energy			
Author Name (Federal or State Project Manager:	N/A		
Author Affiliation:	Savannah River Nuclear Solutions, LLC		
Review Period:	July 15, 2019 – January 21, 2021 (SRS OUs with Groundwater Remedies)		
Date of Site Inspections: August 2019 - November 2019 (SRS OUs with Groundwater Remedies)			
Type of Review:	Statutory		
Review Number:	6		
Triggering Action Date:	January 21, 2019		
Due Date *(five years after triggering action date)*:	January 21, 2024 (includes all five phases)		

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Table 2. SRS OUs with Groundwater Remedies

#	Appendix	Operable Unit	SEMS No.	Decision Document Issuance Year[a]	Remedial Action[b]	Area with Groundwater Plumes (contaminant-acres)	LUCs (acres)
1	C	C-Area Groundwater	82	2004	Electrical Resistance Heating (ERH) with Soil Vapor Extraction (SVE)[c]	456.3	TBD
2	D	Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, and 080-183G)	24	2000, 2002, 2003, 2005	Enhanced Bioremediation, ERH, SVE, Passive SVE, Soil Cover, MNA, and Land Use Controls (LUCs)	39.7	62.6
3	E	D-Area Oil Seepage Basin (631-G)	27	1995, 1999	Removal Action (Excavation), Groundwater Mixing Zone (GWMZ), LUCs	14.7	23.2
4	F	L-Area Southern Groundwater	77	2007, 2014	MNA, LUCs	211.1	952.2
5	G	R-Area Operable Unit	95	2009, 2011	Removal Actions (In Situ Decommissioning of R-Reactor Building [105-R], Excavation, Cover), MNA, LUCs	49.7	450.4
6	H	R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, and 904-104G) and 108-4R Overflow Basin	25	2004	Concrete Intruder Barrier, Excavation, On-Site Disposal, GWMZ, LUCs	34.7	37.8

[a] Reflects the year the decision document (i.e., RODs, EARODs, IRODs, and ROD Amendments) was issued or the year of the last signature on the decision document.

[b] The OUs were grouped together because of similar groundwater remedies and monitoring activities. Some OUs may also include subunits with contaminants in soils or building material (i.e., concrete) that are addressed by the remedy decision document.

[c] LUCs are not a component of the interim remedy and will be addressed (if needed) by the final remedial action for the CAGW OU.

TBD – to be determined

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Table 3. LUC Summary Table

Operable Units	**Media, Engineered Controls, and Areas that do not support UU/UE based on current conditions**	**LUCs Needed**	**LUCs Called for in the Decision Documents**	**Impacted Parcel(s)[a]**	**LUC Objectives[b]**	**Title of LUC Instrument Implemented and Date (or Planned)**
C-Area Groundwater[c]	Groundwater, Surface Water, Vadose Zone Soil	TBD	No	82	• TBD	TBD
Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G)	Soil, Groundwater	Yes	Yes	24	• Prevent contact, removal, or excavation of Ballast Area and Vadose Zone contaminated soil • Maintain the integrity of the existing cover • Maintain the use of the site for industrial activities only in order to prevent residential exposure • Prevent unauthorized access to the closed waste unit as long as waste remains a threat to human health or the environment in order to protect the industrial worker • Prevent unauthorized residential or agricultural access to groundwater in the area	WSRC 2007
D-Area Oil Seepage Basin (631-G)	Groundwater	Yes	Yes	27	• Prevent unauthorized exposure to the contaminated groundwater	WSRC 1999

Table 3. LUC Summary Table *(continued)*

Operable Units	Media, Engineered Controls, and Areas that do not support UU/UE based on current conditions	LUCs Needed	LUCs Called for in the Decision Documents	Impacted Parcel(s)[a]	LUC Objectives[b]	Title of LUC Instrument Implemented and Date (or Planned)
L-Area Southern Groundwater	Groundwater	Yes	Yes	77	• Preclude future residential development or potable water use of local contaminated groundwater • Maintain the integrity of any current or future remedial or monitoring system or component such as monitoring wells until remedial goals are achieved and restrictions are no longer warranted • Prevent access to contaminated groundwater in the area as long as contaminant concentrations exceed MCLs for purposes other than implementing the selected remedy	WSRC 2008a
R-Area Operable Unit	Concrete, Metal Components, Rail Bed Materials, Soil, Sediment, Groundwater	Yes	Yes	95	• Restrict unauthorized worker access and prevent contact, removal, or excavation of contaminated waste, pipelines, equipment, and buildings • Prohibit development and use of property for residential housing, elementary and secondary schools, child care facilities and playgrounds • Prohibit industrial use of the R-Area Isolated Contamination Area Potential Source Area • Maintain the integrity of any current or future remedial or monitoring system, such as soil covers, or groundwater monitoring wells • Prevent access or use of contaminated groundwater until cleanup levels are met • Prevent construction of inhabitable buildings without an evaluation of indoor air quality to address vapor intrusion	SRNS 2011

Table 3. LUC Summary Table *(continued/end)*

Operable Units	Media, Engineered Controls, and Areas that do not support UU/UE based on current conditions	LUCs Needed	LUCs Called for in the Decision Documents	Impacted Parcel(s)[a]	LUC Objectives[b]	Title of LUC Instrument Implemented and Date (or Planned)
R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin	Soil, Groundwater	Yes	Yes	25	• Prevent contact, removal, or excavation of contaminated soil and pipelines • Preclude residential use of the area • Prevent unauthorized access to contaminated groundwater in the area	WSRC 2004

a The Impacted Parcel(s) identification is represented by the SEMS number.

b The LUC objectives statements were obtained directly from the referenced LUC document. LUC objective statements vary in complexity due to the age of the document and guidance in place at the time the remedial decision was selected.

c LUCs are not a component of the interim remedy for CAGW OU and will be addressed (if needed) by the final remedial action for CAGW OU.

TBD – to be determined
UU – unlimited use
UE – unrestricted exposure

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Table 4. Operation and Maintenance Cost Comparison for SRS OUs with Groundwater Remedies

Operable Unit	Main Remedy	Remedy Decision Document Year[a]	FY2015-FY2019 O&M Estimated Cost	FY2015-FY2019 O&M Actual Cost	% of Estimate	Comments
C-Area Groundwater	Electrical Resistance Heating (ERH) with Soil Vapor Extraction (SVE)[a],	2004[b]	$0	$65,652	0%	Actual costs for performance/ groundwater monitoring was more than expected because on-going groundwater monitoring and five-year remedy review costs beyond FY2013 were not included in the original IROD cost estimate.
Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G)	Enhanced Bioremediation, ERH, SVE, Passive SVE, Soil Cover, MNA, LUCs	2005	$234,793	$760,232	324%	Actual costs were higher than expected because the current number of monitoring wells and surface water sampling locations (76) is much larger than the ROD estimate (12) requiring increased maintenance activities.
D-Area Oil Seepage Basin (631-G)	Removal Action (Excavation), Groundwater Mixing Zone (GWMZ), LUCs	1999	$16,666	$269,817	1,619%	Actual costs are higher than expected because groundwater monitoring and reporting costs have continued beyond FY2009 as estimated in the ROD. The ROD estimate was based on 12 locations verses 23 wells that are currently being monitored.
L-Area Southern Groundwater	MNA, LUCs	2007	$269,560	$135,043	50%	Actual costs are lower than expected because well redevelopment costs are significantly lower than estimated.
R-Area Operable Unit	Removal Actions (ISD of R-Reactor Building [105-R], Excavation, Cover), MNA, LUCs	2011	$286,500	$1,023,392	357%	Actual costs are higher than expected because groundwater monitoring reports are being submitted annually. Additional maintenance activities were also required.
R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin	Concrete Intruder Barrier, Excavation, On-Site Disposal, GWMZ, LUCs	2004	$2,652,242	$503,459	19%	Actual costs are less than expected due to optimization of the groundwater monitoring.

a Document which included the O&M estimated costs.

b LUCs are not a component of the interim remedy for CAGW OU and will be addressed (if needed) by the final remedial action for CAGW OU.

Table 5. Protectiveness Determinations/Statements from the Fifth Five-Year Remedy Review for the SRS OUs with Groundwater Remedies (SRNS 2017a)

SEMS No.	Operable Unit	Protectiveness Determination	Protectiveness Statement
82	C-Area Groundwater	Protective	The remedy at the CAGW OU is protective of human health and the environment.
24	Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, 080-190G)	Protective	The remedy at CMP Pits OU is protective of human health and the environment. However, in order to establish long-term protectiveness, additional remedial actions may need to be evaluated and selected, as necessary, based on the results of groundwater modeling and continued groundwater and surface water monitoring.
27	D-Area Oil Seepage Basin (631-G)	Protective	The remedy at the DOSB OU is protective of human health and the environment.
77	L-Area Southern Groundwater	Protective	The remedy at the LASG OU is protective of human health and the environment.
95	R-Area Operable Unit	Protective	The remedy at RAOU is protective of human health and the environment.
25	R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin	Protective	The remedy at the RRSB OU is protective of human health and the environment.

Table 6. Status of Recommendations from the Fifth Five-Year Remedy Review Report for SRS OUs with Groundwater Remedies (SRNS 2017a)

SEMS No.	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
27	1,4-Dioxane has been identified as a potential contaminant based on its association with other solvents that are present at the OU. However, there is a lack of groundwater data to dismiss 1,4-dioxane as being present at levels which would be harmful to human health and the environment.	1,4-Dioxane will be monitored and reported as detailed in the OU remedy review report. Based on the monitoring results, the USEPA, SCDHEC, and USDOE will determine whether or not 1,4-dioxane should be permanently added to the list of monitored constituents.	Ongoing	1,4-dioxane sampling was completed in 2Q2016, 2Q2017, 2Q2018 and 2Q2019. The data was reported to the USEPA and SCDHEC in the Calendar Year 2018 D-Area Oil Seepage Basin OU (631-G) Groundwater Mixing Zone Letter Report (IACD-19-175, dated July 25, 2019). Based on the results, 1,4-dioxane was added to the annual groundwater monitoring at three wells (DOB 15, DOL 2, and DOB 16) to collect sufficient trending data.	N/A
95	1,4-Dioxane has been identified as a potential contaminant at RAOU based on its possible association with other solvents that are present at RAOU. However, there is a lack of groundwater data to dismiss 1,4-dioxane as being present at levels which would be harmful to human health and the environment.	1,4-Dioxane will be monitored and reported as detailed in the OU remedy review report. Based on the monitoring results, the USDOE, USEPA, and SCDHEC will determine whether or not 1,4-dioxane should be permanently added to the list of monitored constituents.	Complete	SRS performed a comprehensive round of 1,4-dioxane sampling in 2015. The data was reported to the USEPA and SCDHEC in the R-Area Groundwater (NBN) Effectiveness Monitoring Report in Support of R-Area Operable Unit, January 2015 through December 2015 (SRNS-RP-2016-00347, Revision 0, June 2016). Monitoring for 1,4-dioxane is no longer required at the RAOU based on monitoring results and regulatory agreement.	2017

N/A – not applicable

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Table 7. Operable Units without Issues and Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review	
SEMS #:	**24, 25, 27, 77, 82, 95**

Table 8. Issues and Recommendations Identified in the Five-Year Review Report

<table>
<tr><th colspan="5">Issues and Recommendations Identified in the Five-Year Review</th></tr>
<tr><td rowspan="3">OU(s): NA</td><td colspan="4">Issue Category: N/A</td></tr>
<tr><td colspan="4">Issue: None</td></tr>
<tr><td colspan="4">Recommendation: None</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>

N/A – not applicable

Table 9. Protectiveness Statements for the Sixth Five-Year Review Report for SRS OUs with Groundwater Remedies

<table>
<tr><th colspan="3">PROTECTIVENESS STATEMENT(S)</th></tr>
<tr><td><i>Operable Unit:</i>
C-Area Groundwater (CAGW)
SEMS # 82</td><td><i>Protectiveness Determination</i>:
Short-term Protective</td><td><i>Addendum Due Date (if applicable):</i>
N/A</td></tr>
<tr><td colspan="3"><i>Protectiveness Statement:</i>
The remedy at the CAGW OU is protective of human health and the environment in the short-term. In order for the remedy to be protective in the long-term, additional remedial actions, including LUCs (if needed), will need to be implemented.</td></tr>
<tr><td><i>Operable Unit:</i>
Chemical, Metals, and Pesticides (CMP) Pits (080-17G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, 080-190G), SEMS # 24</td><td><i>Protectiveness Determination</i>:
Protective</td><td><i>Addendum Due Date (if applicable):</i>
N/A</td></tr>
<tr><td colspan="3"><i>Protectiveness Statement:</i>
The remedy at the CMP Pits OU is protective of human health and the environment.</td></tr>
<tr><td><i>Operable Unit:</i>
D-Area Oil Seepage Basin (DOSB) (631-G), SEMS #27</td><td><i>Protectiveness Determination:</i>
Protective</td><td><i>Addendum Due Date (if applicable):</i>
N/A</td></tr>
<tr><td colspan="3"><i>Protectiveness Statement:</i>
The remedy at the DOSB OU is protective of human health and the environment.</td></tr>
<tr><td><i>Operable Unit:</i>
L-Area Southern Groundwater (LASG), SEMS #77</td><td><i>Protectiveness Determination:</i>
Protective</td><td><i>Addendum Due Date (if applicable):</i>
N/A</td></tr>
<tr><td colspan="3"><i>Protectiveness Statement:</i>
The remedy at the LASG OU is protective of human health and the environment.</td></tr>
<tr><td><i>Operable Unit:</i>
R-Area Operable Unit (RAOU), SEMS #95</td><td><i>Protectiveness Determination:</i>
Protective</td><td><i>Addendum Due Date (if applicable):</i>
N/A</td></tr>
<tr><td colspan="3"><i>Protectiveness Statement:</i>
The remedy at the RAOU is protective of human health and the environment.</td></tr>
<tr><td><i>Operable Unit:</i>
R-Reactor Area Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin (RRSB), SEMS #25</td><td><i>Protectiveness Determination:</i>
Protective</td><td><i>Addendum Due Date (if applicable):</i>
N/A</td></tr>
<tr><td colspan="3"><i>Protectiveness Statement:</i>
The remedy at the RRSB OU is protective of human health and the environment.</td></tr>
</table>

SIXTH FIVE-YEAR REMEDY REVIEW REPORT PHASED REVIEWS

I. FIVE-YEAR REMEDY REVIEW PHASES

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

The SRS OUs are grouped by the following remedy types:

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

The trigger date for submittal of the next five-year remedy review report to the regulatory agencies is based on the USEPA signature date of the previous report. The final signature for the last grouping of Sixth Five-Year Remedy Review Report is due no later than January 21, 2024. For the sixth five-year remedy review reports, Table A-1 provides a schedule for issuance of the remedy reviews for the five OU remedy groupings to ensure that the five-year limit required between document reviews remains in compliance with Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency.

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

Phase 1: Native Soil Covers and/or LUCs

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

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

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

Phase 2: Groundwater Remedies

For purposes of the sixth five-year phased remedy review, SRS OUs that have monitoring activities associated with Monitored Natural Attenuation (MNA) or a Mixing Zone (MZ) permit are grouped in the Groundwater 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, and configuration of the plume. These attributes are the result of the nature and mass of the source of contamination and the subsurface characteristics in the area 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. In the dilute fringe zone, contaminants are generally low in concentration and can often be treated with passive techniques.

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

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

Phase 3: Engineered Cover Systems

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

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

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

Phase 5: Operating Equipment

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

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

II. SRS OUS WITH REMEDIAL DECISIONS

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

- Table A-3 provides a summary of SRS OUs for remedial actions without operating equipment;
- Table A-4 provides a summary SRS OUs for remedial actions with operating equipment;
- Table A-5 chronologically lists all SRS issued decision documents. Document numbers are provided for reference;
- Table A-6 provides a summary of SRS OUs with the No Remedial Actions selected in the decision documents; and
- Table A-7 provides the list of OUs with remedial actions selected and their associated Superfund Enterprise Management System (SEMS) number.

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

Sixth Five-Year Remedy Review		Seventh Five-Year Remedy Review	
Issuance Year	**Years Between Reviews**	**Issuance Year**	**Remedy Type**
2020	5	2025	Phase 1: Native Soil Covers and/or LUCs
2021[a]	5	2026	Phase 2: Groundwater
2022	5	2027	Phase 3: Engineered Cover Systems
2023	5	2028	Phase 4: Geosynthetic or Stabilization/ Solidification Cover Systems
2024	5	2029	Phase 5: Operating Equipment

[a] Indicates the issue year for this report: Sixth Five-Year Remedy Review Report for SRS OUs with Groundwater Remedies.

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

<table>
<tr><th colspan="2">Native Soil Covers and/or LUCs</th><th colspan="2">Groundwater</th><th colspan="2">Engineered Cover Systems</th><th colspan="2">Geosynthetic or Stabilization/Solidification Cover Systems</th><th colspan="2">Operating Equipment</th></tr>
<tr><th>Submittal Date[a]</th><th>Issuance Year</th><th>Submittal Date[a]</th><th>Issuance Year</th><th>Submittal Date[a]</th><th>Issuance Year</th><th>Submittal Date[a]</th><th>Issuance Year</th><th>Submittal Date[a]</th><th>Issuance Year</th></tr>
<tr><th>2018</th><th>2020</th><th>2019</th><th>2021</th><th>2020</th><th>2022</th><th>2021</th><th>2023</th><th>2022</th><th>2024</th></tr>
<tr><td colspan="2">C-Area Operable Unit</td><td colspan="2">C-Area Groundwater</td><td colspan="2">Central Shops Burning/Rubble Pits (631-1G and 631-3G)</td><td colspan="2">B-Area Operable Unit</td><td colspan="2">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)</td></tr>
<tr><td colspan="2">C-, K-, and L-Reactor Complexes</td><td colspan="2">Chemicals, Metals, and Pesticides Pit (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, 080-190G)</td><td colspan="2">D-Area Burning/Rubble Pits (431-D and 431-1D)</td><td colspan="2">C-Area Reactor Seepage Basins (904-66G, 904-67G, and 904-68G)</td><td colspan="2">A/M Area Groundwater</td></tr>
<tr><td colspan="2">Early Construction and Operational Disposal Site (ECODs) L-1, N-2, P-2, and R-1A, R -1B, R -1C</td><td colspan="2">D-Area Oil Seepage Basin (631-G)</td><td colspan="2">F-Area Hazardous Waste Management Facility (904-41G, 904-42G, 904-43G)</td><td colspan="2">D-Area Expanded Operable Unit Consisting of D-Area Ash Basin (488-D) and D-Area Rubble Pit (431-2D)</td><td colspan="2">A-Area Miscellaneous Rubble Pile (731-6A)</td></tr>
<tr><td colspan="2">F-Area Burning/Rubble Pits (231-F, 231-1F, and 231-2F)</td><td colspan="2">L-Area Southern Groundwater</td><td colspan="2">Ford Building Seepage Basin (904-91G)</td><td colspan="2">E-Area Low-Level Waste Facility (643-26E)</td><td colspan="2">C-Area Burning/Rubble Pit (131-C)</td></tr>
<tr><td colspan="2">Gunsite 012</td><td colspan="2">R-Area Operable Unit[c]</td><td colspan="2">H-Area Hazardous Waste Management Facility (904-44G, 904-45G, 904-46G, 904-56G)</td><td colspan="2">F-Area Retention Basin (281-3F)</td><td colspan="2">D-Area Operable Unit</td></tr>
<tr><td colspan="2">Heavy Equipment Wash Basin (NBN)</td><td colspan="2">R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, and 904-104G) and 108-4R Overflow Basin</td><td colspan="2">K-Area Burning/Rubble Pit and Rubble Pile (131-K and 631-20G)</td><td colspan="2">F-Area Tank Farm</td><td colspan="2">F-Area Groundwater Operable Unit</td></tr>
<tr><td colspan="2">K-Area Bingham Pump Outage Pit (643-1G)</td><td colspan="2"></td><td colspan="2">M-Area Hazardous Waste Management Facility (904-51G and 904-112G)</td><td colspan="2">General Separations Area Consolidation Unit</td><td colspan="2">H-Area Groundwater Operable Unit</td></tr>
</table>

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

Native Soil Covers and/or LUCs		**Groundwater**		**Engineered Cover Systems**		**Geosynthetic or Stabilization/Solidification Cover Systems**		**Operating Equipment**	
Submittal Date[a]	***Issuance Year***	***Submittal Date***[a]	***Issuance Year***	***Submittal Date***[a]	***Issuance Year***	***Submittal Date***[a]	***Issuance Year***	***Submittal Date***[a]	***Issuance Year***
2018	**2020**	**2019**	**2021**	**2020**	**2022**	**2021**	**2023**	**2022**	**2024**
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		M-Area Settling Basin Inactive Process Sewer Lines (081-M)	
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)		TNX Area Operable Unit	
Wetland Area at Dunbarton Bay in Support of Steel Creek IOU[b]						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 ROD was issued in June 2018. This OU was not included in the first phase of the sixth five-year remedy review (i.e., native soil covers and/or LUCs) because the remedy had not been implemented.

c R-Reactor Complex will be discussed as part of R-Area Operable Unit.

Table A-3. Summary of Remedial Actions without Operating Equipment at SRS

Unit Name	FYR Phase	OU	Area Covered (acres)	Volume Covered (yd^3)	Volume Stabilized (yd^3)	Volume Consolidated (yd^3)	Volume Removed (yd^3)	LUC (acres)
Compacted Native Soil								
C-Reactor Complex	1	CKL Rx	0	0	0	0	0	3.4
K-Reactor Complex	1	CKL Rx	0	0	0	0	0	3.8
L-Reactor Complex	1	CKL Rx	0	0	0	0	0	3.5
Early Construction and Operational Disposal Site (ECODS) C-1	1	CAOU	0.16	0	0	0	0	1.27
ECODs L-1	1	ECODS	0.40	0	0	0	0	0.94
ECODs N-2	1	ECODS	0.47	0	0	0	0	1.31
ECODs P-2	1	ECODS	0.18	0	0	0	0	2.42
ECODs R-1A, R-1B, R-1C	1	ECODS	0.3	0	0	0	0	1.76
F-Area Burning/Rubble Pits (231-F, 231-1F, and 231-2F)	1	FBRP	1.18	0	0	0	0	3.8
K-Area Bingham Pump Outage Pit (BPOP) (643-1G)	1	KBPOP	0.55	0	0	0	0	0.59
L-Area BPOP (643-2G and 642-3G)	1	L/P-BPOP	0.31	0	0	0	0	0.73
P-Area BPOP (643-4G)	1	L/P-BPOP	0.28	0	0	0	0	0.41
R-Area BPOP (643-8G, 643-9G and 643-10G) and R-Area Unknown Pits #1, #2, and #3	1	RBPOP	0.88	0	0	0	0	3.1
Silverton Road Waste Unit (731-3A)	1	SRWU	1.36	0	0	0	0	5.3
Central Shops Burning/Rubble Pits (631-1G and 631-3G)	3	CSBRP	0.43	0	0	0	0	2.81
D-Area Burning/Rubble Pits (431-D and 431-1D)	3	DBRP	0.54	0	0	0	0	0.73
A-Area Burning/Rubble Pits (731-A and 731-1A) and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A), Metals Burning Pit (731-5A)	5	ABRP/RP MCB/MBP	9.95	0	0	0	10,200	10.1
M-Area Operable Unit	5	MAOU	0.84	3,600	0	4,350	0	70.9
Land Use Controls Only								
C-Area Operable Unit	1	CAOU	0	0	0	0	0	56.5
Gunsite 012	1	Gunsite 012	0	0	0	0	0	8.9
Heavy Equipment Wash Basin (NBN)	1	HEWB	0	0	0	0	0	0.3
Lower Three Runs IOU Tail Portion (Middle and Lower Subunits)	1	PAR Pond	5535.2	0	0	0	0	5535.2
Water Cover								
PAR Pond (685-G) (Including the Pre-Cooler Ponds and Canals)	1	PAR Pond	1,340	0	0	0	0	2556.1

Table A-3. Summary of Remedial Actions without Operating Equipment at SRS *(continued)*

Unit Name	FYR Phase	OU	Area Covered (acres)	Volume Covered (yd^3)	Volume Stabilized (yd^3)	Volume Consolidated (yd^3)	Volume Removed (yd^3)	LUC (acres)
Geosynthetic Clay (hydraulic conductivity 1E-07 cm/sec, 1E-08 cm/sec)								
General Separations Area Consolidation Unit	4	GSACU	77.3	0	0	50,950	0	86
D-Area Expanded Operable Unit consisting of D-Area Ash Basin (488-D) and D-Area Rubble Pit (431-2D)	4	DEXOU	25	0	0	110,110	74	43.27
E-Area Low-Level Waste Facility (643-26E)	4	E-Area LLWF	13.6	123,072	0	0	0	0
T-Area Operable Unit	4	TAOU	9.4	0	0	1,531	0	47.58
P-Area Reactor Seepage Basin (904-61G, 904-62G, and 904-63G)	4	PRSB	2.3	0	7,400	1,928	0	3.13
R-Area Burning/Rubble Pits (131-R and 131-1R) and Rubble Pile (631-25G)	4	RBRP/RP	0.32	0	0	0	250	0.44
Compacted Clay (hydraulic conductivity 1E-07 cm/sec)								
F-Area Hazardous Waste Management Facilities (HWMFs) (904-41G, 904-42G, and 904-43G)	3	F-HWMF	6.8	0	0	0	0	10
H-Area HWMFs (904-44G, 904-45G, 904-46G, 904-56G)	3	H-HWMF	22.1	0	0	0	0	25
M-Area HWMFs (904-51G and 904-112G)	3	M-HWMF	2.4	0	37,800	39,700	0	4.5
Metallurgical Laboratory HWMF (904-110G)	3	Met Lab HWMF	0.2	0	0	0	0	3.5
Mixed Waste Management Facility (943-28E)	3	MWMF	58	0	0	0	0	85
P-Area Burning/Rubble Pit (131-P)	5	PBRP	0.6	0	0	0	0	0.89
Compacted Clay w/Waste Solidification (hydraulic conductivity 1E-05 cm/sec)								
C-Area Reactor Seepage Basins (904-66G, 904-67G, and 904-68G)	4	CRSB	3.1	0	2,667	0	0	3.1
F-Area Retention Basin (281-3F)	4	FRB	0.59	0	1,150	42	0	1.07
Old F-Area Seepage Basin (904-49G)	4	OFASB	1.8	0	10,154	0	0	1.8
L-Area Reactor Seepage Basin (904-64G)	4	LRSB	1.73	0	0	0	0	1.73
L-Area Oil and Chemical Basin (904-83G)	4	LAOCB	0.45	0	2,170	200	0	1.32
K-Area Reactor Seepage Basin (904-65G)	4	KRSB	0.2	0	583	0	0	0.74
Asphalt/Concrete								
R-Area Operable Unit	2	RAOU	1.55	0	123,091	0	13,404	450
R-Area Reactor Seepage Basin (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, and 904-104G) and 108-4R Overflow Basin	2	RRSB	18.1	0	0	370	0	37.8
Heavy Water Components Test Reactor	4	BAOU	0.15	0	7,208	0	0	0.15
P-Area Operable Unit	4	PAOU	0.86	0	117,981	0	10,905	85.32

Table A-3. Summary of Remedial Actions without Operating Equipment at SRS *(continued/end)*

Unit Name	FYR Phase	OU	Area Covered (acres)	Volume Covered (yd^3)	Volume Stabilized (yd^3)	Volume Consolidated (yd^3)	Volume Removed (yd^3)	LUC (acres)
Compacted Common Fill (no hydraulic conductivity requirement)								
Chemical, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G)	2	CMP Pits	0.3	0	0	0	0	7.1
R-Area Ash Basin (188-R)	2	RAOU	15	0	0	0	0	15
Ford Building Seepage Basin (904-91G)	3	FBSB	0.22	0	0	0	0	0.28
K-Area Burning/Rubble Pit (131-K) and Rubble Pile (631-20G)	3	KBRP	0.8	0	0	10,000	0	1.15
SRL Seepage Basins (904-53G1, 904-53G2, 904-54G, and 904-55G)	3	SRL SB	2.1	0	0	0	6,200	2.56
P-007 Outfall	4	PAOU	4.5	0	0	0	8,000	4.5
P-Area Ash Basin (188-P)	4	PAOU	13.7	0	0	0	0	13.7
A-Area Miscellaneous Rubble Pile (731-6A)	5	AMRP	1.2	0	0	0	23.7	3.08
D-Area Operable Unit (Bubble Tower and Moderator Processing)	5	DAOU	0.7	0	0	16,500	116.7	165
C-Area Burning/Rubble Pit (131-C)	5	CBRP	0.6	0	0	0	0	141.2
D-Area Coal Pile Runoff Basin (489-D) (25% northern portion)	5	DAOU	4.8	0	0	5,720	0	4.96
New TNX Seepage Basin (904-102G)	5	NTSB	0.51	0	0	0	0	2.24

ABRP/RP = A-Area Burning/Rubble Pits and Rubble Pit
AMRP = A-Area Miscellaneous Rubble Pile
BAOU = B-Area Operable Unit
BPOP = Bingham Pump Outage Pits
CAOU = C-Area Operable Unit
CBRP = C-Area Burning/Rubble Pit
CKL Rx = C-, K-, and L-Reactor Complexes
CMP Pits = Chemicals, Metals, and Pesticides Pits
CSBRP = Central Shops Burning/Rubble Pit
CRSB = C-Area Reactor Seepage Basin
DAOU = D-Area Operable Unit
DBRP = D-Area Burning/Rubble Pit
DEXOU = D-Area Expanded Operable Unit
ECODS = Early Construction and Operational Disposal Site
FBRP = F-Area Burning/Rubble Pits
FBSB = Ford Building Seepage Basin
FRB = F-Area Retention Basin
GSACU = General Separations Area Consolidation Unit
HEWB = Heavy Equipment Wash Basin (NBN)
HWMF = Hazardous Waste Management Facility
KBRP = K-Area Burning/Rubble Pit
KRSB = K-Reactor Seepage Basin
LAOCB = L-Area Oil and Chemical Basin
LLWF = Low-Level Waste Facility
LRSB = L-Area Reactor Seepage Basin
MAOU = M-Area Operable Unit
MCB/MBP = Miscellaneous Chemical Basin / Metals Burning Pit
Met Lab = Metallurgical Laboratory
MWMF = Mixed Waste Management Facility
NBN = no building number
NTSB = New TNX Seepage Basin
OFASB = Old F-Area Seepage Basin
PAOU = P-Area Operable Unit
PAR Pond = PAR Pond (685-G) (Including the Pre-Cooler Ponds and Canals) and Lower Three Runs IOU Tail Portion (Middle and Lower Subunits)
PBRP = P-Area Burning/Rubble Pit (131-P)
PRSB = P-Reactor Seepage Basin
RAOU = R-Area Operable Unit
RBRP/RP = R-Area Burning/Rubble Pits and Rubble Pile
RRSB = R-Area Reactor Seepage Basin
SRLSB = SRL Seepage Basin
SRWU = Silverton Road Waste Unit
TAOU = T-Area Operable Unit

cm/sec = centimeter per second
FYR = Five-Year Remedy
yd^3 = cubic yards

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Table A-4. Summary of Remedial Actions with Operating Equipment at SRS

Unit Name	FYR Phase	OU	Start	Finish	ZOI Area (acres)	Volume Treated	Volume Removed	COCs
Pump-and-Treat								
Water Treatment Units								
F-Area Groundwater OU	5	FAGW	1997	2003	250	345,718,674 gal	--	--
H-Area Groundwater OU	5	HAGW	1997	2003	250	347,165,473 gal	--	--
Air Stripper								
A-Area Groundwater OU	5	A/M GW	1992	Ongoing	1,600	1,914,506,457 gal	17,306 lbs	PCE, TCE
M-Area Groundwater OU	5	A/M GW	1983	Ongoing	--	5,267,510,897 gal	508,684 lbs	PCE, TCE
TNX-Area Groundwater OU	5	TNX GW	1996	2007	80	3,500,000 gal	--	--
Airlift Recirculation Pumps								
A/M-Area Groundwater OU	5	A/M GW	1997	Ongoing	0.08	1,900,000,000 gal	--	--
Thermal Treatments								
Dynamic Underground Stripping								
A/M-Area Groundwater OU	5	A/M GW	2000	2001	1.1	1,600,000 gal	70,000 lbs	VOC
A/M-Area Groundwater OU	5	A/M GW	2005	2010	3+	12,000,000 gal	450,000 lbs	VOC
Electrical Resistance Heating with Soil Vapor Extraction								
C-Area Groundwater OU	5	CMP Pits	2006	2006	0.02	1,800 gal	730 lbs	TCE
Chemical, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G)	2	CMP Pits	2008	2009	0.05	5,300 gal	2,300 lbs	VOCs
Detritiation								
D-Area Operable Unit	5	DAOU	2009	2011	--	1,650 gal	472 Ci	Tritium
Soil Vapor Extraction								
Mechanical								
A-Area Burning/Rubble Pits (731-A and 731-1A) and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A), Metals Burning Pit (731-5A)	5	ABRP/RP MCB/MBP	2008	2017	0.34	55,000 yd^3	143 lbs	TCE
Miscellaneous Chemical Basin (731-4A)	5	A/M GW	2001	2002	--	582 yd^3	170 lbs	TCE
A-Area Miscellaneous Rubble Pile (731-6A)	5	AMRP	2004	2017	--	6,000 yd^3	146 lbs	VOCs
A/M-Area Groundwater OU (WSTS)	5	A/M GW	2012	Ongoing	--	--	2,078 lbs	VOCs
A/M-Area Groundwater OU (A014 - 782-3M)	5	A/M GW	1995	Ongoing	--	--	7,424 lbs	VOCs

Table A-4. Summary of Remedial Actions with Operating Equipment at SRS *(continued)*

Unit Name	FYR Phase	OU	Start	Finish	ZOI Area (acres)	Volume Treated	Volume Removed	COCs
Soil Vapor Extraction (continued)								
Mechanical (continued)								
A/M-Area Groundwater OU (A-014 - Mobile #3)	5	A/M GW	2008	Ongoing	--	--	9,211 lbs	VOCs
C-Area Burning/Rubble Pit (131-C)	5	CBRP	2000	2004	0.28	4,500 yd^3	2,100 lbs	VOCs
M-Area Settling Basin Inactive Process Sewer Lines (081-M)	5	MIPSL	2007	Ongoing	0.05	1,200 yd^3	4,474 lbs	PCE, TCE
Chemical, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G) Field A	2	CMP Pits	2002	2005	0.56	9,000 yd^3	9,300 lbs	VOCs
Chemical, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G) Field B	2	CMP Pits	2001	2002	0.21	3,400 yd^3	230 lbs	VOCs
MicroBlowers™								
A-Area Burning/Rubble Pits (731-A and 731-1A) and Rubble Pit (731-2A)	5	ABRP/RP MCB/MBP	2003	Ongoing	0.07	1,200 yd^3	0.44 lbs	VOCs
Miscellaneous Chemical Basin (731-4A), Metals Burning Pit (731-5A)	5	ABRP/RP MCB/MBP	2001	Ongoing	0.04	580 yd^3	9 lbs	VOCs
A/M-Area Groundwater OU (DUS)	5	A/M GW	2006	Ongoing	--	--	2,536 lbs	VOCs
A/M-Area Groundwater OU (WSTS)	5	A/M GW	2015	Ongoing	--	--	682 lbs	VOC
C-Area Burning/Rubble Pit (131-C)	5	CBRP	2004	Ongoing	--	--	682 lbs	VOCs
D-Area Operable Unit (Bubble Tower)	5	DAOU	2010	Ongoing	0.03	465 yd^3	257 lbs	VOCs
M-Area Settling Basin Inactive Process Sewer Lines (081-M)	5	MIPSL	2008	Ongoing	--	4,033 yd^3	40 lbs	VOCs
A-Area Miscellaneous Rubble Pile (731-6A)	5	AMRP	2017	Ongoing	--	--	5 lbs	VOCs
P-Area Operable Unit PSAs 3A and 3B	4	PAOU	2010	2012	--	94,622 yd^3	45 lbs	VOCs
TNX-Area Groundwater OU	5	TNX GW	2007	Ongoing	--	1,500 yd^3	4.81 lbs	VOCs
BaroBalls™								
A-Area Burning/Rubble Pits (731-A and 731-1A) and Rubble Pit (731-2A)	5	ABRP/RP MCB/MBP	2003	Ongoing	0.22	3,500 yd^3	--	--
Miscellaneous Chemical Basin (731-4A)	5	ABRP/RP MCB/MBP	2001	Ongoing	0.19	3,200 yd^3	--	--
A/M-Area Groundwater OU	5	A/M GW	1998	Ongoing	--	--	--	--

Table A-4. Summary of Remedial Actions with Operating Equipment at SRS *(continued/end)*

Unit Name	FYR Phase	OU	Start	Finish	ZOI Area (acres)	Volume Treated	Volume Removed	COCs
Soil Vapor Extraction (continued)								
BaroBalls™ (continued)								
Chemical, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G) Field B	2	CMP Pits	2001	2010	0.21	3,374 yd^3	--	--
M-Area Operable Unit	5	MAOU	2010	Ongoing	0.59	4,350 yd^3	--	--
P-Area Burning/Rubble Pit (131-P)	5	PBRP	2004	Ongoing	0.03	1,400 yd^3	--	--
Injection								
Base Injection with Vertical Barrier Walls								
F-Area Groundwater OU	5	FAGW	2005	Ongoing	--	--	--	--
H-Area Groundwater OU	5	HAGW	2010	Ongoing	--	--	--	--
Edible Oil								
TNX-Area Groundwater OU	5	TNX GW	2008	2010	--	--	--	--

A/M GW = A/M-Area Groundwater
ABRP/RP = A-Area Burning/Rubble Pits and Rubble Pit
AMRP = A-Area Miscellaneous Rubble Pile
CBRP = C-Area Burning/Rubble Pit
CMP Pits = Chemical, Metals, and Pesticides Pits
COC = contaminant of concern
DAOU = D-Area Operable Unit
DUS = Dynamic Underground Stripping
FAGW = F-Area Groundwater
HAGW = H-Area Groundwater
MAOU = M=Area Operable Unit
MCB/MBP = Miscellaneous Chemical Basin / Metals Burning Pit
MIPSL = M-Area Settling Basin Inactive Process Sewer Lines
PAOU = P-Area Operable Unit
PBRP = P-Area Burning/Rubble Pit
PSA = Potential Source Area
TNX GW = TNX Groundwater
WSTS = Western Sector Treatment System
Ci = curies
FYR = Five-Year Remedy
gal = gallon
lbs = pounds
OU = operable unit
PCE = tetrachloroethylene
TCE = trichloroethylene
VOC = volatile organic compound
yd^3 = cubic yards
ZOI = zone of influence

-- No data

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Table A-5. Chronological Listing of SRS Issued Decision Documents

Document Title[a]	Document Number	Rev.	Issuance Date[b]
Consent Decree Signed			***May 26, 1988***
NPL Listing Effective Date			***December 21, 1989***
A/M Area Groundwater IROD (RCRA)	WSRC-RP-92-744	0	September 16, 1992
M-Area Hazardous Waste Management Facility (904-51G, 904-112G) IROD (RCRA)	WSRC-RP-92-743	0	September 16, 1992
Metallurgical Laboratory Hazardous Waste Management Facility (904-110G) IROD (RCRA)	WSRC-RP-92-745	0	September 16, 1992
Federal Facility Agreement Declared Effective			***August 16, 1993***
F-Area Hazardous Waste Management Facility (904-41G, 904-42G, 904-43G) ROD (RCRA)	WSRC-RP-93-1042	1	October 1, 1993
H-Area Hazardous Waste Management Facility (904-44G, 904-45G, 904-46G, 904-56G) ROD (RCRA)	WSRC-RP-93-1043	1	October 1, 1993
Mixed Waste Management Facility (643-28E) ROD (RCRA)[c]	WSRC-RP-93-1511	1	September 23, 1994
Tank 105-C Hazardous Waste Management Facility ROD (RCRA)[c]	WSRC-RP-94-106	1	September 23, 1994
TNX Groundwater Operable Unit IROD[c]	WSRC-TR-94-0375	1	November 16, 1994
PAR Pond (685-G) IROD[c]	WSRC-RP-93-1549	0	February 16, 1995
D-Area Oil Seepage Basin (631-G) IROD[c]	**WSRC-RP-93-1550**	**1**	**March 6, 1995**
F-Area Groundwater Operable Unit (904-41G, 904-42G, 904-43G) IROD (RCRA)[c]	WSRC-RP-94-1162	1	April 13, 1995
H-Area Groundwater Operable Unit (904-44G, 904-45G, 904-45G, 904-56G) IROD (RCRA)[c]	WSRC-RP-94-1163	1	April 13, 1995
M-Area West Unit (631-21G) ROD[c]	WSRC-RP-95-626	0	September 29, 1995
Old Radioactive Waste Burial Ground (643-E) IROD	WRSC-RP-96-102	0	July 25, 1996
Burma Road Rubble Pit (231-4F) ROD	WSRC-RP-96-101	1	July 25, 1996
D-Area Burning/Rubble Pits (431-D, 431-1D) ROD	WSRC-RP-96-867	1	July 3, 1997
F-Area Burning/Rubble Pits (231-F, 231-1F, and 231-2F) ROD	WSRC-RP-96-868	1	July 3, 1997
Grace Road Site (631-22G) ROD	WSRC-RP-96-160	1	July 3, 1997
Gunsite 113 Access Road Unit (631-24G) ROD	WSRC-RP-96-833	1	July 3, 1997
Gunsite 720 Rubble Pit Unit (631-16G) ROD	WSRC-RP-96-832	1	July 3, 1997
Silverton Road Waste Unit (713-3A) ROD	WSRC-RP-96-171	1	July 3, 1997
Central Shops Burning/Rubble Pit (631-6G) ROD	WSRC-RP-96-873	1	July 3, 1997
Old F-Area Seepage Basin (904-49G) ROD	WRSC-RP-96-872	1.1	July 3, 1997
First Five-Year Remedy Review	***WSRC-RP-97-403***	***0***	***August 27, 1997***

Table A-5. Chronological Listing of SRS Issued Decision Documents *(continued)*

Document Title[a]	Document Number	Rev.	Issuance Date[b]
TNX Groundwater Operable Unit ESD	WSRC-RP-97-169	1	October 10, 1997
K-Area Bingham Pump Outage Pit (643-1G) ROD	WSRC-RP-97-178	1	June 11, 1998
C-, F-, K-, and P-Area Coal Pile Runoff Basins (189-C, 289-F, 189-K, 189-P) ROD[c]	WSRC-RP-97-850	1	November 10, 1998
L-Area Oil and Chemical Basin and L-Area Acid/Caustic Basin (904-83G, -79G) ROD	WSRC-RP-97-143	1	November 10, 1998
716-A Motor Shops Seepage Basin (904-101G) ROD	WSRC-RP-97-840	0	November 16, 1998
Fire Department Hose Training Facility (904-113G) ROD	WSRC-RP-97-171	1	November 16, 1998
Old F-Area Seepage Basin (904-49G) ESD	WSRC-RP-98-4123	1	December 16, 1998
D-Area Oil Seepage Basin (631-G) ROD	**WSRC-RP-97-402**	**1**	**May 7, 1999**
C-Area Burning/Rubble Pit (131-C) IROD	WSRC-RP-98-4039	0	May 7, 1999
F-Area Retention Basin (281-3F) ROD	WSRC-RP-97-145	1.1	May 19, 1999
Ford Building Waste Site (643-11G) ROD	WSRC-RP-98-4066	1	October 13, 1999
Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, 080-190G) IROD	**WSRC-RP-98-4192**	**1.1**	**January 19, 2000**
SRL Seepage Basins (904-51G1, 904-52G2, 904-52G, 904-55G) ROD	WSRC-RP-97-848	1.1	April 26, 2000
C-Reactor Seepage Basins (904-66G, 904-67G, 904-68G) Plug-In ROD ESD	WSRC-RP-2000-4032	0	October 18, 2000
L & P Bingham Pump Outage Pits (643-2G, 643-3G, 643-4G) ROD	WSRC-RP-98-4015	1	October 18, 2000
Burma Road Rubble Pit, 231-4F ESD[c]	WSRC-RP-98-4170	1	February 6, 2001
A-Area Burning/Rubble Pits (731-A/1A) and Rubble Pit (731-2A) IROD	WSRC-RP-2000-4001	1	February 9, 2001
Miscellaneous Chemical Basin/Metals Burning Pit (731-4A/5A) IROD	WSRC-RP-98-4031	1.1	February 9, 2001
West of SRL "Georgia Fields" Site (631-19G) ROD	WSRC-RP-99-4164	0	February 22, 2001
F-Area Retention Basin (281-3F) ESD[c]	WSRC-RP-2000-4079	1	June 7, 2001
K-Area Burning/Rubble Pit (131-K & 631-20G) ROD[c]	WSRC-RP-97-862	1	August 8, 2001
ORWBG Old Solvent Tanks (650-01E through 650-22E) IROD	WSRC-RP-2000-4193	1	September 27, 2001
Ford Building Seepage Basin ROD	WSRC-RP-2000-4156	1	April 5, 2002
Chemical, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, 080-190G) IROD Amendment	**WSRC-RP-2000-4158**	**1.2**	**April 8, 2002**
K-Area Reactor Seepage Basin ESD[c]	WSRC-RP-99-4200	1.1	September 16, 2002
General Separations Area Consolidation Unit ROD	WSRC-RP-2002-4002	0	October 25, 2002

Table A-5. Chronological Listing of SRS Issued Decision Documents *(continued)*

Document Title[a]	Document Number	Rev.	Issuance Date[b]
Central Shops Sludge Lagoon (080-24G) ROD	WSRC-RP-2000-4189	1	November 15, 2002
C-Area & L-Area Reactor Seepage Basin ROD Amendment	WSRC-RP-2002-4063	1	December 5, 2002
R-Area Acid/Caustic Basin (904-77G) ROD	WSRC-RP-2002-4015	1	February 10, 2003
L-Area Burning/Rubble Pit (131-L) & Rubble Pile (131-3L) & Gas Cylinder Disposal Facility (131-2L) ROD	WSRC-RP-98-4195	1.1	February 17, 2003
A-Area Burning/Rubble Pits (731-A/731-1A) and Rubble Pit (731-2A) ESD	WSRC-RP-2001-4281	1	March 10, 2003
R-Area Bingham Pump Outage Pits (643-8G, 643-9G and 643-10G) and R-Area Unknown Pits #1, #2, and #3 ROD	WSRC-RP-2001-4129	1.1	April 28, 2003
TNX Area Groundwater Operable Unit ESD[c]	WSRC-RP-2001-00764	0	May 19, 2003
Central Shops Burning/Rubble Pits (631-1G and 631-3G) ROD	WSRC-RP-2001-4265	1.1	June 30, 2003
P-Area Burning/Rubble Pit (131-P) ROD	WSRC-RP-2000-4197	1	August 8, 2003
A-Area Miscellaneous Rubble Pile (731-6A) ROD	WSRC-RP-2001-4197	1.3	August 11, 2003
P-Area Reactor Seepage Basin (904-61G, 904-62G, 904-63G) Plug-In ROD ESD	WSRC-RP-2002-4105	1.1	October 2, 2003
Chemical, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, 080-190G) Second IROD Amendment	**WSRC-RP-2001-4232**	**1.1**	**October 21, 2003**
L-Area Hot Shop (717-G) ROD	WSRC-RP-2002-4025	1.1	November 3, 2003
Road A Chemical Basin (904-111G) ROD	WSRC-RP-2002-4153	0	November 3, 2003
Second Five-Year Remedy Review[c]	***WSRC-RP-2001-4163***	***1.1***	***February 12, 2004***
R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G and 108-4R Overflow Basin) ROD	**WSRC-RP-2003-4093**	**1**	**March 18, 2004**
TNX Burying Ground (643-G), New TNX Seepage Basin, Old TNX Seepage Basin and TNX Groundwater (082-G) ROD	WSRC-RP-2003-4017	1	April 7, 2004
SRL Oil Test Site (808-16G) ROD	WSRC-RP-2003-4164	1	September 20, 2004
R-Area Burning/Rubble Pits (131-R and 131-1R) and Rubble Pile (631-25G) ROD	WSRC-RP-2004-4004	1	September 28, 2004
C-Area Reactor Groundwater IROD	**WSRC-RP-2004-4022**	**1**	**October 15, 2004**
D-Area Expanded Operable Unit (Consisting of D-Area Ash Basin, 488-D and D-Area Rubble Pit, 431-2D) ROD	WSRC-RP-2004-4007	1	December 17, 2004
Old F-Area Seepage Basin (904-49G) ROD Amendment	WSRC-RP-2003-4136	1	December 17, 2004
Heavy Equipment Wash Basin and Central Shops Burning/Rubble Pit (631-5G) ROD	WSRC-RP-2003-4185	1.1	January 28, 2005

Table A-5. Chronological Listing of SRS Issued Decision Documents *(continued)*

Document Title[a]	**Document Number**	**Rev.**	**Issuance Date[b]**
Chemical, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, 080-190G) ROD	**WSRC-RP-2004-4090**	**1**	**May 10, 2005**
Silverton Road Waste Unit ESD	WSRC-RP-2004-4092	1.1	June 16, 2005
TNX Area OU ESD	WSRC-RP-2005-4030	1	November 7, 2005
Hydrofluoric Acid Spill (631-4G) ROD	WSRC-RP-2005-4000	0	December 28, 2005
T-Area OU ROD	WSRC-RP-2004-4070	1	January 4, 2006
K-Area Sludge Land Application Site (761-4G) and PAR Pond Sludge Land Application Site (761-5G) ROD	WSRC-RP-2005-4064	1	June 30, 2006
211-FB Pu-239 Release (081-F) ROD	WSRC-RP-2005-4090	1	September 18, 2006
M-Area Inactive Process Sewer Lines (081-M) ROD	WSRC-RP-2006-4001	1	April 26, 2007
L-Area Southern Groundwater ROD	**WSRC-RP-2006-4052**	**1.1**	**May 9, 2007**
A-Area Burning/Rubble Pits and Rubble Pit (731-A, 731-1A, 731-2A) and the Miscellaneous Chemical Basin/Metals Burning Pit (731-4A, 731-5A) ROD	WSRC-RP-2005-4095	1.1	August 2, 2007
C-Area Burning/Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) ROD	WSRC-RP-2007-4082	1	July 9, 2008
Third Five-Year Remedy Review	***WSRC-RP-2007-4063***	***1.1***	***January 28, 2009***
P-Area Operable Unit Early Action ROD	WSRC-RP-2008-4037	1.1	January 29, 2009
M-Area Operable Unit ROD	WSRC-RP-2008-4030	1	February 5, 2009
M-Area Operable Unit ESD	SRNS-RP-2009-00406	1	July 9, 2009
P-Area Operable Unit Early Action ROD ESD	SRNS-RP-2009-00704	1	October 27, 2009
C-, K-, L- and R-Reactor Complexes Early Action ROD	**SRNS-RP-2009-00707**	**1**	**December 8, 2009**
E-Area Low Level Waster Facility (Slit Trench Disposal Units 1 and 2) IROD	SRNS-RP-2009-00538	1	January 22, 2010
Early Construction and Operational Disposal Site L-1, N-2, P-2, R-1A, R-1B, R-1C ROD	SRNS-RP-2009-00072	1	March 30, 2010
E-Area Low Level Waste Facility (Slit Trench Disposal Units 1 and 2) ESD	SRNS-RP-2009-01128	1	April 22, 2010
P-Area Operable Unit ROD	SRNS-RP-2009-01368	1	July 22, 2010
Gunsite 218 Rubble Pile ROD	SRNS-RP-2010-00051	1	October 22, 2010
R-Area Operable Unit ROD	**SRNS-RP-2010-01062**	**1**	**April 20, 2011**
L-Area Northern Groundwater ROD	SRNS-RP-2011-00134	1	June 20, 2011
Gunsite 012 (including ECODS G-3) ROD	SRNS-RP-2010-01232	1	June 27, 2011
D-Area Operable Unit Early Action ROD	SRNS-RP-2010-00162	1.2	September 26, 2011
PAR Pond Unit: Lower Three Runs IOU Tail Portion (Middle and Lower Subunits) ESD	SRNS-RP-2012-00121	1	September 13, 2012
B-Area Operable Unit ROD	SRNS-RP-2012-00354	1	April 16, 2013

Table A-5. Chronological Listing of SRS Issued Decision Documents *(continued/end)*

Document Title[a]	Document Number	Rev.	Issuance Date[b]
F-Area Tank Farm, Waste Tanks 17 and 20 IROD	SRR-CWDA-2013-00111	1	April 30, 2013
TNX Area Operable Unit (Second ESD to the ROD)	SRNS-RP-2012-00205	1	June 12, 2013
F-Area Tank Farm (Tanks 18 and 19 ESD to the IROD)	SRR-CWDA-2013-00007	1.1	September 23, 2013
Fourth Five-Year Remedy Review	***SRNS-RP-2012-00011***	***1.1***	***February 4, 2014***
L-Area Southern Groundwater Operable Unit (ESD to the ROD)	**SRNS-RP-2012-00736**	**1**	**September 10, 2014**
F-Area Tank Farm (Tanks 5 and 6 ESD to the IROD)	SRR-CWDA-2014-00008	1	September 11, 2014
C-Area Operable Unit Early Action ROD	SRNS-RP-2014-00836	1	September 2, 2015
Fifth Five-Year Remedy Review for SRS OUs with Native Soil Covers and/or LUCs	***SRNS-RP-2014-00902***	***1***	***November 30, 2015***
H-Area Tank Farm (Waste Tank 16) IROD	SRR-CWDA-2015-00157	1	August 16, 2016
Fifth Five-Year Remedy Review for SRS OUs with Groundwater Remedies	***SRNS-RP-2015-00419***	***1***	***February 2, 2017***
H-Area Tank Farm (Waste Tank 12) ESD to the IROD	SRR-CWDA-2016-00107	0	April 20, 2017
Fifth Five-Year Remedy Review for SRS OUs with Engineered Covers	***SRNS-RP-2016-00609***	***1***	***February 21, 2018***
Fifth Five-Year Remedy Review for SRS OUs with Geosynthetic or S/S Cover Systems	***SRNS-RP-2016-00610***	***1***	***March 27, 2018***
Wetland Area at Dunbarton Bay in Support of Steel Creek Integrator Operable Unit ROD[d]	**SRNS-RP-2013-00730**	**1**	**June 20, 2018**
Fifth Five-Year Remedy Review Report for SRS OUs with Operating Equipment	***SRNS-RP-2017-00567***	***1***	***December 5, 2018***
G-Area Oil Seepage Basin (761-13G) Operable Unit ROD	SRNS-RP-2018-01050	1	June 26, 2019
Sixth Five-Year Remedy Review Report for SRS OUs with Native Soil Covers and/or LUCs	***SRNS-RP-2018-00811***	***1***	***November 5, 2019***

a Shaded text identifies the SRS OUs evaluated in this report for the second phase of the sixth five-year remedy review (i.e., groundwater remedies).

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 Wetland Area at Dunbarton Bay (WADB) is included in the native soil covers and/or LUCs phase. However, since the sixth five-year remedy review document development will occur before completion of the remedy implementation, WADB will not be included in this review cycle.

RCRA – Resource Conservation and Recovery Act

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Table A-6. Summary of No Remedial Actions at SRS OUs

Operable Unit	Remedial Action
No Action/No Further Action	
211-FB Pu-239 Release (081-F)	No Action
716-A Motor Shops Seepage Basin (904-101G)	No Action
Burma Road Rubble Pit (231-4F)	No Action
Central Shops Burning/Rubble Pit (631-6G)	No Action
Central Shops Sludge Lagoon (080-24G)	No Action
C-, F-, K-, and P-Area Coal Pile Runoff Basins (189-C, 289-F, 189-K, 189-P)	No Further Action
Fire Department Hose Training Facility (904-113G)	No Action
Ford Building Waste Site (643-11G)	No Further Action (Removal)
G-Area Oil Seepage Basin (761-13G)	No Action
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
L-Area Rubble Pile (131-3L)	No Action
M-Area West Unit (631-21G)	No Action
R-Area Acid/Caustic Basin (904-77G)	No Action
Road A Chemical Basin (904-111G)	No Action
SRL Oil Test Site (080-16G)	No Action
West of SRL "Georgia Fields" Site (631-19G)	No Action
No Action/No Further Action OUs Associated with OUs Requiring Remedial Action	
108-4R Overflow Basin (108-4R)[1]	No Further Action
Central Shops Burning/Rubble Pit (631-5G)[2]	No Action
ECODS B-3 and B-5 (NBN)[3]	No Further Action
ECODS G-3 (Adjacent to Gunsite 012) (NBN)[4]	No Action
L-Area Acid/Caustic Basin (904-79G)[5]	No Action
Rubble Pile Across from Gunsite 012 (NBN)[4]	No Action
RCRA Units that are No Further Action under CERCLA	
H-Area Hazardous Waste Management Facility (904-44G, 904-45G, 904-46G, 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, 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 (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, and 904-104G)
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)

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Table A-7. List of OU Subunits with Remedial Actions

#	OU Subunits[a,b]	SEMS #
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	48
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, R-1B, R-1C, NBN	
	ECODS N-2, NBN	

Table A-7. List of OU Subunits with Remedial Actions *(continued)*

#	OU Subunits[a,b]	SEMS #
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 (904-41G, 904-42G, 904-43G)	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 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	
	HP-52 Ponds, NBN	
25	Gunsite 012 Rubble Pile, NBN	78
26	H-Area Groundwater OU	9
27	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)	
28	H-Area Tank Farm, Waste Tank 12	89
	H-Area Tank Farm, Waste Tank 16	
29	Heavy Equipment Wash Basin, NBN	25
30	K-Area Bingham Pump Outage Pit, 643-1G	20
31	K-Area Burning/Rubble Pit, 131-K	40
	K-Area Rubble Pile, 631-20G	
32	K-Area Reactor Seepage Basin, 904-65G	55
33	L-Area Bingham Pump Outage Pit, 643-2G	26
	L-Area Bingham Pump Outage Pit, 643-3G	
	P-Area Bingham Pump Outage Pit, 643-4G	39
34	L-Area Oil Chemical Basin, 904-83G	17
35	L-Area Reactor Seepage Basin, 904-64G	65
36	L-Area Southern Groundwater, NBN	77
37	M-Area Hazardous Waste Management Facility: Lost Lake, 904-112G	1
	M-Area Hazardous Waste Management Facility: M-Area Settling Basin, 904-51G	
38	M-Area Settling Basin Inactive Process Sewers to Manhole 1, 081-M	19

Table A-7. List of OU Subunits with Remedial Actions *(continued)*

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

Table A-7. List of OU Subunits with Remedial Actions *(continued/end)*

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

c Wetland Area at Dunbarton Bay (WADB) is included in the native soil covers and/or LUCs phase. However, since the sixth five-year remedy review document development will occur before completion of the remedy implementation, WADB will not be included in this review cycle.

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 2015 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 2016).

An evaluation was performed for analytes that were identified as constituents of concern (COCs) for the OUs evaluated. As discussed in Appendix A, the OUs evaluated in this report were grouped in the Groundwater category because they have monitoring activities associated with Monitored Natural Attenuation or a Mixing Zone permit. However, these OUs may also have subunits with COCs in soil or building material (concrete and metal) media in addition to groundwater as documented in the respective remedy selection documents. For this reason, an evaluation of changes in standards and toxicity values for chemical and radiological COCs identified in soil, concrete, and groundwater media is shown in Tables B-1 through B-6.

The United States Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) for Nonradiological Constituents (May 2019), USEPA Preliminary Remediation Goals (PRGs) for Radionuclides (January 2019), USEPA Surface Preliminary Remediation Goals (SPRGs) for Radionuclides (May 2018), and USEPA Maximum Contaminant Levels (MCLs) for radiological and chemical constituents were evaluated in this review. These values are identified as 2019 RSLs, 2019 PRGs, 2019 SPRGs, or MCLs in Tables B-1 through B-6 and were compared to the values available in 2015 when the last five-year remedy review for OUs in the Groundwater category 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-6 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 H.

Changes to a standard or toxicity factor are 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.

In 2016, a major revision to the approach for calculating PRGs was announced by USEPA. The primary change was that the plus daughters (+D) isotopes designation was removed and the secular equilibrium PRG calculation was identified as the preferred (i.e., default) value. The PRGs for each daughter are combined with the parent on a fractional basis to produce a single PRG for the parent, and the resulting PRG is based on secular equilibrium of the full chain regardless of half-life. By comparison, the PRG (+D) values available in 2015 only included daughter products with a half-life of six months or less. For this reason, the difference in the criteria for inclusion of the daughter products must be considered when comparing the 2015 and 2019 PRG values.

There are two entries for the 2019 PRGs in Tables B-2, B-3, and B-6. 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 secular equilibrium 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 H. The evaluations shown in Tables B-1 through B-6 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, 2016. *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, LLC, Savannah River Site, Aiken, SC

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

Analyte[a]	2015 RSLs[b] Residential Soil (mg/kg)	2015 RSLs[b] Industrial Worker Soil (mg/kg)	2019 RSLs[c] Residential Soil (mg/kg)	2019 RSLs[c] Industrial Worker Soil (mg/kg)	SEMS Number(s)[d]
Arsenic	6.8E-01	3.0E+00	6.8E-01	3.0E+00	95
p,p'-dichorodiphenyl dichloroethane (DDD)	2.3E+00	9.6E+00	1.9E+00	9.6E+00	24
p,p'-dichlorodiphenyl dichloroethylene (DDE)	2.0E+00	9.3E+00	2.0E+00	9.3E+00	24
p,p'-dichlorodiphenyl trichloroethylene (DDT)	1.9E+00	8.5E+00	1.9E+00	8.5E+00	24
Dieldrin	3.4E-02	1.4E-01	3.4E-02	1.4E-01	24
Endrin	1.9E+01	2.5E+02	1.9E+01	2.5E+02	24
Heptachlor epoxide	7.0E-02	3.3E-01	7.0E-02	3.3E-01	24
PCBs (Aroclor 1254)	2.4E-01	9.7-01	2.4E-01	9.7-01	24

[a] Analytes listed were identified as COCs for the OUs discussed in Appendix C through Appendix H.

[b] USEPA Nonradiological RSLs for soil, June 2015.

[c] USEPA Nonradiological RSLs for soil, May 2019.

[d] OUs and corresponding SEMS number(s) are identified in Appendix A, Table A-7.

mg/kg = milligrams per kilogram
PCBs = polychlorinated biphenyls
SEMS = Superfund Enterprise Management System

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

Analyte[a]	2015 PRGs[b]		2019 PRGs[c]		SEMS Number(s)[d]
	Residential Soil (ρCi/g)	Industrial Worker Soil (ρCi/g)	Residential Soil (ρCi/g)	Industrial Worker Soil (ρCi/g)	
Americium-241	2.3E+00	4.7E+00	2.3E+00 (5.2E-02)	4.7E+00 (8.4E-02)	25
Cesium-137(+D)	6.1E-02	9.1E-02	2.5E+01 (4.6E-02)	5.7E+01 (6.9E-02)	25, 95
Cobalt-60	3.3E-02	4.8E-02	3.3E-02 (9.4E-03)	4.8E-02 (1.4E-02)	25, 95
Europium-154	4.7E-02	7.0E-02	4.7E-02 (2.0E-02)	7.0E-02 (3.0E-02)	95
Plutonium-238	4.3E+00	1.4E+01	4.3E+00 (1.3E-02)	1.4E+01 (2.0E-02)	25
Plutonium-239	3.8E+00	1.2E+01	3.8E+00 (4.5E-02)	1.2E+01 (7.3E-02)	25
Plutonium-240	3.8E+00	1.2E+01	3.8E+00 (9.8E-03)	1.2E+01 (1.5E-02)	25
Potassium-40	1.4E-01	2.2E-01	1.4E-01 (1.4E-01)	2.2E-01 (2.2E-01)	95
Radium-226(+D)	1.4E-02	2.1E-02	1.0E+00 (1.3E-02)	3.1E+00 (2.0E-02)	95
Strontium-90(+D)	4.2E+00	9.0E+00	1.3E+01 (3.1E+00)	3.8E+01 (6.8E+00)	25, 95
Tritium	2.4E-01	3.0E-01	2.4E-01 (1.3E-01)	3.0E-01 (1.6E-01)	95
Uranium-235(+D)	1.9E-01	3.0E-01	2.0E-01 (4.6E-02)	3.2E-01 (7.3E-02)	95
Uranium-238(+D)	8.0E-01	1.4E+00	6.5E+00 (1.2E-02)	3.1E+01 (2.0E-02)	95

a Analytes listed were identified as COCs for the OUs discussed in Appendix C through Appendix H.
b USEPA Radiological PRGs for soil, November 2014.
c USEPA Radiological PRGs for soil, January 2019. Top entry for each constituent is the PRG for the individual radionuclide (no progeny included, with decay). Bottom entry (in parenthesis) is the default secular equilibrium PRG that includes daughter products from the entire decay chain.
d OUs and corresponding SEMS number(s) are identified in Appendix A, Table A-7.

mg/kg = milligrams per kilogram
ρCi/g = picoCuries per gram
SEMS = Superfund Enterprise Management System

Table B-3. Comparison of Radiological Standards in Concrete Media

	2015 SPRGs[b]	2019 SPRGs[c]	
Analyte[a]	Industrial Worker Concrete (ρCi/g)	Industrial Worker Concrete (ρCi/g)	SEMS Number(s)[d]
Americium-241(+D)	6.0E+00	6.5E+00 (8.7E-02)	95
Americium-243(+D)	2.7E-01	1.8E+00 (5.8E-02)	95
Barium-133	3.0E-01	2.5E-01 (1.2E-01)	95
Cesium-137(+D)	1.2E-01	4.2E+02 (6.9E-02)	95
Cobalt-60	7.0E-02	4.8E-02 (1.4E-02)	95
Europium-152	7.0E-02	5.8E-02 (3.2E-02)	95
Nickel-63	-- [e]	-- [e]	95
Silver-108m	3.2E-02	2.5E-02 (2.5E-02)	95
Strontium-90(+D)	7.3E+00	5.4E+02 (9.0E+00)	95

[a] Analytes listed were identified as COCs for the OUs discussed in Appendix C through Appendix H.

[b] USEPA Radiological SPRGs for concrete, September 2014.

[c] USEPA Radiological SPRGs for concrete, May 2018. Top entry for each constituent is the PRG for the individual radionuclide (no progeny included, with decay). Bottom entry (in parenthesis) is the default secular equilibrium PRG that includes daughter products from the entire decay chain.

[d] OUs and corresponding SEMS number(s) are identified in Appendix A, Table A-7.

[e] PRG for nickel-63 was not published in the September 2014 or May 2018 update.

ρCi/g = picoCuries per gram
SEMS = Superfund Enterprise Management System

Table B-4. Comparison of Nonradiological Standards in Groundwater Media (RSLs)

Analyte[a]	2015 RSL[b] (µg/L)	2019 RSL[c] (µg/L)	SEMS Number(s)[d]
alpha-Benzene hexachloride (α-BHC)	7.1E-03	7.2E-03	24
beta-Benzene hexachloride (β-BHC)	2.5E-02	2.5E-02	24
delta-Benzene hexachloride (δ-BHC)	2.5E-02	2.5E-02	24
Dieldrin	1.7E-03	1.8E-03	24

[a] Analytes listed were identified as COCs for the OUs discussed in Appendix C through Appendix H.

[b] USEPA Nonradiological RSLs for tapwater, June 2015.

[c] USEPA Nonradiological RSLs for tapwater, May 2019.

[d] OUs and corresponding SEMS number(s) are identified in Appendix A, Table A-7.

µg/L = micrograms per liter
SEMS = Superfund Enterprise Management System

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

Analyte[a]	**MCL (µg/L)**[b]	**SEMS Number(s)**[c]
PCBs (Aroclor-1254)	5.0E-01[c]	95
Benzene	5.0E00	27
Bis(2-ethylhexl) phthalate (BEHP)	6.0E00	24
Carbon tetrachloride	5.0E00	24, 95
1,1-Dichloroethene (1,1-DCE)	7.0E00	27
Chloroform	8.0E+01	95
cis-1,2-Dichloroethene (cis-1,2-DCE)	7.0E+01	27, 95
Dichloromethane (Methylene chloride)	5.0E00	24, 27
Lead	1.5E+01[d]	95
Lindane	2.0E-01	24
Tetrachloroethylene (PCE)	5.0E00	24, 27, 77
Trichloroethylene (TCE)	5.0E00	24, 27, 77, 82, 95
Trihalomethanes (Total)	8.0E+01	24
Vinyl chloride (VC)	2.0E00	27, 95

[a] Analytes listed were identified as COCs for the OUs discussed in Appendix C through Appendix H.

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

[c] OUs and corresponding SEMS number(s) are identified in Appendix A, Table A-7.

[d] MCL used for contaminant migration analysis. Constituent is not a groundwater COC.

µg/L = micrograms per liter
PCBs = polychlorinated biphenyls
SEMS = Superfund Enterprise Management System

Table B-6. Radiological Standards in Groundwater Media (PRGs/MCLs)

Analyte[a]	2015 PRG (ρCi/L)[b]	2019 PRG (ρCi/L)[c]	MCL (ρCi/L)[d]	SEMS Number(s)[e]
Americium-241	--	--	1.5E+01[f]	25
Carbon-14	--	--	2.0E+03[g,h]	25, 95
Chlorine-36	--	--	7.0E+02[g,h]	95
Iodine-129	--	--	1.0E00[g,h]	95
Molybdenum-93	6.8E00[g]	1.7E+01[g] (1.4E+01)	--	95
Nickel-59	--	--	3.0E+02[g,h]	95
Niobium-94	4.2E00[g]	6.7E+00[g] (6.7E+00)	--	95
Plutonium-239/240	--	--	1.5E+01[f,g]	25
Potassum-40	80E-01[g]	2.1E+00[g] (2.1E+00)	--	95
Silver-108m	4.2E00[g]	6.5E+00[g] (6.5E+00)	--	95
Strontium-90	--	--	8.0E00[h]	25
Tritium	--	--	2.0E+04[h]	77, 95

a Analytes listed were identified as COCs for the OUs discussed in Appendix C through Appendix H.
b USEPA Radiological PRGs for tapwater, June 2015.
c USEPA Radiological PRGs for tapwater, January 2019. Top entry for each constituent is the PRG for the individual radionuclide (no progeny included, with decay). Bottom entry (in parenthesis) is the default secular equilibrium PRG that includes daughter products from the entire decay chain.
d USEPA Radioactivity in Drinking Water, Appendix III (January 1981). Comparative analysis is not shown for MCLs because standards have not changed since the previous five-year remedy review.
e OUs and corresponding SEMS number(s) are identified in Appendix A, Table A-7.
f Gross alpha particle activity = 15 ρCi/L
g PRG/MCL used for contaminant migration analysis. Constituent is not a groundwater COC.
h Man-made beta/gamma emitters = 4 mrem/year dose

mrem = millirem
ρCi/L = picoCuries per liter
SEMS = Superfund Enterprise Management System

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C-AREA GROUNDWATER OPERABLE UNIT

I. Introduction

This is the fourth five-year remedy review for the C-Area Groundwater (CAGW) Operable Unit (OU). The review was conducted from August 2019 through November 2019. Contaminants have been left in place at the CAGW OU at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the interim action remedy in place at the CAGW OU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table C-1 lists the chronology of site events for the CAGW OU.

III. Background

The CAGW OU is listed as a Resource Conservation and Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act unit in Appendix C of the Federal Facility Agreement (FFA) for the Savannah River Site (SRS) (FFA 1993). The media associated with the CAGW OU are the vadose zone soil (source area), surface water, and groundwater.

Physical Characteristics

CAGW OU is located in the west-central portion of the SRS, entirely within the Fourmile Branch watershed (Figure C-1). CAGW OU encompasses groundwater below C Area, north to unnamed tributaries of Fourmile Branch, west to Fourmile Branch, and south to Castor Creek (Figure C-2), which comprises approximately 3.29 km^2 (1.27 mi^2).

The hydrogeologic conceptual site model for the interim action for the CAGW OU depicts contamination from volatile organic compounds (VOCs), primarily trichloroethylene (TCE), and tritium above their respective maximum contaminant levels (MCLs). The contamination originated in C Area from reactor operations and migrated through the vadose zone to the Transmissive Zone (TZ) of the Upper Three Runs Aquifer (UTRA). Contaminants in the TZ are readily transported west toward Fourmile Branch and to the south towards Castor Creek. Below the TZ is the Tan Clay Confining Zone (TCCZ), which is composed of the Upper Tan Clay Layer, the Middle Aquifer Zone (MAZ), and a Lower Tan Clay Layer. The TCCZ inhibits downward migration of contaminants into the Lower Aquifer Zone (LAZ) of the UTRA. However, the Upper Tan Clay Layer is discontinuous in places and downward contaminant migration does occur, primarily contaminating the MAZ and to a lesser extent the LAZ. The contaminated groundwater in the MAZ and LAZ discharges into Fourmile Branch or Castor Creek (SRNS 2014a).

CAGW OU is currently monitored by the following:

- Fifty-six groundwater monitoring wells;
- Eight seepline monitoring stations; and
- Sixteen surface water sampling stations.

Periodic groundwater monitoring in CAGW OU began in 1983 and continues to the present. The VOC contamination in C-Area groundwater that originated from the C-Area Burning/Rubble Pit (131-C) (CBRP) OU, mainly TCE and tetrachloroethylene (PCE), is being addressed by the CBRP OU.

Land and Resource Use

The CAGW OU sources are located within an industrial use area, but the distal portion of the groundwater plume extends beyond the industrial use boundary. However, shallow groundwater and surface water at SRS are not used for drinking water, hygiene, recreation, or process water. According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The future land use for the CAGW OU is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

In 1955, C-Reactor began operations with a mission of producing nuclear materials for the defense program. C-Reactor was placed in cold standby in 1987, followed by shutdown due to reduced requirements for the defense-related products. Known sources associated with reactor operations resulted in tritium and VOC contamination in groundwater.

During reactor operations, TCE was released to the soil at a manhole along a storm sewer line south of the C-Reactor Building (105-C). A TCE groundwater plume extending from the C-Reactor Building (105-C) to Castor Creek, where the TCE plume discharges south of C Area. Figure C-3 shows the location of the TCE vadose zone (the unsaturated zone above the water table) source relative to the reactor building, the location of soil borings, and monitoring well data in 2002. An Interim Record of Decision (IROD) for the TCE vadose zone source area was issued on October 15, 2004 (WSRC 2004a). The interim remedial action selected in the IROD was Electrical Resistance Heating (ERH) with Soil Vapor Extraction (SVE). The purpose of the interim remedial action was to reduce vadose zone TCE concentrations to levels that would not exceed the MCL (5 μg/L), if the contaminant leached into the groundwater. Groundwater monitoring during 2012 to 2019 found that TCE concentrations are still above its MCL (5 μg/L) but declining (Figure C-4). PCE has been below its MCL (5 μg/L) since 2006.

Tritium was produced during the operation of the reactor and was released from numerous sources. No tritium has been produced since C-Reactor was shut down in June 1985. Other than atmospheric releases, the two primary discharge areas for tritium were the C-Area Discharge Canal and the C-Area Reactor Seepage Basins (CRSBs). Characterization data indicated contaminants released to the C-Area Discharge Canal from C-Reactor operations were carried by high discharge flows to Fourmile Branch. The CRSBs, a known historical source of tritium and other radionuclides, were remediated using low-permeability grout stabilization of basin soils as documented in the *Post-Construction Report/Final Remediation Report for the C-Area Reactor Seepage Basins (904-66G, -67G, and -68G) Operable Unit* (WSRC 2003). Although tritium concentrations are still above the MCL (20 pCi/mL), groundwater and surface water data collected from 2014 through 2019 indicate the size and concentration of the CAGW OU tritium plume has significantly decreased relative to the original 1998 to 2002 characterization (Figure C-5) (SRNS 2014a). The IROD did not address tritium in the groundwater; therefore, tritium is not part of this remedy review. However, tritium will continue to be monitored to document the decreasing trend and will be addressed in the final CAGW OU ROD that is proposed to be issued in April 2027.

Initial Response

The nature and extent of groundwater contamination within the CAGW OU was comprehensively investigated between 1998 and 2002. The results were presented in the RCRA Facility Investigation (RFI) / Remedial Investigation (RI) Report (WSRC 2004b).

Basis for Taking Action

The RFI/RI characterization data indicated that groundwater concentrations of TCE in the vicinity of the manhole along a storm sewer line south of the C-Reactor Building (105-C) exceeded its MCL (5 µg/L) by 2,600 times, at 13,000 µg/L. The 2019 TCE plume (Figure C-4) extends from south of the C-Reactor Building to over 1.6 km (1 mi) downgradient to Castor Creek. In 2002, residual TCE (maximum = 51.846 mg/kg) in the vadose zone soil was present at levels that were still impacting groundwater. Although shallow groundwater aquifers at SRS are not used as drinking water sources, the potential for unacceptable human exposure to contaminated groundwater exists as long as TCE remains above its MCL. Thus, control of the migration of TCE was necessary through a source control action. The geometry of the TCE vadose zone source is a vertical cylinder approximately 18 m (60 ft) in diameter extending 21 m (70 ft) below ground surface.

IV. Remedial Actions

Remedy Selection

As stated in the IROD for CAGW OU (WSRC 2004a), the interim remedial action objective (RAO) is to reduce TCE concentrations in the vadose zone so that any leaching of the contaminant will not cause groundwater to exceed the MCL (5µg/L). The selected interim action remedy was ERH with SVE. The constituents of concern and remedial goals selected for the interim action are provided in Table C-2.

Tritium contamination in groundwater and surface water was not addressed in the IROD (WSRC 2004a). The final remedial action for the tritium and VOC contamination at the CAGW OU will be documented in the final CAGW OU ROD that is proposed to be issued in April 2027.

Remedy Implementation

Interim Remedial Action – Electrical Resistance Heating

Implementation of the interim remedial action for CAGW OU consisted of the following activities:

- Installed ERH system with a single six-phase heating array consisting of six input electrode/SVE wells equally spaced around the circumference of a 9-m (30-ft) diameter circle. A central neutral electrode/SVE well was centered on the highest contaminant levels in the TCE source. Two SVE wells and two electrodes were installed in a single large well boring at each of the seven locations. An electrolyte addition system was installed.
- Installed an active SVE unit skid consisting of a 300 ft^3/min blower, condensate tank, knockout pot, water/vapor separator, heat exchanger and cooling tower.

ERH used the electrical resistance of soil to heat the soil in-situ using an electrical current. The electrolyte drip tube was used to provide the means to inject an electrolyte solution into the electrode to increase conductivity between the electrode and the soil interface. The heat vaporized VOCs in the soil. These vapors were withdrawn by the SVE system, via a manifold to a vacuum pumping system, treated and discharged per an air quality control permit. Figure C-6 is a generalized graphic of an ERH with SVE system.

Systems Operations/Operation and Maintenance

Currently, there are no remedial systems operating. ERH with SVE operated from June 15, 2006 until the IROD shutdown criterion was met on September 7, 2006. The SVE system continued to operate until September 28, 2006 with 730 lbs of TCE removed during operations (WSRC 2007). The shutdown criterion was met when the temperature in the treatment zone exceeded 189ºF (boiling point of TCE) for at least 30 days cumulatively.

The following actions will be conducted at the CAGW OU until the scheduled FFA final remedial action start date of July 2028:

- Groundwater monitoring as required by the Interim Remedial Action Implementation Plan Effectiveness Monitoring Plan (WSRC 2005). The groundwater wells CRW020D, CRW021DR, and CRW-1D (background) monitor groundwater TCE and tritium concentrations, which are performance measures of the completed ERH system operations.

Costs associated with the selected interim action remedy for the CAGW OU include operation and maintenance (O&M) costs as reported in the IROD (WSRC 2004a). ERH with SVE activity was completed in 2006 and the remaining O&M cost is associated with groundwater monitoring. The estimated O&M cost since the last remedy review is $0 for Fiscal Year (FY) 2015 through FY2019 because costs beyond FY2013 were not included in the original estimate. The actual O&M cost for the same time period is for groundwater monitoring $62,652. The actual O&M costs (Table C-3) for performance/groundwater monitoring was more than expected because on-going groundwater monitoring and five-year remedy review costs beyond FY2013 were not included in the original IROD cost estimate.

V. Progress Since Last Review

This is the fourth five-year remedy review for the CAGW OU. The previous protectiveness statement concluded that because the interim remedial actions are protective, the CAGW OU is protective of human health and the environment.

Soil data collected in 2011 determined that the interim remedial action of ERH with SVE at CAGW OU continues to be protective of the groundwater. In 2011, residual TCE (maximum = 1.064 mg/kg) in the vadose zone soil was below levels that would impact groundwater. In 2012, the maximum groundwater TCE concentration downgradient of the former ERH/SVE interim remedial action was 1,770 µg/L; it decreased to 260 µg/L in 2015 and to 203 µg/L in 2019 (Figure C-7). The groundwater monitoring network is functioning properly.

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

Subsequent to the interim action and based on TCE discharge to a tributary of Castor Creek, removal action alternatives were evaluated to address this problem. Per the *Action Memorandum and Responsiveness Summary for the Non-Time Critical Removal Action for the C-Area Groundwater Operable Unit* (USDOE 2018), the removal action objective is to protect human health and the environment by reducing the mass of TCE present in the groundwater. The selected non-time critical removal (NTCR) action remedy is treatment barrier using emulsified edible oil for the distal portion of the CAGW OU TCE groundwater plume. The implementation of the NTCR action for CAGW OU consisted of installing 15 direct push technology injection points to create the treatment barriers.

The groundwater was augmented with the emulsified oil substrate BAC-9, which is an enriched bioaugmentation culture of *Dehalococcoides mccartyi* and enzymes in a water-based medium (SRNS 2019). The emulsified oil mixture (EOS_{100}™ emulsified oil, vitamin B12, dechlorinated dilution water, and $CoBupH_{Mg}$™ buffer) and BAC-9 culture were injected to act as a treatment barrier both by sequestering TCE at the injection points and enhancing the natural ability of the formation to biodegrade TCE between the point of injection and discharge to the unnamed tributary. In addition, TCE preferentially partitions from the groundwater phase into the oil phase, which should lower the groundwater concentration.

Effectiveness monitoring of the CAGW OU NTCR action began in November 2019 and will continue for five years per the *Removal Action Design Plan with Effectiveness Monitoring Plan for C-Area Groundwater Operable Unit* (SRNS 2018).

VI. Five-Year Review Process

The following tasks were performed as part of the five-year remedy review:

- Reviewed the documents listed in Section XII, Documents Reviewed;
- Confirmed implementation and completion of the interim remedial action;
- Reviewed all process and performance monitoring data provided by the groundwater data reports and provided a technical assessment of whether the ERH with SVE functioned 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 C-1, with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance.

Data Review

Groundwater and surface water data collected from 2015 to 2019 indicate the concentration of the CAGW OU TCE plume has significantly decreased relative to the original 1998 to 2002 characterization. In 2019, the TCE plume has also decreased in extent relative to the original 1998 to 2002 characterization. Groundwater monitoring wells (CRW 20D and CRW021DR) near the TCE vadose zone source area indicate rapidly decreasing TCE concentrations since the completion of the ERH with SVE interim action remedy from 2006 to 2014, but slowly decreasing TCE concentrations since 2014 (Figure C-7).

Summary of Inspections and Interviews

Interviews were conducted with Phil Carter, O&M staff member, and with Brian Hanshew, O&M Site Manager, on November 5, 2019 at the O&M organization offices. No issues were identified for the CAGW OU during these interviews. The CAGW OU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) Environmental Compliance and Area

Completion Projects (EC&ACP) on October 22, 2019. No issues were identified during these inspections.

The CAGW OU was inspected by SRNS EC&ACP and USDOE personnel on December 17, 2019. No issues were identified for the CAGW OU during this inspection.

A site inspection was conducted by U.S. Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control personnel, accompanied by USDOE and SRNS personnel on February 27, 2020. No significant problems regarding this OU were identified during the inspection.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The interim action remedy is functioning as intended as demonstrated below:

- The ERH with SVE system was effective at reducing TCE concentrations in the vadose zone to a level that prevents TCE leaching from its MCL in the groundwater. The ERH with SVE system exceeded its shutdown criteria by operating longer (56 days) than the required minimum 30 days with soil temperatures above 189°F. After ERH was shut down, SVE continued operating for an additional 21 days, to further decrease TCE levels. ERH with SVE removed a total of 730 lbs of TCE. Follow up soil sampling indicated that TCE removal efficiency from the vadose zone source was better than 99.2% after 85 days of ERH operation and 106 days of SVE operation (WSRC 2007). Average concentrations were reduced from 6.31 mg/kg to 0.039 mg/kg. Soil data collected in 2011 from both inside and outside the ERH target zone indicated that residual TCE in vadose zone soil does not present a contaminant migration threat to groundwater.
- Semiannual groundwater monitoring data indicate the TCE plume in the source area is slowly decreasing in concentration since the last five-year remedy review (Figure C-7), and TCE concentrations have significantly decreased relative to the RFI/RI characterization data (TCE maximum concentration = 13,100 µg/L) collected

RFI/RI characterization data (TCE maximum concentration = 13,100 µg/L) collected from 1998 to 2002. In 2019, the maximum groundwater TCE concentration was 203 µg/L.

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

There have been no changes in MCLs that would impact the interim action remedy. An evaluation of the changes in toxicity data and risk methods are not relevant at this time as the baseline risk assessment to support a final action has not been conducted.

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 interim action remedy for the CAGW OU 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 interim action remedy at the CAGW OU is currently protective of human health and the environment because access is controlled by SRS facility security and administrative controls. However, in order for the remedy to be protective in the long-term, additional remedial actions, including LUCs (if needed), will need to be implemented. The final ROD for CAGW OU is scheduled for issuance in April 2027.

The exposure pathways that could result in unacceptable risks are being restricted through SRS land use controls. All threats to the CAGW OU are being addressed through physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the CAGW OU for industrial use only, use restrictions via the SRS Site Use/Site Clearance Program. Protectiveness of the interim remedial action will be verified by continued groundwater monitoring.

SRS facility security and administrative controls that restrict unauthorized access to the CAGW OU are not part of the interim remedy and therefore not recognized as long-term protective. SRS will include the CAGW OU in the FFA Annual Progress Report to demonstrate long-term protectiveness through the SRS facility security and administrative controls. The report is required by the FFA and includes an annual certification by the USDOE SRS Manager that the listed OUs are in compliance with land use requirements.

XI. Next Review

As shown in Appendix A, Table A-1, the next five-year remedy review for SRS OUs with Groundwater is scheduled for January 2026.

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, 2014a. *Data Report for the C-Area Groundwater (CAGW) Operable Unit (OU) (U)*, SRNS-RP-2014-00835, Revision 0, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

SRNS, 2014b. *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, Savannah River Site, Aiken, SC

SRNS, 2018. *Removal Action Design Plan with Effectiveness Monitoring Plan for the C-Area Groundwater Operable Unit (U)*, SRNS-RP-2018-00807, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2019. *Underground Injection Control Permit Application for the Implementation of the Non-Time Critical Removal Action at the C-Area Groundwater Operable Unit (U)*, SRNS-RP-2019-00030, Revision 0, Savannah River Nuclear Solutions, 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

USDOE, 2018. *Action Memorandum and Responsiveness Summary for the Non-Time Critical Removal Action for the C-Area Groundwater Operable Unit (U)*, SEMS Number: 82, IACD-18-150, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 2003. *Post-Construction Report (PCR)/Final Remediation Report (FRR) for the C-Area Reactor Seepage Basin (904-66G, -67G, and -68G) Operable Unit (U)*, WSRC-RP-2002-4149, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2004a. *Interim Record of Decision Remedial Alternative Selection for the Remediation of the Trichloroethylene Vadose Zone Source Unit at the C-Reactor Groundwater Operable Unit (U)*, WSRC-RP-2004-4022, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2004b. *RCRA Facility Investigation/Remedial Investigation Report for the C-Area Reactor Groundwater (CRGW) Operable Unit,* WSRC-RP-2003-4073, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2005. *Interim Remedial Action Implementation Plan (IRAIP) for the Trichloroethylene Vadose Zone Source Unit at the C-Reactor Groundwater Operable Unit (U)*, WSRC-RP-2004-4114, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2007. *Report on the Effectiveness of the TCE Vadose Source Unit at C Reactor Groundwater (VCRGW) OU Interim Remedial Action*, WSRC-RP-2007-4006, Revision 1, Washington Savannah River Company, Aiken, SC

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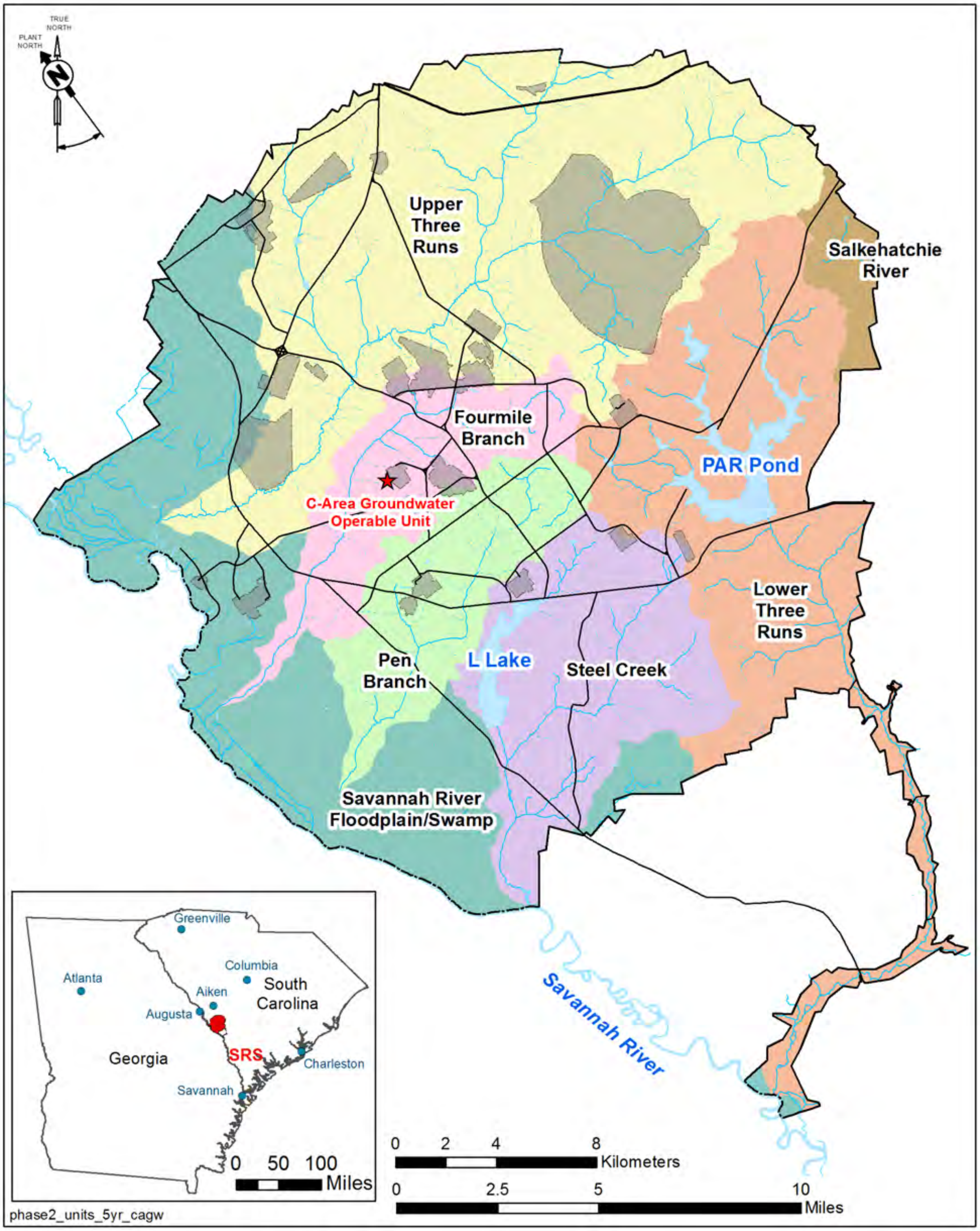

Figure C-1. Location of the CAGW OU within the Savannah River Site

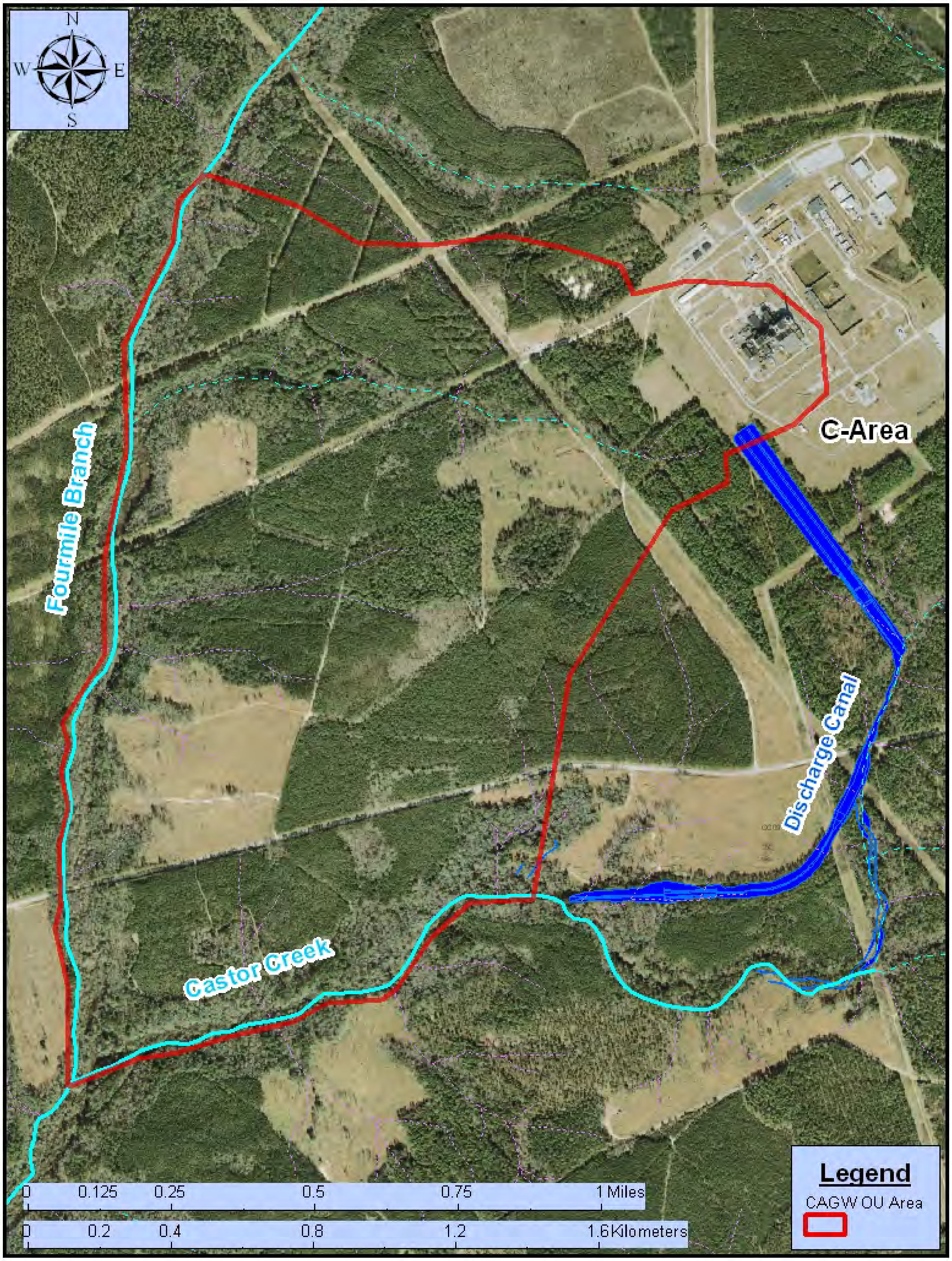

Figure C-2. CAGW OU Boundary Area

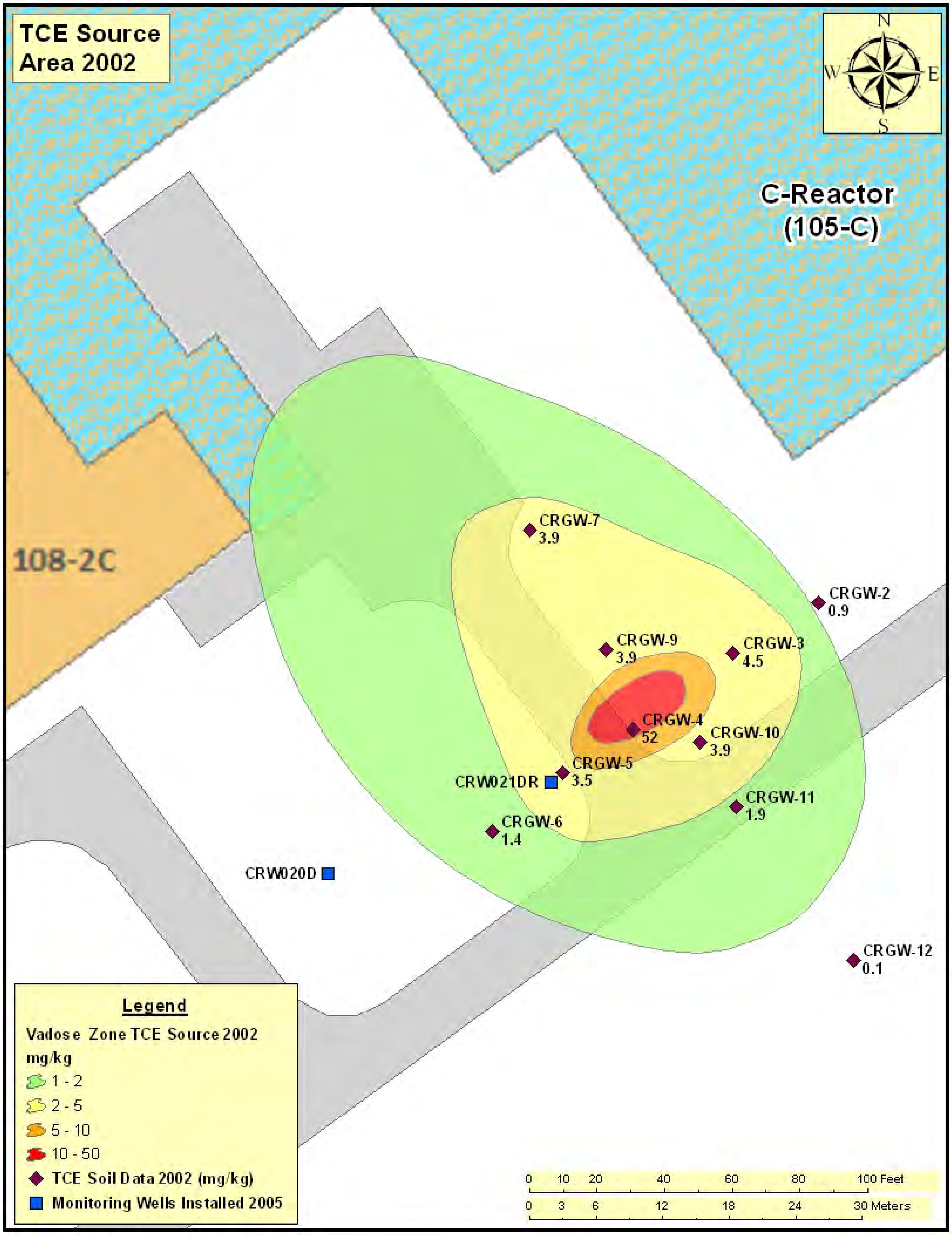

Figure C-3. CAGW OU 2002 TCE Vadose Zone Source Subunit

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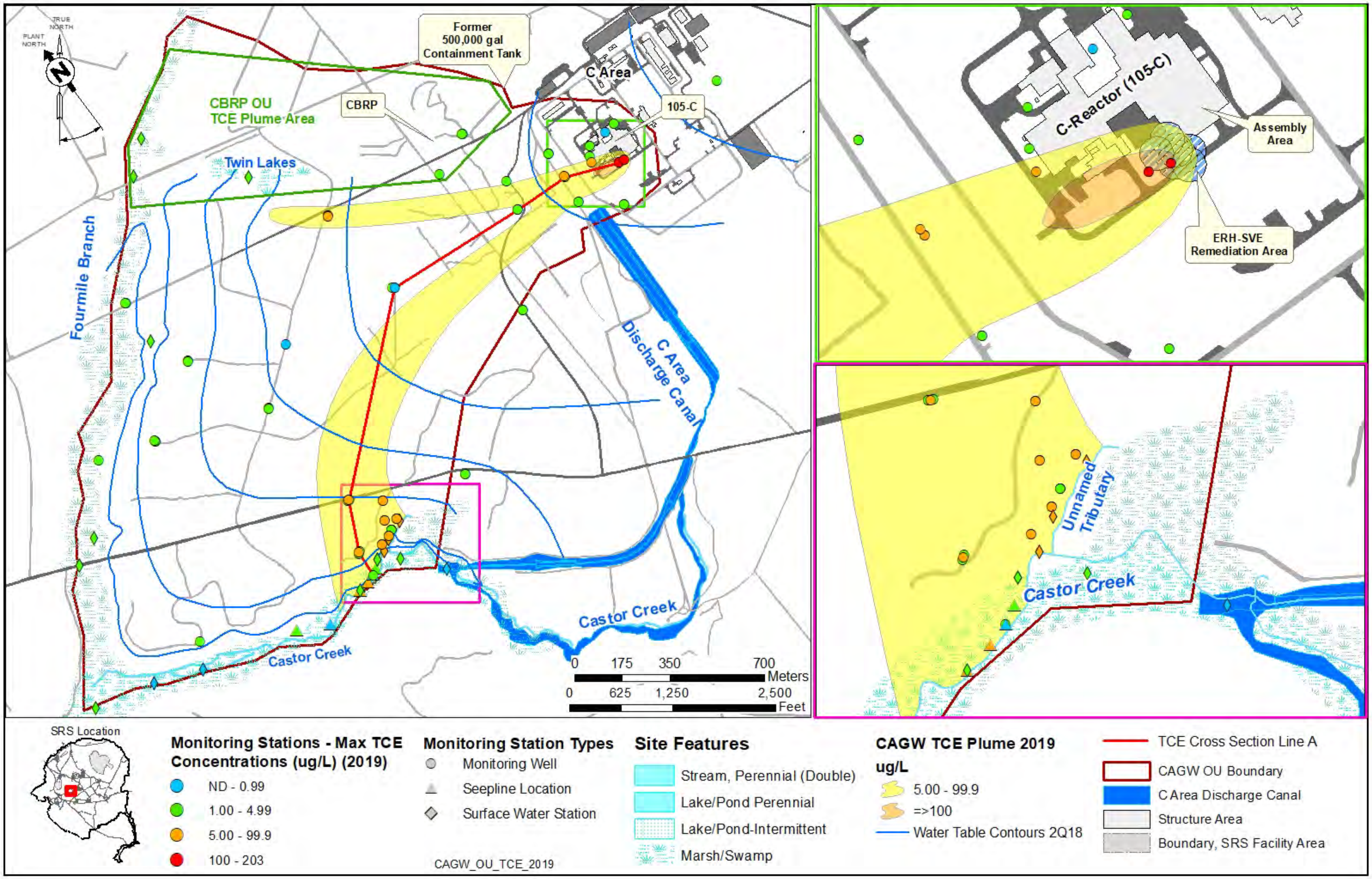

Figure C-4. CAGW OU 2019 TCE Plume Map for Upper Three Runs Aquifer

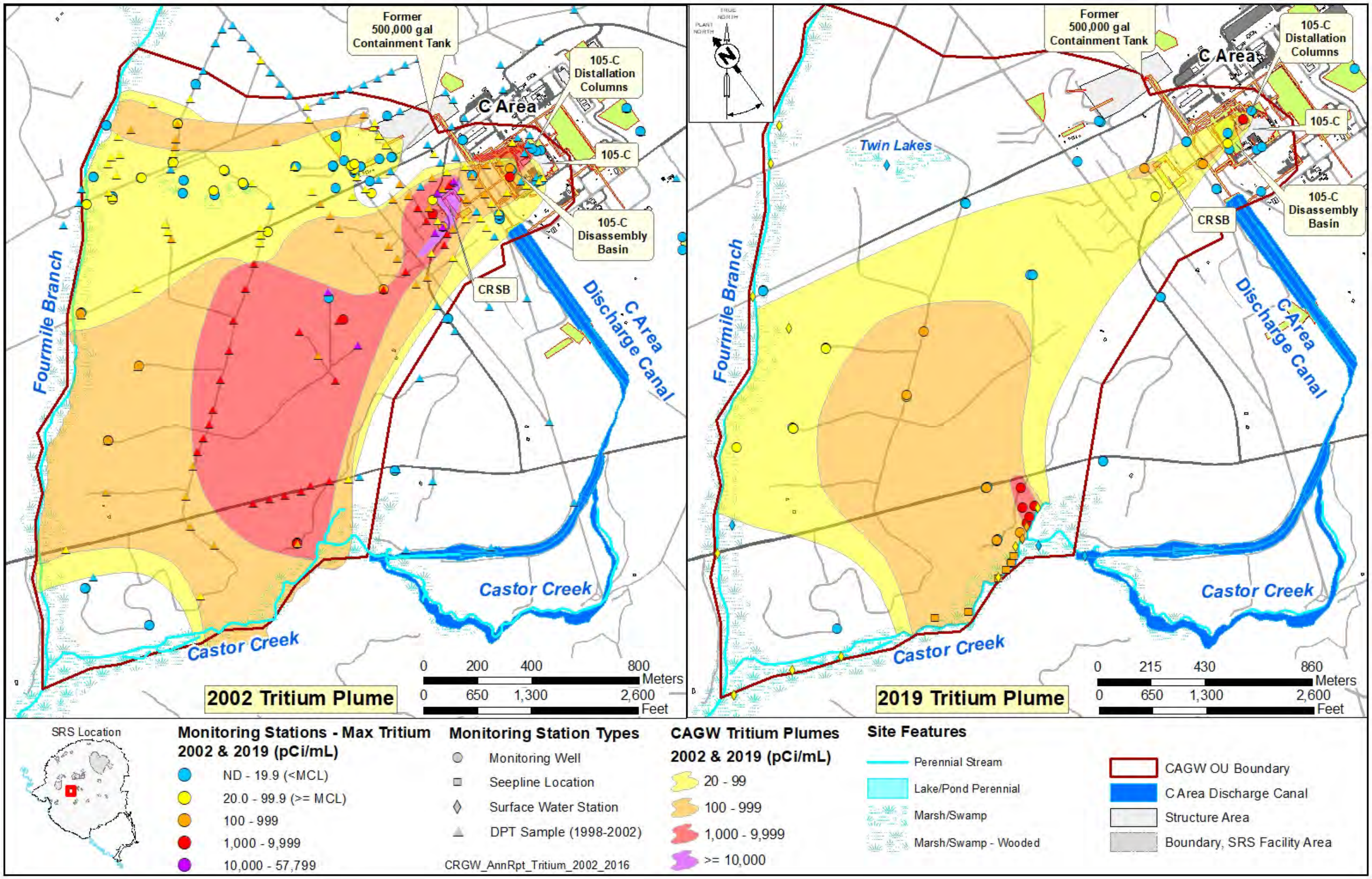

Figure C-5. CAGW OU 2002 and 2019 Tritium Plume Maps

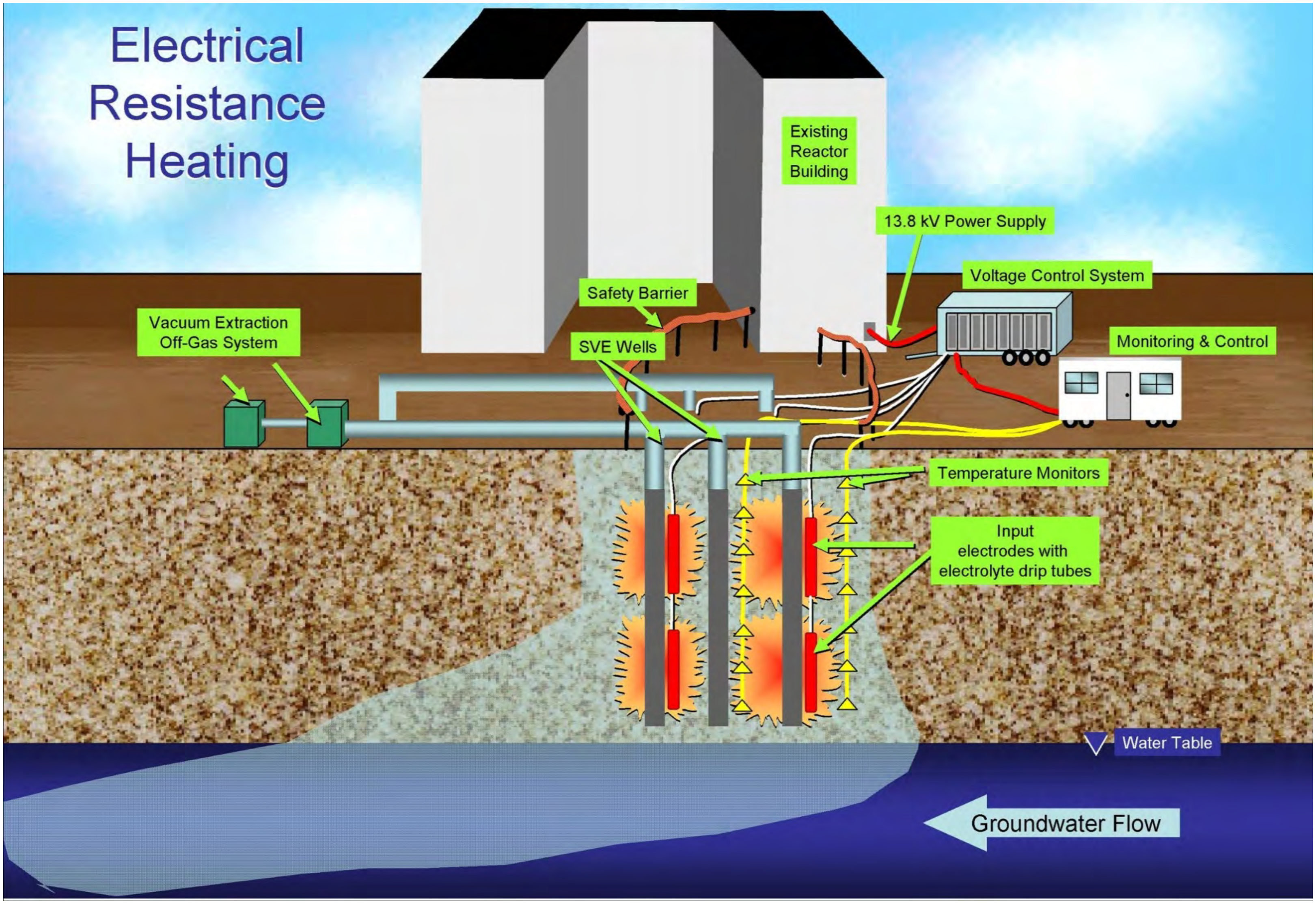

Figure C-6. Generalized Graphic of an ERH with SVE System

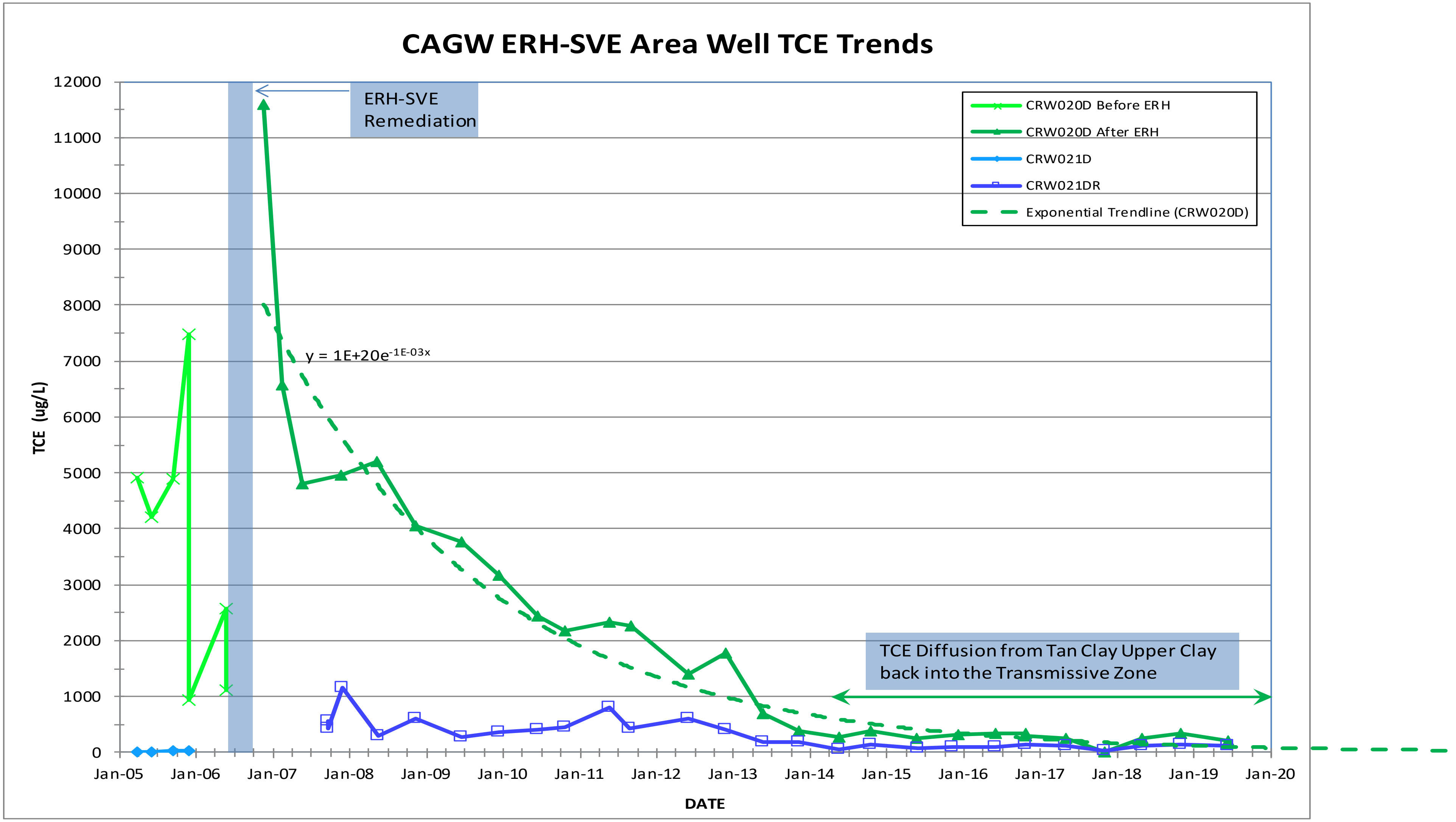

Figure C-7. TCE Groundwater Trends at the ERH with SVE Area Wells (2005 to 2019)

Table C-1. Chronology of OU Events

Event	Date
RFI/RI Field Start	February 20, 2002
Interim Record of Decision (ROD) Issuance	October 15, 2004
Interim Remedial Action Construction Start / Completion	July 13, 2005 / June 15, 2006
Interim Remedial Action Operations Start / Completion	June 15, 2006 / September 28, 2006
NTCR Action Memorandum Issued	May 30, 2018
Removal Action Operations Field Start / Completion	July 9, 2019 / September 5, 2019
FFA Proposed Final ROD Issue Date	April 2027
Previous Five-Year Remedy Reviews Issuance	January 28, 2009 / February 4, 2014 / February 2, 2017

Table C-2. Summary of Constituents of Concern and Remedial Goals for CAGW OU

Medium of Concern	Constituents of Concern*	Remedial Goal (MCL)
Groundwater	Trichloroethylene	5 µg/L
	Tetrachloroethylene	5 µg/L
	Tritium	20 ρCi/mL
Surface Water in Castor Creek	Tritium	20 ρCi/mL

* The IROD only addressed trichloroethylene.

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

	FY2015	FY2016	FY2017	FY2018	FY2019	Five-Year Total
Total Actual O&M Costs ($)	15,411	29,984	6,282	5,544	5,431	62,652
Total IROD Estimated Direct O&M Costs ($)[1]	0	0	0	0	0	0

1 – The estimated O&M costs since the last remedy review is $0 for FY2015-FY2019 because costs beyond FY2013 were not include in the original estimate.

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Attachment C-1. Five-Year Review Site Inspection Checklist – C-Area Groundwater Operable Unit

I. SITE INFORMATION

Site Name:	**C-Area Groundwater Operable Unit**	**Date of Inspection:**	**10/22/2019**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**SEMS #31**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**81°F and partly sunny**

Remedy Includes: *(Click all that apply)*

☐ Landfill Cover/Containment

☐ Access Controls

☐ Institutional Controls

☐ Groundwater Pump and Treatment

☐ Surface Water Pump and Treatment

☐ Monitored Natural Attenuation

☐ Groundwater Containment

☐ Vertical Barriers

☒ Other ERH with SVE for vadose zone remediation of VOCs, periodic groundwater monitoring. Please note that access controls and institutional controls are not a component of the interim remedy.

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

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** Brian Hanshew (Name) ACP Field Execution Team 2 (Title) 11/05/2019 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4949

Problems/Suggestions: ☐ Report Attached

2. **O&M Staff:** Phil Carter (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 11/05/2019 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4145

Problems/Suggestions: ☐ Report Attached

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

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

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

Agency: ______________________

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

Problems/Suggestions: ☐ Report Attached ______________________

Agency: ______________________

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

Problems/Suggestions: ☐ Report Attached ______________________

Agency: ______________________

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

Problems/Suggestions: ☐ Report Attached ______________________

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

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

1. **O&M Documents:**

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

Remarks: Monitoring wells are inspected per ER-SOP-011, *Area Completion Projects Monitoring Well Inspection (U)*

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

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

2. Health and Safety Plans (HASPs):

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

Remarks: Routine O&M activities do not require a Site-Specific Health and Safety Plan (SSHASP) under 29 CFR 1910.1201, Hazardous Waste Operations. A SSHASP is prepared if needed.

3. O&M and OSHA Training Records: ☒ Readily Available ☒ Up to Date ☐ N/A
Remarks: Training Records are complete and up to date per ACP training matrix.

4. Permits and Service Agreements:
☐ Air Discharge Permit ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Effluent Discharge ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Waste Disposal; POTW ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Other Permits ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

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

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

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

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

9. Discharge Compliance Records:
☐ Air ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Water (Effluent) ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

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

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

IV. O&M COSTS

1. O&M Organization:

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

2. O&M Cost Records:

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place

☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

Total annual cost by year for review period, if available

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

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

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

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

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

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

Describe costs and reasons: N/A

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

A. Fencing

1. Fencing Damage: ☐ Location shown on site map ☐ Gates secured ☒ N/A

Remarks: OU-specific fencing is not required by the remedial action.

B. Signs

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

Remarks:______

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

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

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

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

Contact:	Karen Adams	Federal Project Director	12/17/19	803-952-7871
	(Name)	(Title)	(Date)	(Phone No.)

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

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

Access is restricted by physical access controls to SRS (fences, guards, security patrols, etc.) and use controls are managed through the SRS Site Use/Site Clearance Program.

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

D. General

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

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

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

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

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

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

Remarks:

B. Other Site Conditions

Remarks:

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

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

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

X. OTHER REMEDIES

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

A. Electrical Resistance Heating with Soil Vapor Extraction System ☒ Applicable ☐ N/A

1. Blowers, Wellhead Plumbing, and Electrical:

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

Remarks: ERH with SVE operations are now complete. The effectiveness of the treatment is being evaluated by groundwater monitoring.

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

☐ Good Condition ☐ Needs maintenance ☒ N/A

Remarks:

3. Spare Parts and Equipment:

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

Remarks: N/A

4. Monitoring Wells (ERH with SVE):

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition

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

Remarks: The effectiveness of the treatment is being evaluated by sampling monitoring wells CRW-1D, CRW020D and CRW021DR.

Attachment C-1. Five-Year Review Site Inspection Checklist – C-Area Groundwater Operable Unit *(continued/end)*

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

Groundwater monitoring indicates the interim remedial action of ERH with SVE was successful in preventing further groundwater impact. Until the final CAGW ROD is issued, the exposure pathways that could lead to unacceptable risk are being restricted through the SRS Site Use/Site Clearance Program and monitored by periodic groundwater sampling.

B. Adequacy of O&M

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

The protectiveness of the completed interim action of ERH with SVE is being monitored by continued groundwater sampling. The O&M procedures are effectively maintaining the monitoring wells. The wells are properly secured/locked, functioning and are in good condition. Unauthorized access to the CAGW OU is restricted by physical access controls to SRS (fences, guards, security patrols, etc.), administrative controls (SRS is a secured government facility with land use restrictions) and use controls (SRS Site Use/Site Clearance Programs.

C. Early Indicators of Potential Remedy Failure

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

N/A

D. Opportunities for Optimization

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

N/A

End of Checklist

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CHEMICALS, METALS, AND PESTICIDES (CMP) PITS (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, AND 080-190G) OPERABLE UNIT

I. Introduction

This report is the fifth five-year remedy review for the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU). Contaminants have been left in place at the CMP Pits OU at levels that do not allow for unlimited use and unrestricted exposure. The review was conducted from August 2019 through November 2019. The purpose of this review is to determine whether the remedy in place at the CMP Pits OU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table D-1 lists the chronology of site events for the CMP Pits OU.

III. Background

The CMP Pits OU is listed as a Resource Conservation and Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act unit in Appendix C of the Federal Facility Agreement (FFA) for the Savannah River Site (SRS) (FFA 1993). The media of concern is surface soil, subsurface soil, groundwater, sediment, and surface water.

Physical Characteristics

The CMP Pits OU is located in the central portion of the SRS in Barnwell County more than 11.2 km (7 mi) from the site boundary and is approximately 1,560 m (5,200 ft) north of the L-Area perimeter fence (Figure D-1). The CMP Pits are located within the Pen Branch watershed approximately 375 m (1,250 ft) southeast of Pen Branch. The OU consists of five subunits: the ballast area soils, CMP Pits and associated vadose zone (Field A), vadose zone (Field B), groundwater, and Pen Branch surface water and sediment (Figure D-2). Characteristics of each subunit are described below:

- The CMP Pits and associated vadose zone (Field A) – An approximately 0.4-hectare (1-acre) area which includes the seven former unlined pits. The seven pits are located in two rows and occupy an area 3 to 4.5 m (10 to 15 ft) wide, 13.5 to 21 m (45 to 70 ft) long, and 3 to 4.5 m (10 to 15 ft) deep. The pits occupy the top of a knoll at an approximate elevation of 94.5 m (310 ft) mean sea level. Field A is the vadose zone area that was contaminated by the CMP Pits operation.

- Vadose zone (Field B) – An area approximately 0.4 hectare (1 acre) that is located 30 m (100 ft) north of Field A. Field B is another vadose zone area that was contaminated by the CMP Pits operation.
- Ballast Area – An area approximately 0.2 hectare (0.5 acre) that is located adjacent to and part of Field A. The Ballast Area was used to stockpile excavated pit soils and fluorescent lighting ballasts during the 1984 excavation.
- Groundwater – Previous wastes dumped at the CMP Pits has contaminated the groundwater at and near the CMP Pits with volatile organic compounds (VOCs) (primarily tetrachloroethylene [PCE] and trichloroethylene [TCE]) and the pesticide, lindane, above maximum contaminant levels (MCLs). The groundwater plume extends from the CMP Pits northward towards Pen Branch.
- Pen Branch Surface Water and Sediment – Groundwater from CMP Pits flows towards and discharges to Pen Branch. However, the stream has only been intermittently and minimally impacted. The sediment at Pen Branch has not been impacted by the CMP Pits operations.

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. Although the CMP Pits OU is located in the unrestricted land use zone of SRS, outside of the industrial zone defined by the *Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999a), the future land use for the CMP Pits OU is reasonably anticipated to be industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

The CMP Pits were designed to receive nonradioactive wastes (chemicals, metals, and pesticides) and operated from August 1971 until February 1979. During that time, chemicals, metals, pesticides, and fluorescent lighting ballasts containing polychlorinated biphenyls (PCBs) were disposed of in the pits. In 1984, the buried wastes and surrounding soil were excavated.

PCBs and pesticides were detected in soil at or near the ground surface to the west of the CMP Pits in an area that is now referred to as the "Ballast Area". The presence of the PCB- and pesticide-contaminated soil is attributed to stockpiling material recovered from the pits during the 1984 excavation.

However, not all contaminated soils were removed during the 1984 action, and the vadose zone remained contaminated with VOCs. Groundwater contamination occurred as a result of the contaminants leaching from soil. Two groundwater plumes, designated as the main plume and the northeast distal plume, now exist at the CMP Pits. These plumes are moving northward towards Pen Branch. Groundwater modeling indicates that the CMP Pits are the source for the main plume (WSRC 2002). Particle tracking towards and from the northeast plume suggests that this plume is from a different source than that of the main plume. A possible source area is a drainage ditch located approximately 110 m (361 ft) north of the CMP Pits (Figure D-2). However, additional characterization efforts concluded that if a source was once present, it is now depleted (WSRC 2003b). It is also possible that the distal plume originated from the main plume but has been separated due to the drop in the water table elevation over time, which has created a dry zone in the upper aquifer zones (Figure D-3).

No contaminants were found at levels that posed a risk to human health or the environment in the Pen Branch surface water or sediment (WSRC 2003b).

Figures D-4 and D-5 presents photographs of the CMP Pits OU before remediation (early 1980s) and currently (2019), respectively.

Initial Response

The following pre-Record of Decision (ROD) activities were performed to support the overall cleanup strategy for the CMP Pits OU:

- Original excavation of the CMP Pits conducted with clean backfill and cover system (1984).
- Soil vapor extraction (SVE) units installed in CMP Pits Field A (Interim Action) (2001) (WSRC 1999b); however, possible dense non-aqueous phase liquid (DNAPL) was found and unexpected conditions forced additional characterization before SVE startup. During operations, 9,300 lbs of VOCs were removed (WSRC 2005).
- Ballast Area Soil Excavation / Off-site Incineration (Interim Action) (2000) (WSRC 1999b); however, soil containing Silvex was found, which could not be treated or disposed of offsite. The amount of contaminated soil was found to be significantly greater than originally estimated. An evaluation of treatment technologies for bioremediation of Silvex contaminated soils was needed.
- SVE implemented in CMP Pits Field B (Interim Action) (2001) (WSRC 2001). During operations, 230 lbs of VOCs were removed (WSRC 2003c).
- Ballast Area Soil Excavation / Bioremediation (Treatability Study – Phase I) (2001)
- SVE implemented in CMP Pits Field A (Interim Action) (2002) (WSRC 2001).
- SVE units converted to passive system (BaroBalls^{TM}) in Field B (Interim Action) (2002) (WSRC 2001).
- Ballast Area Soil Excavation / Bioremediation (Treatability Study – Phase II) (2002) (WSRC 2003d)
- Ballast Area Soil Excavation / Bioremediation (Interim Action) (2004) (WSRC 2003a)

DNAPL VOC contamination was found to be trapped in the clay horizon beneath the CMP Pits in Field A, where SVE units alone could not remediate the contamination. Additional techniques were needed to remediate the contaminant source to groundwater.

Basis for Taking Action

Releases of VOCs (predominantly PCE and TCE) and pesticides to groundwater have occurred from contaminated soil at the CMP Pits. Groundwater is contaminated above MCLs with PCE, TCE, lindane, and carbon tetrachloride. Exposure to these constituents above MCLs through ingestion or prolonged dermal contact increases the risk of cancer. The refined constituents of concern (RCOCs) for the CMP Pits OU are listed in Table D-2.

The CMP Pits OU remedial goals (RGs) were developed to be protective in soil based upon future industrial land use and in groundwater to achieve MCLs or residential RGs (Table D-2).

IV. Remedial Actions

Remedy Selection

In 2005, a final ROD (WSRC 2004) was issued to address the source of contamination in the vadose zone and the groundwater plume. The selected remedy for the Ballast Area is land use controls (LUCs) to prevent direct contact to PCB-contaminated soils above concentrations of 1 mg/kg. The selected remedy for the CMP Pits and associated vadose zone is a combination of electrical resistance heating (ERH) to remove DNAPL from the vadose zone and continued operation of the SVE system in Field A. Continued operation of the passive SVE system via BaroBalls^{TM} was selected for Field B. As stated in the ROD, the remedial action objectives (RAOs) are as follows:

Ballast Area

- Prevent human and ecological receptors from direct contact with PCB-contaminated surface soil at concentrations > 1 mg/kg, and

- Prevent direct contact with pesticide-contaminated surface soils so that constituents of concern (COCs) do not present an unacceptable risk to human and ecological receptors.

CMP Pits Field A and B Vadose Zone

- Prevent COC migration to groundwater, and
- Prevent residential exposure to surface soil above RGs.

Groundwater

- Prevent human exposure to contaminated groundwater above MCLs or RGs,
- Reduce the COC concentrations in the groundwater plume to MCLs, and
- Prevent discharge of contaminated groundwater to surface water at concentrations above MCLs.

Surface Water and Sediment

No RAOs were established for the Pen Branch surface water and sediment because no COCs were identified.

Remedy Implementation

The implementation of the final remedial action included the following activities:

Ballast Area

- Established LUCs (i.e., physical access controls to prevent unauthorized entry to SRS [fences, guards, security patrols, etc.], administrative controls that maintain the CMP Pits OU for industrial use only, warning signs, and use restrictions via the SRS Site Use/Site Clearance Program) after the completion of the interim action. The interim action included a small portion of contaminated soil that was removed for incineration at an offsite facility. The remaining Silvex contaminated soil was treated onsite using enhanced bioremediation.

CMP Pits Field A Vadose Zone

- Operated ERH to remove DNAPL and continued operation of the SVE system throughout the ERH operation.

CMP Pits Field B Vadose Zone

- Continued operation of the interim action passive SVE system via BaroBalls™.

Groundwater

- Established a monitored natural attenuation (MNA) network by installing additional groundwater monitoring wells. MNA will effectively remediate the low-concentration residual groundwater contamination that remains following completion of the source control remedial action. The PCE plumes comprised approximately 17.8 hectares (44 acres); the TCE plumes comprised approximately 16.6 hectares (41 acres) in 2011.
- Submitted an Effectiveness Monitoring Plan (EMP), which provides the sampling and reporting requirements associated with MNA (WSRC 2006a).
- Established LUCs for 2.9 hectares (7.1 acres) at the CMP Pits OU (Figure D-2).

System Operations/Operation and Maintenance

Operations at the CMP Pits OU are now complete.

- ERH and SVE have been completed in Field A. The ERH equipment and associated SVE wells were removed or abandoned in accordance with SRS Manual 3Q5 (i.e., currently SRS Manual 3Q1) and R.61-71 South Carolina Well Standards. The results of the ERH/SVE operations were reported in the 2009 Effectiveness Monitoring Report (EMR) (SRNS 2009). Confirmation soil sampling was reported in the 2010 EMR (SRNS 2010).
- At Field B, the passive SVE units were abandoned concurrently with the Field A SVE abandonments.

The following maintenance activities are ongoing:

- Groundwater and surface water monitoring for the MNA network. Sampling will continue until MCLs have been attained. The MNA remedy will be evaluated annually in EMRs based on groundwater monitoring data as defined in the approved EMP (WSRC 2006a). Groundwater monitoring data has been reported in EMRs since June

2009. Based on modeling projections (WSRC 2002), the MNA remedy is expected to reduce groundwater concentrations to below MCLs in as soon as 40 years (approximately 2055).

- Annual site inspections for evidence of damage to the cover system due to erosion or intrusion by burrowing animals. The inspections also address upkeep of the vegetative cover and access control barriers (e.g., the warning signs).
- Necessary repairs (e.g., replacing eroded or disturbed soil, sign repair, etc.) and vegetation management (e.g., mowing, removal of larger vegetation, etc.) are being performed when required.
- LUCs (i.e., physical access controls to prevent unauthorized entry to SRS [fences, guards, security patrols, etc.], administrative controls that maintain the CMP Pits OU for industrial use only and warning signs) are being enforced to preclude access through the SRS Site Use/Site Clearance program and SRS site security.

The operation and maintenance (O&M) costs associated with the selected remedy for CMP Pits OU includes maintenance of the soil cover, groundwater monitoring and LUCs (WSRC 2004). The estimated O&M cost from the ROD since the last remedy review for these activities is $234,793 for Fiscal Year (FY) 2015 through FY2019. The actual O&M cost for FY2015 until FY2019 is $760,232. The actual O&M costs (Table D-3) were higher than expected because the current number of monitoring wells and surface water sampling locations (76) is much larger than the ROD estimate (12 wells) requiring increased maintenance activities. Based on inspections conducted from FY2015 through FY2019, various maintenance activities completed at CMP Pits included vegetation cutting and clearing drainage ditches, vegetation cutting on soil cover, treating active ant mounds, and vegetation removal from around drainage pipe.

V. Progress Since Last Review

This is the fifth five-year remedy review for the CMP Pits OU. The previous protectiveness statement concluded that because the remedial actions are protective, the CMP Pits OU is protective of human health and the environment.

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

Due to concerns expressed by the U.S. Environmental Protection Agency (USEPA) during review and Core Team discussion of the 2015 temporary groundwater sample data collected with a Push-Ahead™ sampler, additional groundwater wells (CMP066B and CMP067B) were installed in the Upper Three Runs Aquifer (UTRA) north of Pen Branch in 2016 for long-term monitoring to determine if the VOC contaminant plumes have migrated underneath the stream. Additional wells (CMP055B, CMP064B, CMP064BU, CMP065B, and CMP065BU) were also installed south of Pen Branch to address data gaps. The monitoring results were included in subsequent EMRs and have been included on plume maps. Two additional Gordon Aquifer (GA) wells (CMP010A and CMP055A) were installed in September 2019. Results from these wells will be included in future EMRs. Furthermore, an additional surface water station (CMP-SW-22) was added in between stations CMP-SW-06 and CMP-SW-07 to monitor surface water downgradient from where the highest concentration groundwater PCE/TCE plume is projected to discharge into the stream (Figure D-6).

An updated groundwater modeling effort was conducted in 2017 to reevaluate the hydrogeologic conditions and contaminant plumes (SRNS 2017b). The results of the 2017 modeling effort were summarized in the 2018 EMR (SRNS 2018). The 2017 modeling results support an MNA remedy as fully protective of human health and the environment.

VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII, Documents Reviewed,
- Confirmed implementation of the remedial action,
- Reviewed all process and performance monitoring data provided by the annual EMRs and provided a technical assessment of whether the ERH/SVE and passive SVE functioned as intended by the ROD and whether the shutdown criteria has been achieved,

- Reviewed the groundwater and surface water monitoring data provided in the EMRs (SRNS 2016; SRNS 2017a; SRNS 2018; SRNS 2019) as summarized in Table D-4,
- Inspected the OU, interviewed maintenance personnel, and documented the results on the Inspection Checklist provided in Attachment D-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

Four annual EMRs have been submitted since the last five-year remedy review (2015 data [SRNS 2016]; 2016 data [SRNS 2017a]; 2017 data [SRNS 2018]; 2018 data [SRNS 2019]). These reports include all sample results for PCE, TCE, carbon tetrachloride, associated VOC degradation products, 1,4-dioxane, and lindane collected from monitoring wells and surface water stations between 2015 and 2018. These reports include time-series plots at each monitoring station for PCE, TCE, 1,4-dioxane and lindane since 2001, plume maps for the four main constituents (i.e., PCE, TCE, lindane, and 1,4-dioxane), and cross-sections of the stratigraphy with the PCE, 1,4-dioxane, and lindane plumes.

Data from the additional groundwater wells (CMP066B and CMP067B) installed in 2016 in the UTRA north of Pen Branch to monitor if the VOC contaminant plumes have migrated underneath the stream have shown that the UTRA has not been impacted north of Pen Branch as all VOC results have been non-detect to date. Preliminary data from the new 2019 GA wells show that VOC contamination has not reached the GA as PCE and TCE were non-detect.

The groundwater modeling conducted in 2017 to revise cleanup timeframes based on contamination trends to date was also reviewed (SRNS 2017b). The data collected from the monitoring wells installed since the last modeling effort in 2002 were incorporated into the modeling parameters. Lithology was also updated in the model parameters with the stratigraphic elevations provided by the new monitoring well installations. The model also included the addition of sorption/desorption of contaminants and secondary VOC sources in clay layers into the projections for contaminant trends.

The flow model was calibrated to head measurements in monitoring wells and displayed similar dry zones within the Transmissive Zone and Middle Aquifer Zone as has been depicted in the CMP Pits EMRs. The model was also calibrated to plume behavior over the 2002 to 2016 period. A continuous vadose zone source and no source were modeled. The difference between the modeled future plume behavior between the vadose zone source and no source scenario was minimal, suggesting that the magnitude and extent of contamination is likely due to the pre-remediation source.

Accurate quantification of the source for predicting future plume behavior was deemed unnecessary. With a continuing source and sorption added to the model, PCE is expected to be above MCLs for approximately 91 years (~2107). As a comparison, the original 2002 model predicted the PCE plume to be above MCLs for 50 years (~2050) if all the vadose zone source was removed and 130 years (~2130) if 85% of the source was removed. The updated model expects TCE to discharge above MCLs for 48 years (~2065). For comparison, the original 2002 model predicted the TCE plume to be above MCLs for over 120 year (>2120) if both the full source or 85% of the source was removed. The addition of continuing sources and sorption have not noticeably changed the predictions for the CMP Pits VOC plumes as the anticipated time to reach MCLs is within the ranges presented in the 2002 model. The 2017 model predicted that VOCs should be discharging to Pen Branch above MCLs for many decades; however, VOC degradation in the wetlands is likely reducing these concentrations and the flux of PCE entering Pen Branch.

Summary of Inspections and Interviews

Interviews were conducted with Phil Carter, O&M staff member, and Brian Hanshew, O&M Site Manager, on November 5, 2019 at the O&M organization offices. No issues were identified during these interviews. The CMP Pits OU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) Environmental Compliance and Area Completion Projects (EC&ACP) on October 22, 2019.

The CMP Pits OU was inspected by SRNS EC&ACP and USDOE personnel on December 17, 2019. No issues were identified for the CMP Pits OU during the inspection.

A site inspection was conducted by USEPA and South Carolina Department of Health and Environmental Control personnel, accompanied by USDOE and SRNS personnel on February 27, 2020. No significant problems regarding this OU were identified during the inspection

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The remedy is functioning as intended as demonstrated below:

- The selected remedy component of LUCs is effective in preventing human exposure to groundwater above MCLs. The Land Use Control Implementation Plan for the CMP Pits governs LUC implementation, maintenance, monitoring, reporting and enforcement of LUCs (WSRC 2007). All LUC objectives are being met.
- Soil treatment via enhanced bioremediation was effective in preventing exposure to human and ecological receptors with PCB-contaminated surface soils at the Ballast Area. Monitoring and sampling data verified that the RGs were achieved as shown in Table D-5. Further information on the enhanced bioremediation can be found in the Interim Post-Construction Report (WSRC 2006b).
- The ERH/SVE and passive SVE were effective in preventing RCOC migration to groundwater. As reported in the 2010 EMR (SRNS 2010), concentrations of VOC contamination in the vadose zone soils were greatly reduced to levels below RGs. Pre-ERH/SVE concentrations of PCE were as high as 8,800 mg/kg. After the ERH/SVE shutdown, 59 confirmation soil samples were collected. The maximum PCE result was 1.8 mg/kg, well below the RG of 30.7 mg/kg. Confirmation dichloromethane (DCM) soil sample results were at a maximum of 0.0111 mg/kg, well below the RG of 0.2 mg/kg.

- Groundwater results around the actual CMP Pits source area have shown a general decreasing trend with time, but there was a maximum PCE concentration of 1,150 µg/L in 2018 (Table D-4). Well CMP 35D has shown increases in recent years. The increase in VOCs and lindane at well CMP 35D appears to be related to water elevation rising into contamination trapped in the vadose zone. VOC and lindane concentrations in nearby wells indicate that the contaminants are minimal and highly localized near the CMP 35D location (Figures D-3 and D-7). DCM groundwater results have been below the MCL (5 µg/L) since the ERH/SVE shutdown. The 2018 DCM maximum result was 2.37 µg/L. Table D-4 compares the pre-ERH/SVE groundwater concentrations with current (2018) concentrations.

- Lindane contamination in groundwater continues to stay near the source area and has not impacted the Pen Branch stream. Lindane samples in surface water are not required as part of the EMP. However, samples were analyzed for lindane in the fourth quarter of 2017 and all results were non-detect. The number of groundwater wells exceeding the lindane MCL has decreased from seven monitoring wells in 2008 to five monitoring wells in 2018.

- The Field A cover system is effective in preventing residential exposure to surface soils above RGs. The cover system maintenance program and LUCs have been effective in maintaining the integrity of the cover system. The annual inspection reports indicate no significant deficiencies.

- LUCs are effective in preventing human exposure to contaminated groundwater.

- MNA has shown effectiveness in preventing discharge of contaminated groundwater to surface water. Most surface water results are non-detect. Out of 150 Pen Branch surface water samples and 1,649 analytical results collected since 2002, there have been six non-estimated results for the VOCs monitored at CMP Pits. This number includes detections of PCE, TCE, and cis-1,2-dichloroethylene.

- Although not widespread throughout CMP Pits, biological processes in the wetland area near Pen Branch are degrading VOCs to degradation products. Cis-1,2-

dichloroethylene was detected in 2018 in groundwater at a maximum of 1.5 µg/L, which is below the 70 µg/L MCL. It was not detected in surface water. Vinyl chloride was detected in groundwater during 2018 at a maximum of 0.74 µg/L, which is below the 2 µg/L MCL. Vinyl chloride was not detected in surface water.

The remedial activities are meeting the RGs established for the CMP Pits OU, as discussed in Section IV, by eliminating or controlling all routes of exposure to human health and ecological receptors.

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

The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection are still valid. There have been no changes in standards or physical conditions of the CMP Pits OU that would affect the protectiveness of the remedy.

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

No issues have been identified for the CMP Pits OU.

IX. Recommendations and Follow-up Actions

No recommendations and follow-up actions have been determined for the CMP Pits OU.

X. Protectiveness Statement(s)

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

Exposure pathways that could result in unacceptable risks are being controlled by LUCs to prevent exposure to, or the ingestion of, contaminated soil and groundwater. All threats to the CMP Pits OU are being addressed through physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the CMP Pits OU for industrial use only, warning signs, and use restrictions via the SRS Site Use/Site Clearance Program.

XI. Next Review

As shown in Appendix A, Table A-1, the next five-year remedy review for SRS OUs with Groundwater is scheduled for January 2026.

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, 2009. *Effectiveness Monitoring Report for the Electrical Resistance Heating (ERH)/ Soil Vapor Extraction (SVE) and Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU)(U) March 2008 through March 2009*, SRNS-RP-2009-00573, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010. *Effectiveness Monitoring Report for the Electrical Resistance Heating (ERH)/ Soil Vapor Extraction (SVE) and Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU)(U) March 2009 through March 2010*, SRNS-RP-2010-00896, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2016. *Effectiveness Monitoring Report for the Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU)(U) March 2015 through March 2016*, SRNS-RP-2016-00316, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2017a. *Effectiveness Monitoring Report for the Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU)(U) March 2016 through March 2017*, SRNS-RP-2017-00163, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2017b. *Groundwater Flow and Solute Transport Model of the CMP Pits OU (U) Tetra Tech, Inc. Alpharetta, GA*, SRNS-TR-2017-00312, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2018. *Effectiveness Monitoring Report for the Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU)(U) March 2017 through March 2018*, SRNS-RP-2018-00397, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2019. *Effectiveness Monitoring Report for the Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU)(U) March 2018 through March 2019*, SRNS-RP-2019-00274, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

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

WSRC, 1999a. *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, 1999b. *Interim Record of Decision for the Chemicals, Metals, and Pesticides Pits (080-17G, 080-17.1G, 080-18G, 080-18.1G, 080-18.2G, 080-18.3G, 080-19G) (U)*, WSRC-RP-98-4198, Revision 1.1, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2001. *Interim Record of Decision Amendment for the Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, 080-190G) (U)*, WSRC-RP-2000-4158, Revision 1.2, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2002. *Groundwater Modeling for the Chemical, Metals, and Pesticides (CMP) Pits (U)*, WSRC-RP-2002-4195, Revision 0, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2003a. *Interim Record of Decision Amendment for the Chemicals, Metals, and Pesticides Pits-Ballast Area (U)*, WSRC-RP-2001-4232, Revision 1.1, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2003b. *RCRA Facility Investigation/Remedial Investigation Addendum with Baseline Risk Assessment for the CMP Pits (U)*, WSRC-RP-2002-4049, Revision 1.1, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2003c. *Report on the Effectiveness of the CMP Pits Interim Remedial Action for 2004*, WSRC-RP-2003-4065, Revision 0, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2003d. *Treatability Study Final Report for the Enhanced Bioremediation of Soils Contaminated with Pesticides and PCBs at the CMP Pits*, WSRC-RP-2003-4067, Revision 0, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2004. *Record of Decision Remedial Alternative Selection for the Chemicals, Metals, and Pesticides Pits Operable Unit (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G) (U)*, WSRC-RP-2004-4090, Revision 1, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2005. *Report on the Effectiveness of the CMP Pits Interim Remedial Action for 2004*, WSRC-RP-2005-4050, Revision 0, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2006a. *Effectiveness Monitoring Plan for the Electrical Resistance Heating (ERH)/Soil Vapor Extraction (SVE) System and Monitored Natural Attenuation at the Chemicals, Metals, and Pesticides Pits Operable Unit (U)*, WSRC-RP-2005-4077, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2006b. *Interim Post-Construction Report (IPCR) for the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit – Ballast Area (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, 080-190G) (U)*, WSRC-RP-2005-4065, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2007. *Land Use Control Implementation Plan (LUCIP) for the Chemicals, Metals, and Pesticides Pits Operable Unit (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, and 080-190G) (U)*, WSRC-RP-2005-4078, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

Various - Inspection Data Sheets – *Field Inspection Checklist Chemical, Metal, and Pesticides Pits (U)*, ER-IDS-019-062, Inspection period 2015 through 2019 (annually)

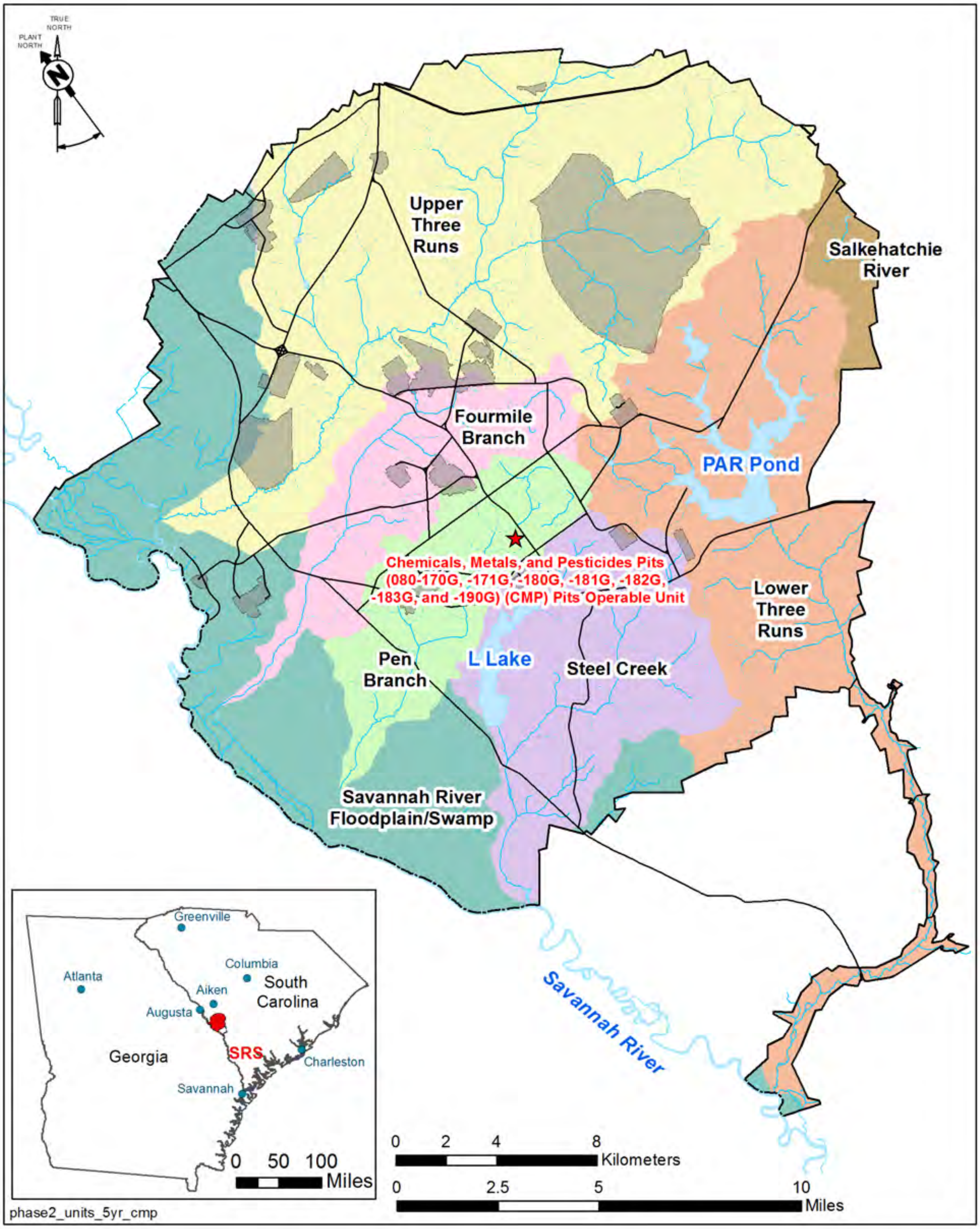

Figure D-1. **Location of the CMP Pits OU at SRS**

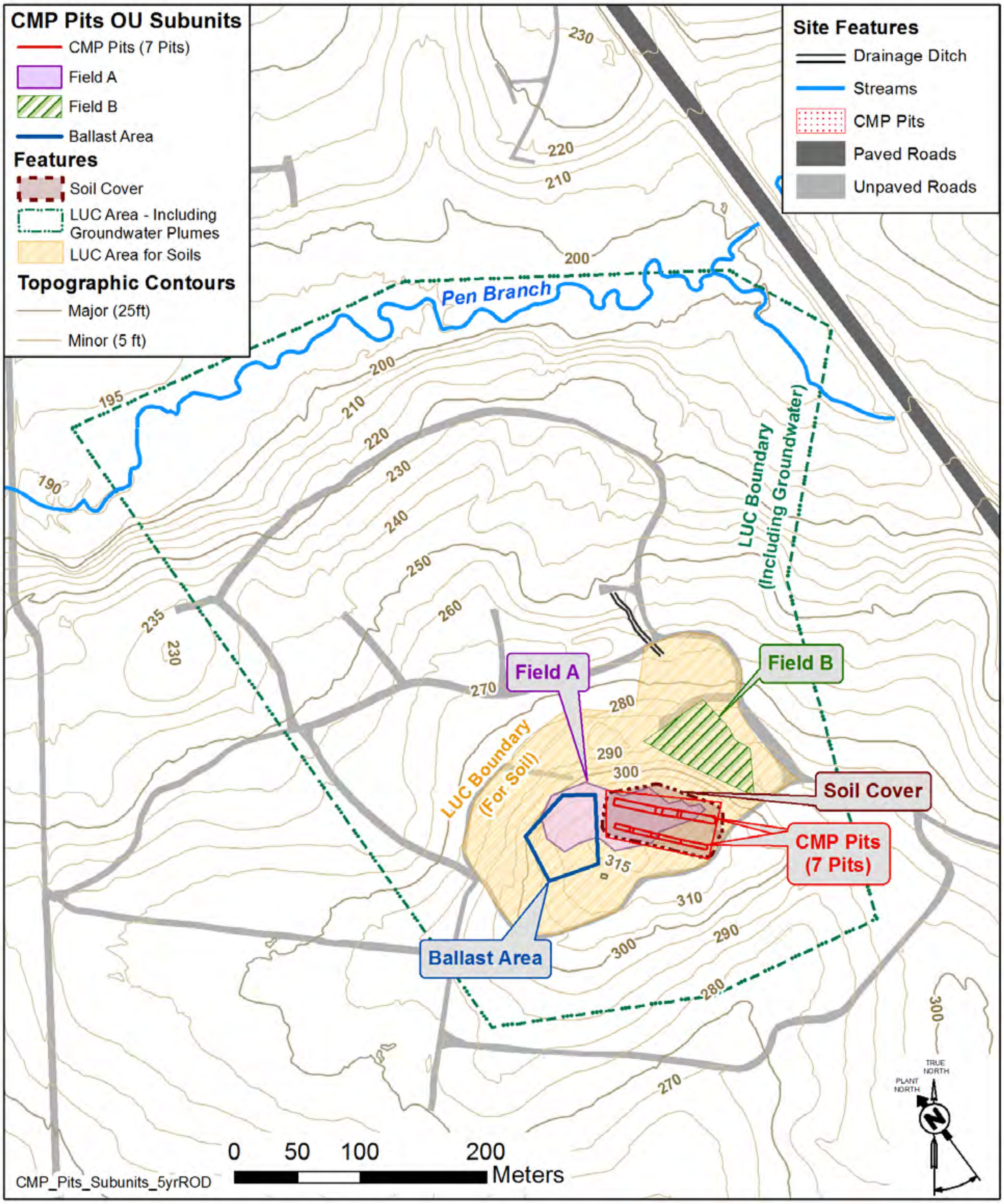

Figure D-2. Layout of the CMP Pits OU

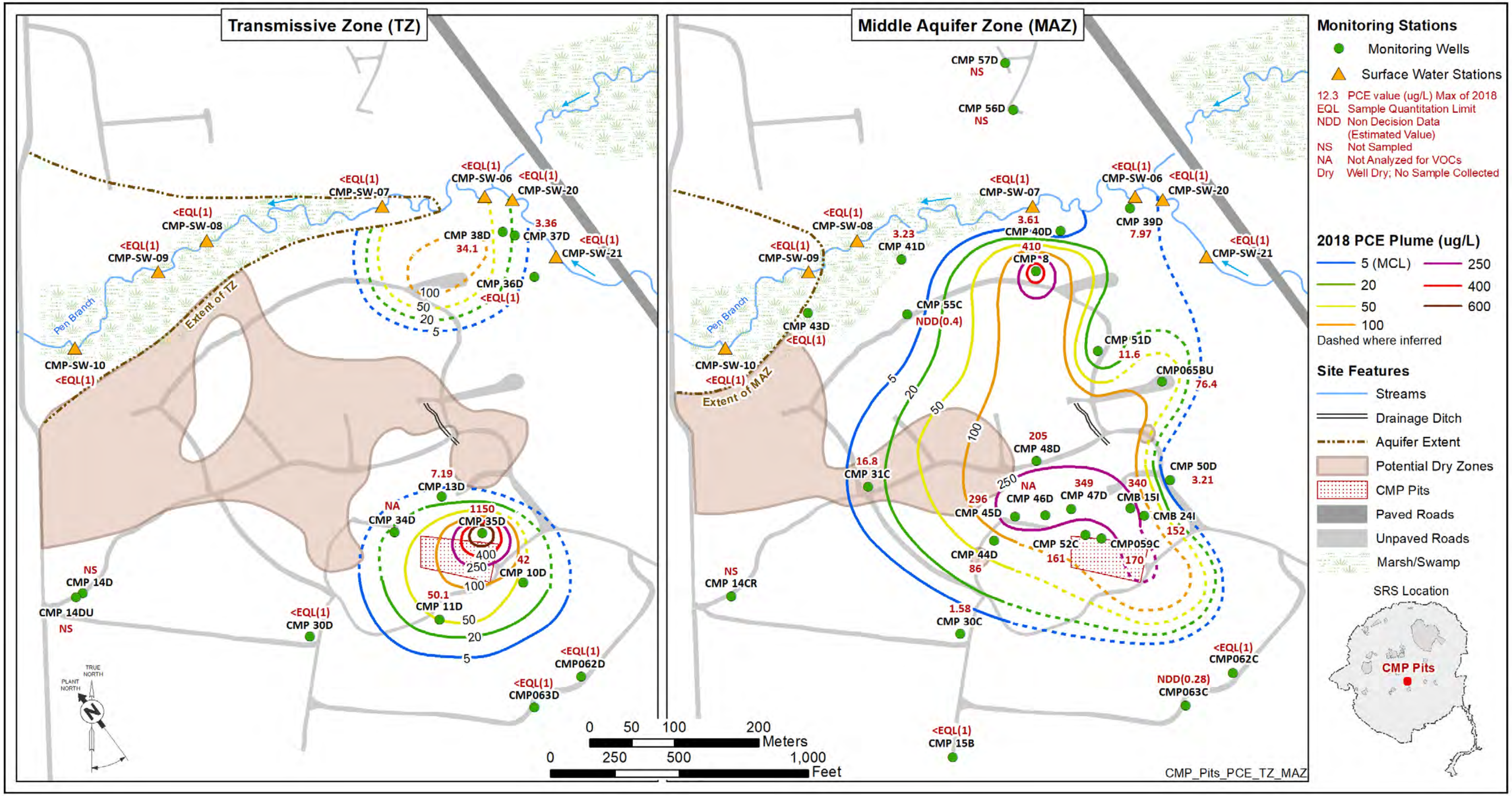

Figure D-3. 2018 PCE Plume in the Transmissive Zone and Middle Aquifer Zone

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Figure D-4. Photo of CMP Pits before Remediation Activities (During Disposal Operation) (early 1980s)

Figure D-5. Photo of CMP Pits (Current) (2019)

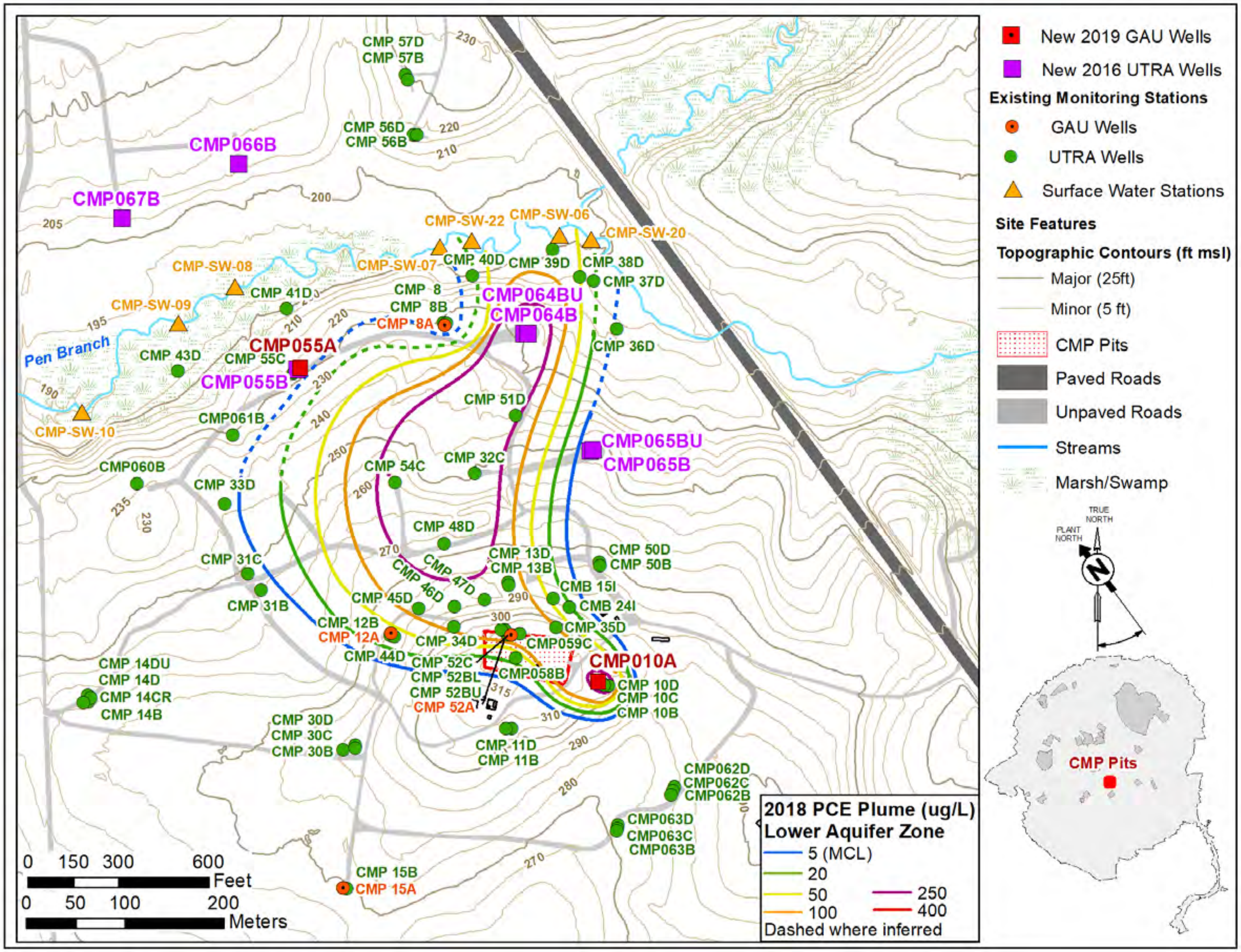

Figure D-6. Locations of Additional Groundwater Investigations in 2016 and 2019 (Lower Aquifer Zone PCE Plume)

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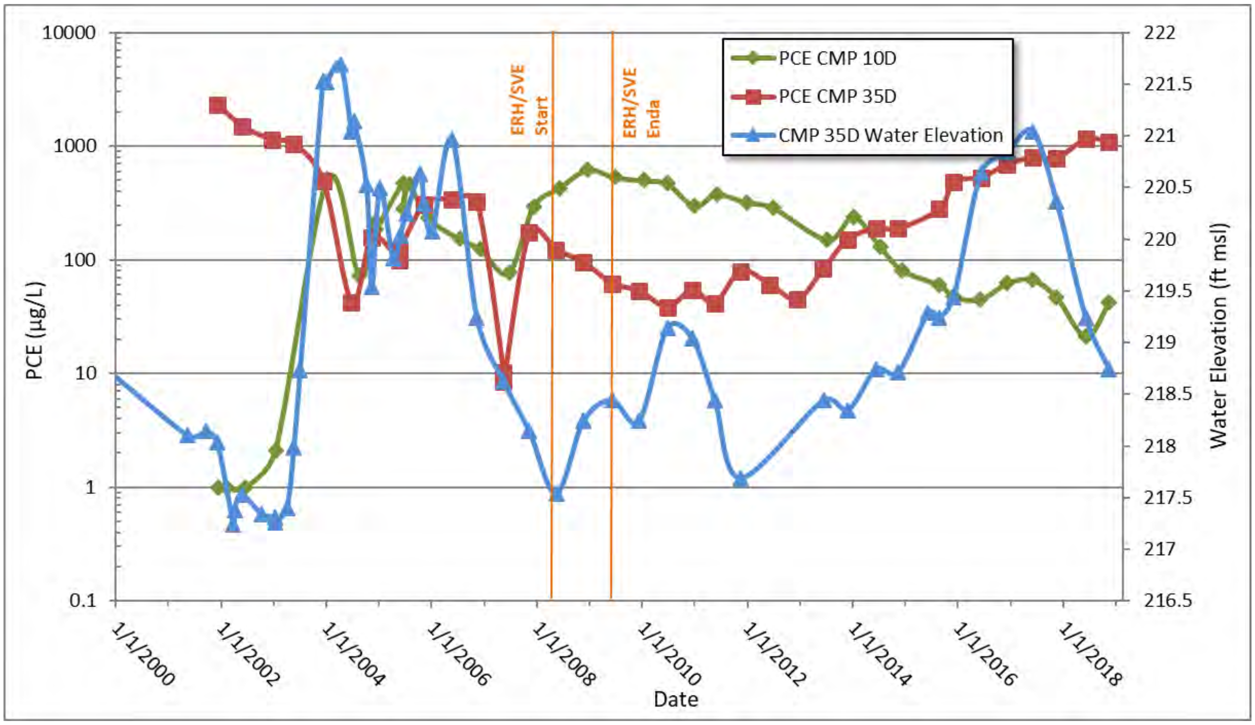

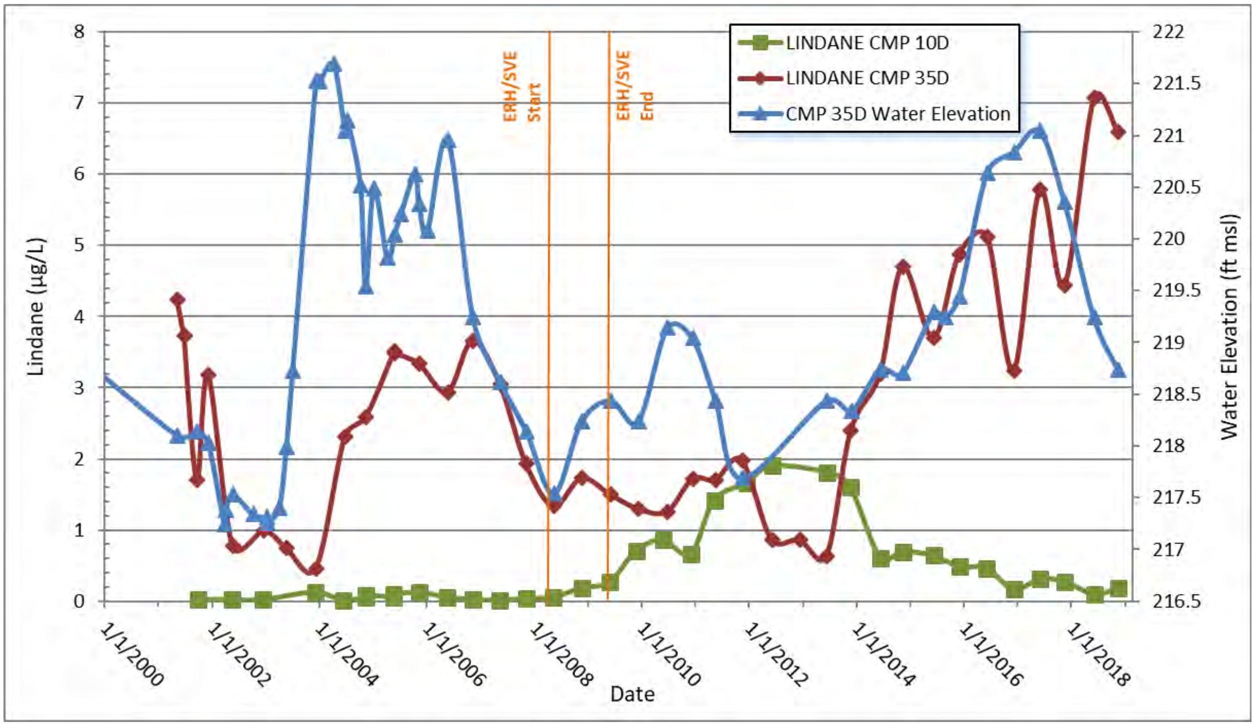

Figure D-7. **Comparison of PCE and Lindane Trends in CMP 35D and CMP 10D**

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Table D-1. Chronology of OU Events

Event	Date
Removal Action (Soil Excavation)	1984
Remedial Investigation Complete	October 1, 1997
Interim ROD Issuance	January 19, 2000
Interim Remedial Action Construction Start / Completion	December 10, 1999 / December 5, 2001
Interim Remedial Action Operations Start / Completion	April 23, 2001 / October 12, 2005
First Interim ROD Amendment Issuance	April 8, 2002
Second Interim ROD Amendment Issuance	October 21, 2003
ROD Issuance	May 10, 2005
Remedial Action Construction Start / Completion	April 6, 2006 / November 7, 2007
Remedial Action Operations Start / Completion	November 2007 / June 28, 2009
Previous Five-Year Remedy Reviews	February 12, 2004 / January 28, 2009 / February 4, 2014 / February 2, 2017

Table D-2. CMP Pits RCOCs by Medium and Subunit with Final Remedial Goals

		Type of RCOC					
Area/Media of Concern	**RCOCs**	**ARAR**	**CM/ PTSM**	**HH**	**ECO**	**RGs (mg/kg or mg/L)**	**Final Remedial Goal Basis**
Ballast Area	PCB	✓			✓	1.00E+00	ARAR
	Dieldrin			✓	✓	6.84E-02	Ecological
	Endrin				✓	3.97E-02	Ecological
	Heptachlor Epoxide				✓	2.10E-02	Ecological
	Dichlorodiphenyldichloro ethane (DDD)				✓	2.87E-01	Ecological
	Dichlorodiphenyldichloro ethylene (DDE)				✓	5.54E-01	Ecological
	Dichlorodiphenyldichloro trichloroethylene (DDT)			✓	✓	1.62E+00	Ecological
CMP Pits and Associated Field A Vadose Zone [2]	Dichloromethane		✓			2.48E-02	Contaminant migration
	Tetrachloroethylene		✓			3.07E+01	Contaminant migration
Groundwater	Alpha-benzene hexachloride			✓		5.33E-06	Future Resident
	Beta-benzene hexachloride			✓		1.84E-05	Future Resident
	Delta-benzene hexachloride			✓		1.84E-05	Future Resident
	Dieldrin			✓		2.09E-06	Future Resident
	Lindane	✓		✓		2.00E-04	ARAR
	Bis(2-ethylhexyl) phthalate	✓		✓		6.00E-03	ARAR
	Total Trihalomethanes[1]	✓		✓		0.80E-01	ARAR
	Carbon Tetrachloride	✓		✓		5.00E-03	ARAR
	Dichloromethane	✓		✓		5.00E-03	ARAR
	Tetrachloroethylene (PCE)	✓		✓		5.00E-03	ARAR
	Trichloroethylene (TCE)	✓		✓		5.00E-03	ARAR

1. Total Trihalomethanes includes chloroform and bromodichloromethane. Although these constituents are not ARAR COCs (Site concentrations pose a risk but do not exceed the MCL), they do have an MCL that is an ARAR and; as such, is the appropriate final RG.
2. Vadose zone RGs apply anywhere in the vadose zone. The RGs are target values based on available data. During remedial action implementation, vadose zone and groundwater monitoring may indicate that different values may be protective and meet the remedial action objective of preventing migration to groundwater.

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

	FY2015	FY2016	FY2017	FY2018	FY2019	Five-Year Total
Total Actual O&M Costs ($)	334,400	146,004	101,852	88,299	89,677	760,232
Total ROD Estimated Direct O&M Costs ($)	44,297	44,297	57,605[a]	44,297	44,297	234,793

a - FY2017 estimated costs include costs associated with the fifth five-year remedy review. Actual costs were accrued in FY2016.

Table D-4. Comparison of RGs and Groundwater and Surface Water Monitoring Data from 2018

	RGs	Groundwater		Surface Water
RCOC	MCL (µg/L)*	2007 (Pre-ERH/SVE) Maximum Concentration (µg/L)	2018 Maximum Concentration (µg/L)	2018 Maximum Concentration (µg/L)
PCE	5.0	1.35E+03	1.15E+03	Non Detect
TCE	5.0	8.51E+02	6.85E+02	Non Detect
Lindane	0.2	3.05E00	7.07E00	Not Analyzed[1]
Carbon Tetrachloride	5.0	2.46E+01	2.45E+01	Non Detect
Dichloromethane	5.0	2.09E00	2.37E00	Non Detect
Bromodichloromethane	80	1.6E+01	9.4E00	Non Detect
Chloroform	80	3.04E+01	2.7E+01	Non Detect

* MCL values are based on USEPA values available May 2019.

[1] Lindane is not required to be analyzed in surface water as part of the EMP.

Table D-5. Ballast Area Enhanced Bioremediation Soil Sample Confirmation Results

RCOC	Remedial Goal (µg/kg)	Maximum Result of Confirmation Samples (µg/kg)
PCB	1.0E+03	1.92E+02
Dieldrin	6.84E+01	4.09E+01
Endrin	4.0E+01	9.06E00
Heptachlor Epoxide	2.1E+01	8.55E00
Dichlorodiphenyldichloro ethane (DDD)	2.87E+02	1.94E+02
Dichlorodiphenyldichloro ethylene (DDE)	5.54E+02	4.96E+01
Dichlorodiphenyldichloro trichloroethylene (DDT)	1.62E+03	3.22E+02

Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit

I. SITE INFORMATION

Site Name:	**Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit**	**Date of Inspection:**	**10/22/2019**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**SEMS #24**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**81°F and partly sunny**

Remedy Includes: *(Click all that apply)*

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

☒ Other Operation with a combination of Electrical Resistance Heating (ERH) and Soil Vapor Extraction (SVE) system (Field A); and passive SVE via BaroBalls^{TM} (Field B) have been concluded. MNA is continuing.

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

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** Brian Hanshew (Name) ACP Field Execution Team 2 (Title) 11/05/2019 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4949

Problems/Suggestions: ☐ Report Attached

2. **O&M Staff:** Phil Carter (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 11/05/2019 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4145

Problems/Suggestions: ☐ Report Attached

Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)*

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

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

Agency:

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

Problems/Suggestions: ☐ Report Attached

Agency:

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

Problems/Suggestions: ☐ Report Attached

Agency:

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

Problems/Suggestions: ☐ Report Attached

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

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

1. **O&M Documents:**

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

Remarks: See *Waste Unit Inspection and Maintenance, ER-SOP-019, Field Inspection Checklist for Chemical Metal and Pesticides Pits*, ER-IDS-019-062.

Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)*

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

2. Health and Safety Plans (HASPs):

☐ Site-Specific Health and Safety Plans ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Contingency Plan/Emergency Response Plan ☐ Readily Available ☐ Up to Date ☒ N/A
Remarks: Routine O&M activities do not require a Site-Specific Health and Safety Plan (SSHASP) under 29 CFR 1910.1201, Hazardous Waste Operations. A SSHASP is prepared if needed.

3. O&M and OSHA Training Records: ☒ Readily Available ☒ Up to Date ☐ N/A
Remarks: Training Records are complete and up to date per EC&ACP training matrix.

4. Permits and Service Agreements:

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

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

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

7. Groundwater Monitoring Records: ☒ Readily Available ☒ Up to Date ☐ N/A
Remarks: Water elevation records only.

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

9. Discharge Compliance Records:

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

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

Attachment D-1. **Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)***

IV. O&M COSTS

1. O&M Organization:

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

2. O&M Cost Records:

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

Total annual cost by year for review period, if available

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

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

Describe costs and reasons: N/A

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

A. Fencing

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

B. Signs

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

Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

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

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Once every five years
Responsible Party/Agent: USDOE Savannah River Field Office
Contact: Karen Adams (Name) Federal Project Director (Title) 12/17/19 (Date) 803-952-7871 (Phone No.)

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

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

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

D. General

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

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

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

Attachment D-1. **Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)***

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

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

B. Other Site Conditions

Remarks:

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

A. Landfill Surface

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

2. Cracks: ☐ Location shown on site map ☒ Cracking not evident
Lengths________ Widths________ Depths________
Remarks:

3. Erosion: ☐ Location shown on site map ☒ Erosion not evident
Areal extent________ Depth________
Remarks:

4. Holes: ☐ Location shown on site map ☒ Holes not evident
Areal extent________ Depth________
Remarks:

5. Vegetative Cover: ☒ Grass ☒ Cover properly established ☒ No signs of stress
Areal extent________ Depth________
Remarks: Vegetation mowed routinely.

Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)*

VII. LANDFILL COVER/CONTAINMENT *(Continued)*

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

Remarks:______________________________

____

7. Bulges: ☐ Location shown on site map ☒ Bulges not evident

Areal extent__________ Depth__________

Remarks:______________________________

____

8. Wet Areas / Water Damage: ☒ Wet areas/water damage not evident

☐ Wet areas ☐ Location shown on site map Areal extent__________

☐ Ponding ☐ Location shown on site map Areal extent__________

☐ Seeps ☐ Location shown on site map Areal extent__________

☐ Soft subgrade ☐ Location shown on site map Areal extent__________

Remarks:______________________________

____

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

Areal extent__________

Remarks:______________________________

____

B. Benches ☐ Applicable ☒ N/A

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

C. Letdown Channels ☐ Applicable ☒ N/A

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

Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)*

VII. LANDFILL COVER/CONTAINMENT *(Continued)*

D. Cover Penetrations ☒ Applicable ☐ N/A

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

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

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

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

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

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

F. Cover Drainage Layer ☐ Applicable ☒ N/A

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

H. Retaining Walls ☐ Applicable ☒ N/A

Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)*

VII. LANDFILL COVER/CONTAINMENT *(Continued)*

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

1. Siltation: ☐ Location shown on site map ☒ Siltation not evident
Areal extent__________________ Depth_____________________
Remarks:____

2. Vegetative Growth: ☐ Location shown on site map ☐ N/A
☒ Vegetation does not impede flow
Areal extent____________________ Type______________________
Remarks:____

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

4. Discharge Structure: ☐ Location shown on site map ☒ N/A
Remarks:____

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

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

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

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

C. Treatment System ☐ Applicable ☒ N/A

D. Monitoring Data ☒ Applicable ☐ N/A

1. Monitoring Data:
☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring Data Suggests:
☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

E. Monitored Natural Attenuation ☒Applicable ☐ N/A

1. Monitoring Wells *(natural attenuation remedy)***:**
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs maintenance ☐ N/A
Remarks:____

Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)*

X. OTHER REMEDIES

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

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

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

The remedial action for CMP Pits groundwater is MNA and LUCs to prevent exposure to contaminated groundwater above MCLs; the selected remedy for the Ballast Area is LUCs to prevent direct contact to PCB-contaminated soils above concentrations of 1 mg/kg. A combination of ERH to remove DNAPL and operation of the SVE system for Source Area (Field A) and of the passive soil vapor extraction system via BaroBalls^{TM} for Source Area (Field B) have concluded their operation. The remedy is fully established and functioning as designed.

B. Adequacy of O&M

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

The O&M procedures consisting of annual (2015-2019) site inspections and site maintenance (repair of erosion damage, cover maintenance, and warning signs) and site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the waste unit) have been implemented. The O&M procedures are adequately maintaining the CMP Pits OU and the condition of its warning signs is good. There are no issues requiring corrective actions.

C. Early Indicators of Potential Remedy Failure

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

N/A

D. Opportunities for Optimization

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

N/A

End of Checklist

D-AREA OIL SEEPAGE BASIN (631-G) OPERABLE UNIT

I. Introduction

This report is the sixth five-year remedy review for the D-Area Oil Seepage Basin (631-G) (DOSB) Operable Unit (OU). DOSB currently meets unrestricted land use criteria for soils, sediment, and surface water. However, groundwater contaminants at the DOSB OU are at levels that do not allow for unlimited use and unrestricted exposure. The review was conducted from August 2019 through November 2019. The purpose of this review is to determine whether the remedy in place at the DOSB OU is protective of human health and the environment. This report documents the results of the review.

II. Operable Unit Chronology

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

III. Background

The DOSB OU is a Resource Conservation Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation, and Liability Act unit listed in Appendix C of the Federal Facility Agreement (FFA) for the Savannah River Site (SRS) (FFA 1993). The media associated with this OU is groundwater.

Physical Characteristics

The DOSB OU is located within SRS in a clearing, approximately 1.6 km (1 mi) north of the coal-fired D-Area Powerhouse (484-D) and approximately 3 km (1.9 mi) from the nearest SRS boundary, the Savannah River (Figure E-1). The DOSB was constructed in 1952 as a series of unlined trenches to dispose of waste oil products. The DOSB is approximately 114.9 m (383 ft) long by 32.4 m (108 ft) wide and 2.4 m (8 ft) deep (Figure E-2). During an interim remedial action (IRA) conducted at the unit, the trenches were found to be continuous, without noticeable berms, and were constructed as a series of adjacent trenches along the back half of the clearing.

The groundwater beneath the DOSB is included in the OU. The DOSB is on the Ellenton Plain along the Savannah River at an elevation of 45 m (150 ft) above mean sea level (msl). The terrain is flat, with no discernible slope or relief, and is surrounded by a mature forest of hardwoods and softwoods. The water table ranges from approximately 1.2 to 4.8 m (4 to 16 ft) below ground surface (bgs) in the area of the DOSB. The water table aquifer system in this area is composed of the sands of Dry Branch, Santee, and Clinchfield Formations and is in the lower aquifer zone (LAZ) of the Upper Three Runs Aquifer (UTRA). Locally, the LAZ of the UTRA is subdivided into three aquifer zones: AQ1, AQ2, and AQ3. The Gordon Aquifer Unit (GAU) lies beneath the Gordon Confining Unit. The Gordon Confining Unit is below the LAZ. Surface drainage is to the southwest, toward the Savannah River, which is at an elevation of 25.5 m (85 ft) msl. The closest surface water feature is a Carolina bay, a natural wetland located adjacent to the unit to the west (Figure E-2). The Carolina bay appears to be dry during the summer months or periods of little to no precipitation, but it may contain surface water during wet seasons. Other wetlands exist approximately 75 m (250 ft) south of the unit (Figure E-2). The major local surface water drainage system is the Savannah River and associated swamps, located approximately 2.6 km (1.6 mi) west of the unit (Figure E-1). Upper Three Runs Creek, a tributary to the Savannah River, is located 2.6 km (1.6 mi) to the north-northwest, and Fourmile Branch, another tributary, is located 2.4 km (1.5 mi) to the south-southeast (Figure E-1).

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 1999a) designates the DOSB OU as being within an industrial area. The future land use for the DOSB OU is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

Prior to SRS ownership, the DOSB area was primarily used for agriculture. In 1952, the DOSB trenches began receiving waste oils and fluids from A-Area and other areas at SRS which were unacceptable for incineration in the 400-D powerhouse boilers. The waste was periodically burned along with general office and cafeteria waste. There is no evidence that the DOSB received radioactive waste. Figure E-3 is a photograph of one of the trenches during its operational period. In 1975, the basin was removed from service and backfilled with soil. The basin remained inactive and covered with natural vegetation, including bushes and grasses. During a limited scope characterization in 1993, 58 buried 55-gallon drums suspected to contain hazardous substances were discovered.

Initial Response

A preliminary unit evaluation and a unit reconnaissance were performed in August 1988. Since the preliminary unit evaluation concluded that the unit had received hazardous substances, a unit screening investigation was implemented, and field investigations conducted between 1988 and 1994. The field investigations involved soil borings, surface geophysics, well and piezometer installation, and groundwater sampling.

Groundwater and soil sampling were performed in 1996 as part of the RCRA Facility Investigation/Remedial Investigation (RFI/RI). The investigation revealed soils contamination in the trenches and a plume of volatile organic compounds (VOCs) in the groundwater. The RFI/RI Report and the Baseline Risk Assessment (BRA) Report for the DOSB (WSRC 1997a) identified eight VOCs as final constituents of concern (COCs): benzene, 1,1-dichloroethylene (DCE), total 1,2-DCE, cis-1,2-dichloroethylene (cDCE), dichloromethane, tetrachloroethylene (PCE), trichloroethylene (TCE), and vinyl chloride (VC). An IRA (WSRC 1995) was implemented in 1996 and included:

- Removing drums, debris, and principal threat source material (PTSM), transferring drum contents into new drums, and properly disposing of all hazardous and non-hazardous materials.

- Backfilling, grading, and seeding the basin in accordance with the Remedial Design/Remedial Action Work Plan (WSRC 1996). The DOSB was graded and seeded to ensure stormwater would runoff to minimize water infiltration and to minimize erosion.
- Installing and testing a biological treatment system (i.e., bioventing system) to volatilize the contaminants in the soil and enhance the aerobic degradation of the contaminants in the soil.

Basis for Taking Action

The potential exposure to or ingestion of groundwater contaminated above maximum contaminant levels (MCLs) poses a potential increased risk of cancer to human receptors and is the basis for taking action at the DOSB OU. Although shallow groundwater aquifers at SRS are not used as drinking water sources, the potential for unacceptable human exposure to contaminated groundwater exists as long as contaminants remain at levels above MCLs.

IV. Remedial Actions

Remedy Selection

As stated in the Record of Decision (ROD) (WSRC 1998), the selected remedy for the DOSB OU is monitored natural attenuation (MNA)/groundwater mixing zone (GWMZ) with institutional controls. The ROD identifies COCs for groundwater only because the remedial action objectives (RAOs) for deep soil were achieved by the IRA. Methylene chloride was initially identified as a soil COC, but concentrations were reduced to levels that would not leach to groundwater above the MCLs through the IRA. For this reason, methylene chloride was not identified as a final COC for deep soils in the ROD. In addition, no COCs were identified for shallow soil, surface water, and sediment during the RFI/RI and BRA (WSRC 1997a). Remedial goals (RGs) for groundwater COCs were determined to be equivalent to their respective MCL values in all monitoring wells. The groundwater contaminants at the DOSB OU and their corresponding RGs are provided in Table E-2. The RAOs for the groundwater are:

- Reduce risk to human health associated with dermal contact and ingestion of groundwater and inhalation of groundwater vapor; and
- Restore groundwater to achieve applicable or relevant and appropriate requirements (ARARs) and RGs.

As stated in the ROD (WSRC 1998), the selected remedial action is as follows:

- DOSB deep soils - No Further Action since RAOs were achieved by the IRA and bioventing testing;
- DOSB shallow soil, surface water and sediment – No Action because no COCs in those media were identified in the RFI/RI Report and BRA; and
- DOSB groundwater - MNA/GWMZ with institutional controls.

Natural attenuation mechanisms such as biodegradation, flushing, volatilization, adsorption, and hydrolysis would continue to reduce contaminant concentrations in the groundwater to acceptable levels. The source of groundwater contamination (i.e., DOSB soil) no longer contributes to groundwater contamination as a result of the interim action and bioventing test.

Remedy Implementation

The final remedial action consisted of the following activities:

- Accepting the interim actions of removing 612 m^3 (800 yd^3) of debris, including 58 drums, and treating 9,371 m^3 (12,250 yd^3) of deep basin soils as final actions;
- Establishing an MNA/GWMZ by implementing a compliance groundwater monitoring program in accordance with the Corrective Measures Implementation/Remedial Design/Remedial Design Report/Remedial Action Work Plan (WSRC 1999b);
- Establishing institutional controls to control unauthorized access to DOSB groundwater including site control of groundwater well installations through existing SRS procedures, the existing SRS security controls and perimeter fences and use of restrictions via the SRS Site Use/Site Clearance Program; and

- Establishing land use controls (LUCs) for 9.35 hectares (23.04 acres) (WSRC 1997b).

Figure E-4 is a current photograph of the OU in 2018.

Systems Operations/Operation and Maintenance

There are no system operational requirements at the DOSB OU. DOSB currently meets unrestricted land use criteria for soils, sediment, and surface water. However, groundwater contaminants at the DOSB OU are at levels that do not allow for unlimited use and unrestricted exposure. LUCs are in place for the groundwater. Therefore, annual site inspections and maintenance (e.g., repair of erosion damage, cover maintenance, removal of trees and warning signs) are not required for soils, sediment, and surface water. Site inspections are performed for the monitoring wells and the Five-Year Remedy Review Reports.

For DOSB groundwater, a compliance groundwater monitoring program has been established to demonstrate compliance with MCLs at the compliance boundary and compliance with the mixing zone contaminant levels (MZCLs) at the plume wells as required by the GWMZ application and the ROD. All monitoring and reporting are in accordance with the GWMZ application (SRNS 2009).

The ROD estimated operations and maintenance (O&M) costs associated with the selected remedy for DOSB has a present worth of $299,000, which was discounted at 5% per year for 30 years of maintenance activities (WSRC 1998). The estimated O&M costs applicable to Fiscal Year (FY) 2015 through FY2019 are $16,666, which is the estimated cost of writing the five-year remedy review. The actual O&M cost from FY2015 until FY2019 is $269,817. The actual O&M costs (Table E-3) are higher than expected because groundwater monitoring and reporting costs have continued beyond FY2009 as estimated in the ROD. Additionally, the ROD estimate was based on monitoring twelve locations for VOC analyses, while 23 wells are monitored for VOC analyses and additional natural attenuation field parameters.

V. Progress Since Last Review

This is the sixth five-year remedy review for the DOSB OU. The previous protectiveness statement concluded that because the remedial actions at DOSB OU are protective, the DOSB OU is protective of human health and the environment.

Due to the presence of chlorinated solvents at DOSB OU, the potential that 1,4-dioxane could be present in groundwater exists, because it was often added to chlorinated solvents as a stabilizer and corrosion inhibitor. A recommendation was made in the previous five-year remedy review to sample for 1,4-dioxane at the DOSB (SRNS 2016). The presence of 1,4-dioxane is not likely to change the protectiveness of the remedial action that includes LUCs (at a minimum), which consequently renders the exposure pathway to human receptors incomplete. SRS performed a historical review of groundwater data for the DOSB OU resulting in a single sampling event of five individual DOB wells in 1991 (two wells) and 2006 (three wells). The results indicated 1,4-dioxane was not detected. Per the fifth five-year remedy review recommendation, all wells were sampled for 1,4-dioxane during the second quarters of 2016, 2017, and 2018 (SRNS 2018). 1,4-Dioxane was only detected in three of the monitoring wells (DOB 15, DOL2, and DOB 16). Results from these wells are shown in Figure E-15. 1,4-Dioxane will continue to be sampled at wells DOB 15, DOL 2, and DOB 16 to collect sufficient trend data. There is currently no MCL for 1,4-dioxane, but the current U. S. Environmental Protection Agency (USEPA) tap water regional screening level is 0.46 µg/L.

VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed documents listed in Section XII, Documents Reviewed;
- Confirmed effective operation of the implemented remedial actions;
- Reviewed the groundwater data to determine the suitability of the mixing zone in evaluating whether MNA will foster reaching MCLs for the COCs in the DOSB groundwater;

- Inspected the OU, interviewed maintenance personnel and documented the results on the Inspection Checklist provided in Attachment E-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance.

Data Review

For evaluating the MNA/GWMZ effectiveness, recent groundwater data from 2014 through 2018, the Revision 1.5 to the groundwater mixing zone application (SRNS 2009), the RFI/RI with BRA report (WSRC 1997a), and the annual mixing zone report for 2017 (SRNS 2018), which includes time series plots and hydrographs, were reviewed.

Per the flow and transport modeling effort (WSRC-RP-2004-4104, Revision 0, September 2004), the contaminated plumes were simulated for 50-years with no continuing sources contributing to groundwater contamination (consistent with source removal in 1996). The model predicted that PCE, TCE, DCE, and VC concentrations in the plume would be below their respective MCLs in 2027. Per the *2017 Annual Mixing Zone Monitoring Report for the D-Area Oil Seepage Basin (631-G) (U)* (SRNS 2018), groundwater contaminant data continues to exist within the parameters predicted in the modeling.

In order to evaluate the remainder of the contaminants and the effectiveness of the MNA remedy, the data were reviewed from several perspectives. The 1996 plume maps (WSRC 1997a) for PCE, TCE, and VC were compared with the 2014 and 2018 plume maps (USDOE 2015 and USDOE 2019) (Figures E-5 through E-12). PCE was below the MCL (5 µg/L) in all wells at the DOSB in 2018. Therefore, a plume map was not created for PCE in 2018. The following were determined from this review:

- Concentrations of PCE in the AQ1/2, AQ3, and GAU aquifers continue to slowly decrease or remain similar to concentrations from previous sampling (Figures E-5 and E-6). The most recent data at the DOSB shows that PCE did not exceed the MCL (5µg/L) at any wells;
- Concentrations of TCE in the AQ1/2, AQ3, and GAU aquifers appear to slowly decrease compared to concentrations from previous sampling. The TCE plume in AQ3

continues to slowly decrease or remain similar compared to concentrations from previous sampling. Those concentrations that exceed the TCE MCL (5 µg/L) are less than the MZCL (200 µg/L);

- The VC 2 µg/L contour in the AQ1/2 aquifer appears relatively stable with little movement downgradient. Concentrations in AQ1/2 continue to decrease compared to results from previous sampling. No detects of VC are found in the GAU. Those concentrations that exceed the VC MCL (2 µg/L) are less than the MZCL (147 µg/L).

In terms of evaluating VOC concentrations of parent to daughter compounds, concentrations of PCE verses TCE and TCE verses cDCE were compared (Figures E-13 and E-14). As shown in Figure E-14, monitoring well data with the highest VOC concentrations demonstrates a significant change from parent to daughter VOCs over time. Alternatively, the wells with relatively low VOC concentrations tend to have relatively constant ratios of the parent and daughter VOC concentrations (Figure E-13). These results suggest that when the groundwater is contaminated with significant concentrations of VOCs, degradation occurs rapidly. However, when the VOC concentrations are low, the degradation rate is low. Figures E-13 and E-14 indicate that degradation from PCE to TCE and TCE to cDCE is occurring in the groundwater at the DOSB OU.

As stated in the GWMZ application (SRNS 2009), reductive dechlorination is not considered a continuous viable process at DOSB. At SRS, groundwater aquifers are normally depleted in natural carbon. However, petroleum hydrocarbons and chlorinated solvents were co-disposed with PCE and TCE at the DOSB (1952 to 1975), which provided an “optimum” situation for the reductive dechlorination of PCE and TCE in groundwater. Biodegradation of PCE and TCE likely occurred in the vadose zone, but the water table is shallow at the DOSB (2.4 to 4.5 m [8 to 15 ft] bgs). Thus, the pathway to groundwater is relatively short. At the DOSB, past biogeochemical zonation may have included reductive dechlorination zones near the source, followed by oxidative degradation of vinyl chloride at some point downgradient. Over time and with the source removal/treatment of DOSB (1995 to 1997), the concentrations of PCE and TCE have significantly declined, as well as the concentrations of the petroleum hydrocarbons themselves.

The co-disposal of petroleum hydrocarbons provided a ready carbon source for biological degraders, and the presence of degradation products (cDCE and VC) in the plume wells suggest that past biodegradation has effectively degraded the parent compounds. Since the source of the carbon has become depleted, groundwater has reverted to natural aerobic conditions in the existing carbon-poor environment. Overall, data do not show reductive dechlorination as a viable process. However, it is possible that reductive dechlorination is still occurring at the DOSB in discrete zones near the source and in “pockets” along the centerline of the plume. Natural attenuation at the DOSB relies mainly on physical processes (dispersion/dilution), except for aerobic degradation of vinyl chloride.

The 2018 natural attenuation field parameters (pH, oxidation-reduction potential [ORP], dissolved oxygen [DO], and alkalinity) are shown in Table E-4. For evaluation, trends for pH, ORP, DO, and alkalinity sampled between 2000 and 2006 are compared to the 2018 data as discussed below.

In terms of pH, wells sampled between 2000 and 2006 had values of pH ranging from 3.5 to 7.8 while the 2018 data (Table E-4) show pH values ranging from 4.3 to 7. The pH of groundwater has an effect on the presence and activity of microbial populations in groundwater. This is especially true for methanogens. Microbes capable of degrading chlorinated aliphatic hydrocarbons and petroleum hydrocarbons generally prefer pH values ranging from 6 to 8; however, the majority of the higher pH levels occur at wells further downgradient from the VOC plumes

Data regarding ORP show that wells sampled between 2000 and 2006 had ORP values ranging from -30 to 600, while the 2018 data show ORP values ranging from 15 to 331 mV. The ORP of groundwater is an indicator of the relative tendency of a solution to accept or transfer electrons. Redox reactions in groundwater containing organic compounds are usually biologically mediated, and therefore, the ORP of a groundwater system depends upon and influences rates of biodegradation. In addition, ORP is important because some biological processes operate only within a prescribed ORP range. Reductive dechlorination typically occurs at an ORP range of -200 to 50; however, 21 of the 22 groundwater measurements were above this range with the majority of them above 150 mV.

With regard to DO, wells sampled between 2000 and 2006 had DO values ranging from 0 to 8.4 mg/L; while the 2018 data show DO values ranging from 1.55 to 6.18 mg/L. DO is the most thermodynamically favored electron acceptor used by microbes for the biodegradation of organic carbon, whether natural or anthropogenic. Anaerobic bacteria generally cannot function at DO concentrations greater than 0.5 mg/L, hence reductive dechlorination will not occur. DO concentrations decrease during aerobic respiration.

For alkalinity, wells sampled between 2000 and 2006 had values ranging from 0 to 180 mg/L, while the 2018 data show alkalinity values from 0 to 75 mg/L. There were 8 out of 23 measurements that were 0 mg/L. There is a positive correlation between zones of microbial activity and increased alkalinity. Increases in alkalinity result from the dissolution of rock driven by the production of CO_2 produced by the metabolism of microorganisms. Alkalinity is important in the maintenance of groundwater pH because it buffers the groundwater against acids generated during both aerobic and anaerobic biodegradation. However, the biodegradation of organic compounds does not generate enough acid to impact the pH of groundwater.

In summary, the 2018 DOSB OU groundwater plumes have minimally changed and sampling data obtained during 2018 confirms that the existing GWMZ boundaries are adequate and continue to enclose the DOSB OU plumes.

Summary of Inspections and Interviews

Interviews were conducted with Phil Carter, O&M staff member, and with Brian Hanshew, O&M Site Manager, on November 5, 2019 at the O&M organization offices. No issues were identified for the DOSB OU during these interviews. The DOSB was inspected by Savannah River Nuclear Solutions, LLC (SRNS) Environmental Compliance and Area Completion Projects (EC&ACP) on October 17, 2019. No issues were identified during these interviews.

The DOSB OU was inspected by SRNS EC&ACP and USDOE personnel on December 17, 2019; no issues were identified for the DOSB OU during this inspection.

A site inspection was conducted by USEPA and South Carolina Department of Health and Environmental Control personnel, accompanied by USDOE and SRNS personnel February 27, 2020. No significant problems regarding this OU were identified during the inspection.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The remedies selected for the DOSB OU are functioning as intended as demonstrated below:

- The selected remedy component of LUCs is effective in preventing human exposure to groundwater above MCLs. The Land Use Control Implementation Plan for the DOSB is discussed in Appendix B of the Corrective Measures Implementation/Remedial Design/Remedial Design Report/Remedial Action Workplan and governs LUC implementation, maintenance, monitoring, reporting and enforcement of LUCs (WSRC 1999b). All LUC objectives are being met.
- Review of documents, ARARs, risk assumptions, and results of the site inspection indicate that the remedy is functioning as intended by the ROD. The low concentration of contaminants, shrinking plumes, and relatively short half-lives indicate the MNA/GWMZ will be effective in restoring groundwater to ARARs and RGs. The timeframe for reaching RGs may be optimistic due to the effect of matrix diffusion.

As stated in the ROD (WSRC 1998), the following conditions at the DOSB support that the selected remedy is adequate to meet the RGs within a reasonable timeframe:

- The source of contamination at the DOSB was removed during the IRA in conjunction with the biovent testing and is no longer contributing to groundwater contamination;
- Naturally occurring mechanisms will continue to reduce contaminant concentrations;
- There are no receptors of groundwater at the DOSB; therefore, the potential for exposure is low;

- The UTRA aquifer is limited in thickness and yield, and the groundwater is not targeted for residential or commercial use; therefore, projected demand for future groundwater use is low; and
- Modeling indicates that contaminant concentrations in the DOSB groundwater would be reduced to below MCLs prior to reaching surface water.

Institutional controls (i.e., LUCs) are effective in preventing exposure to groundwater and its vapor. The DOSB currently meets unrestricted land use criteria for soils, sediment, and surface water. Site inspections are performed for the monitoring wells and the Five-Year Remedy Review Reports. The results of the inspection for this five-year remedy review indicate the controls are effective and no problems have occurred. The original gate and fencing around the DOSB perimeter, although still present, is not required. The fencing is a holdover from previous operations.

Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Still Valid?

The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection are still valid except for the arsenic MCL. At the time of the ROD issuance, the MCL for arsenic was 50 µg/L. This value was changed in 2001 to 10 µg/L. There have been no changes in standards or physical conditions of the DOSB OU that would affect the protectiveness of the remedy.

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 for the DOSB OU from being protective.

IX. Recommendations and Follow-up Actions

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

X. Protectiveness Statement(s)

The remedy at the DOSB 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. All threats to contaminated groundwater at the DOSB OU have been addressed through implementation of MNA/GWMZ, physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the DOSB OU for industrial use only and use restrictions via the SRS Site Use/Site Clearance Program.

XI. Next Review

As shown in Appendix A, Table A-1, the next five-year remedy review for SRS OUs with Groundwater Remedies is scheduled for January 2026.

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, 2009. *Groundwater Mixing Zone Application for the D-Area Oil Seepage Basin (631-G) (U)*, WSRC-RP-97-422, Revision 1.5, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2016. *Fifth Five-Year Remedy Review Report for Savannah River Site Operable Units with Groundwater Remedies (U)*, Aiken, South Carolina, SRNS-RP-2015-00419, 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

SRNS, 2016. *Fifth Five-Year Remedy Review Report for Savannah River Site Operable Units with Groundwater Remedies (U)*, Aiken, South Carolina, SRNS-RP-2015-00419, 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

SRNS, 2018. *2017 Groundwater Mixing Zone Monitoring Report for the D-Area Oil Seepage Basin (631-G) (U)*, SRNS-RP-2018-00647, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

USDOE, 2015. *2011 D-Area Oil Seepage Basin (631-G) Groundwater Mixing Zone Letter Report for Calendar Year 2014 Data*, CERCLIS Number: 27, IACD-15-164, U.S. Department of Energy, Savannah River Operations Office, Aiken, SC

USDOE, 2019. *Calendar Year 2018 D-Area Oil Seepage Basin Operable Unit (631-G) Groundwater Mixing Zone Letter Report (U)*, SEMS Number: 27, IACD-19-175 U.S. Department of Energy, Savannah River Operations Office, Aiken, SC

WSRC, 1995. *Interim Action Record of Decision/ Remedial Alternative Selection (U) D-Area Oil Seepage Basin*, WSRC-RP-93-1550, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1996. *Remedial Design/Remedial Action Work Plan for the D-Area Oil Seepage Basin (U)*, WSRC-RP-94-1287, Revision 1.3, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1997a. RCRA Facility Investigation/Remedial Investigation Report and the Baseline Risk Assessment Report for the D-Area Oil Seepage Basin (631-G) (U), WSRC-RP-96-154, Revision 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1997b. *Post Construction Report for D-Area Oil Seepage Basin Interim Action (U)*, WSRC-RP-00859, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1997c. *Evaluation of D-Area Oil Seepage Basin Bioventing Optimization Test Sediment Samples Data*, WSRC-TR-97-00399, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1998. *Record of Decision Remedial Alternative Selection for the D-Area Oil Seepage Basin (631-G) (U)*, WSRC-RP-97-402, Revision 1, 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, March 2013, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC, 1999b. Corrective Measures Implementation/Remedial Design/Remedial Design Report/Remedial Action Work Plan (CMI/RD/RDR/RAWP) for the D-Area Oil Seepage Basin (631-G) (U) (includes Land Use Control Implementation Plan), WSRC-RP-99-4006, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1999c. *Sixth Semi-Annual Groundwater Monitoring Report for the D-Area Oil Seepage Basin Interim Remedial Action (U)*, WSRC-RP-99-4207, Revision 0, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC.

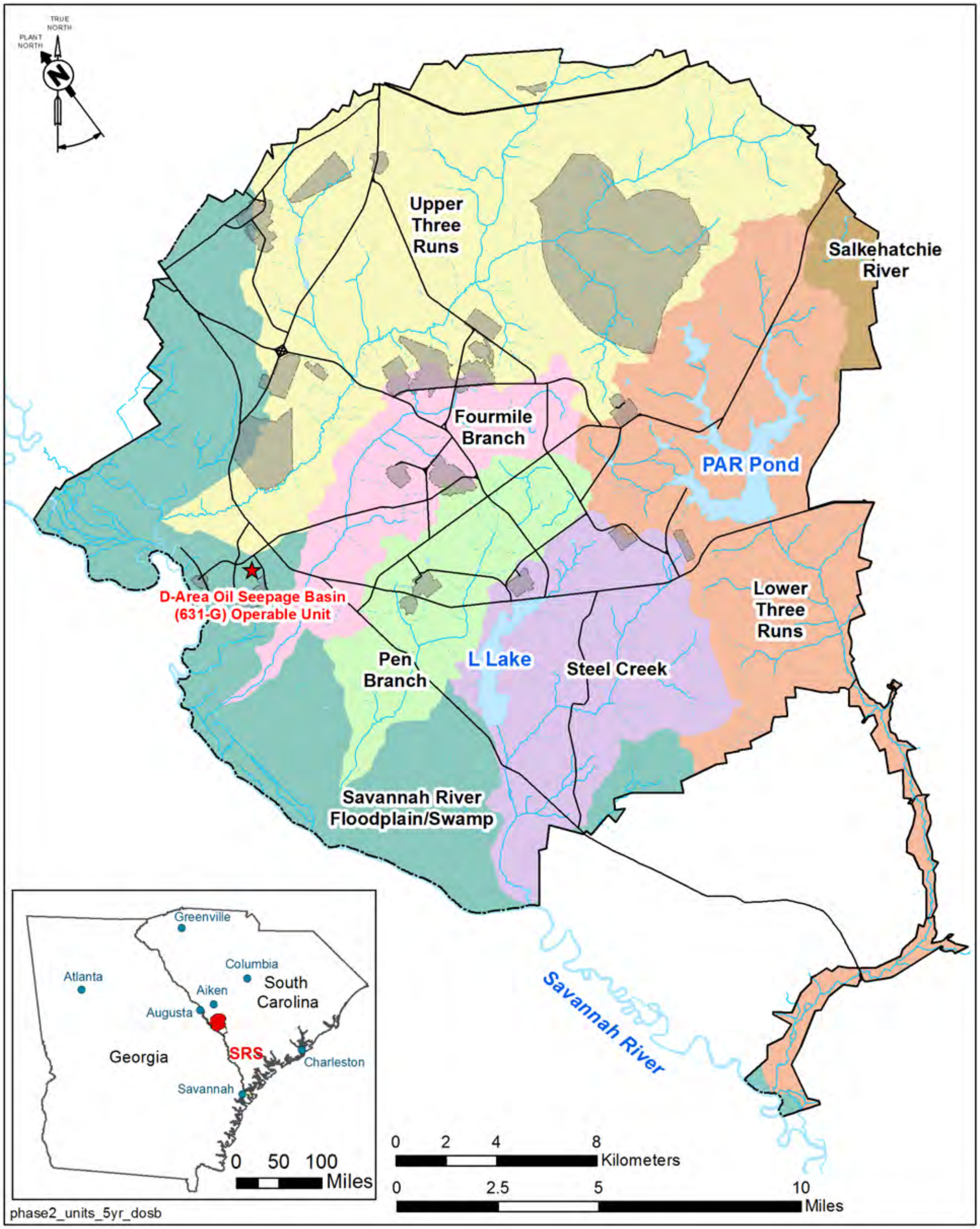


Figure E-1. Location of the D-Area Oil Seepage Basin Operable Unit within SRS

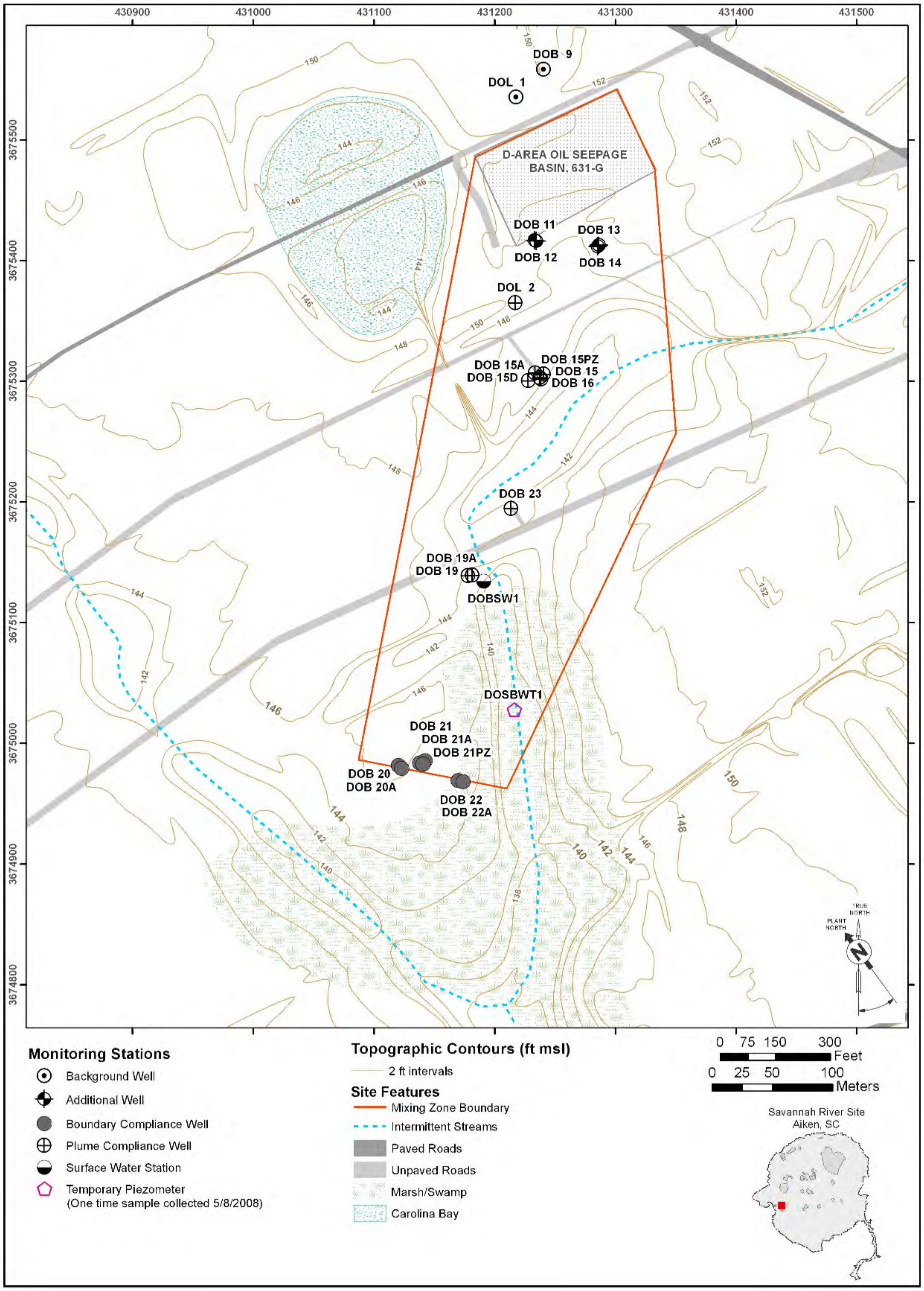


Figure E-2. D-Area Oil Seepage Basin Monitoring Well Location Map

Figure E-3. Photo of the D-Area Oil Seepage Basins Prior to 1975 Backfill Operations

Figure E-4. Current (2018) Photograph of the DOSB

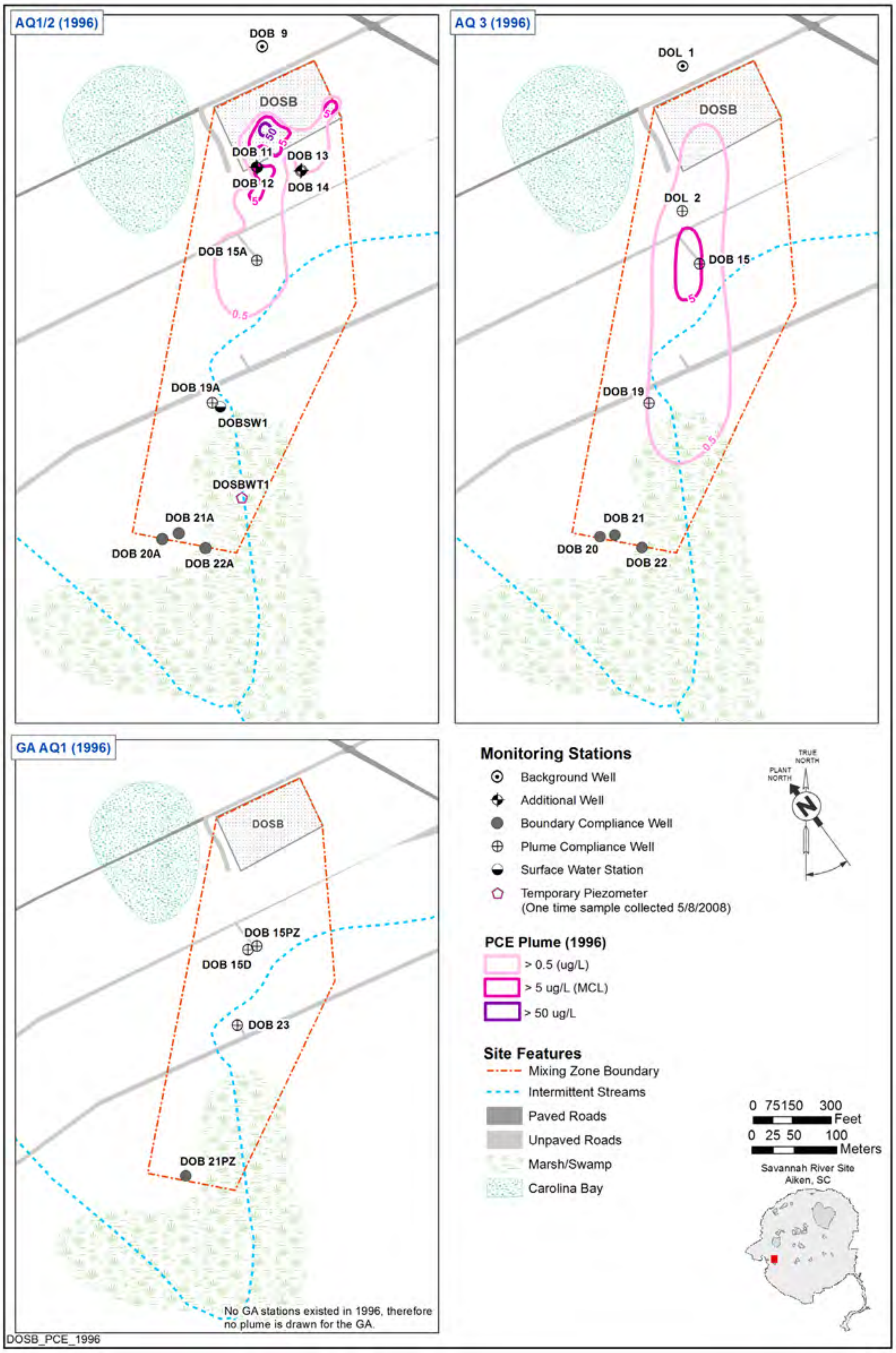


Figure E-5. DOSB PCE plume maps (1996 data) for Aquifers AQ1/2, AQ3, and GA-AQ1 (WSRC 1997a)

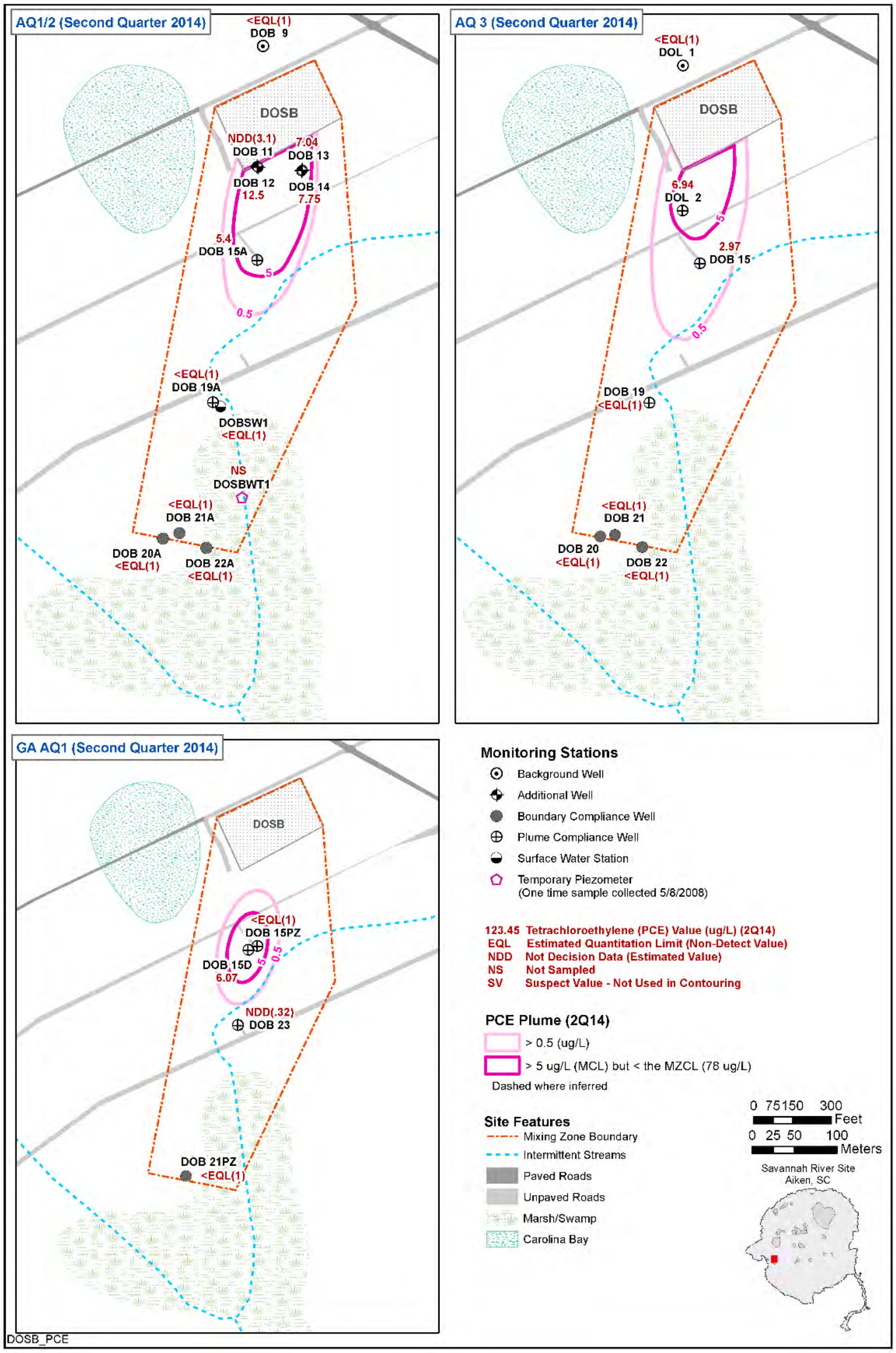
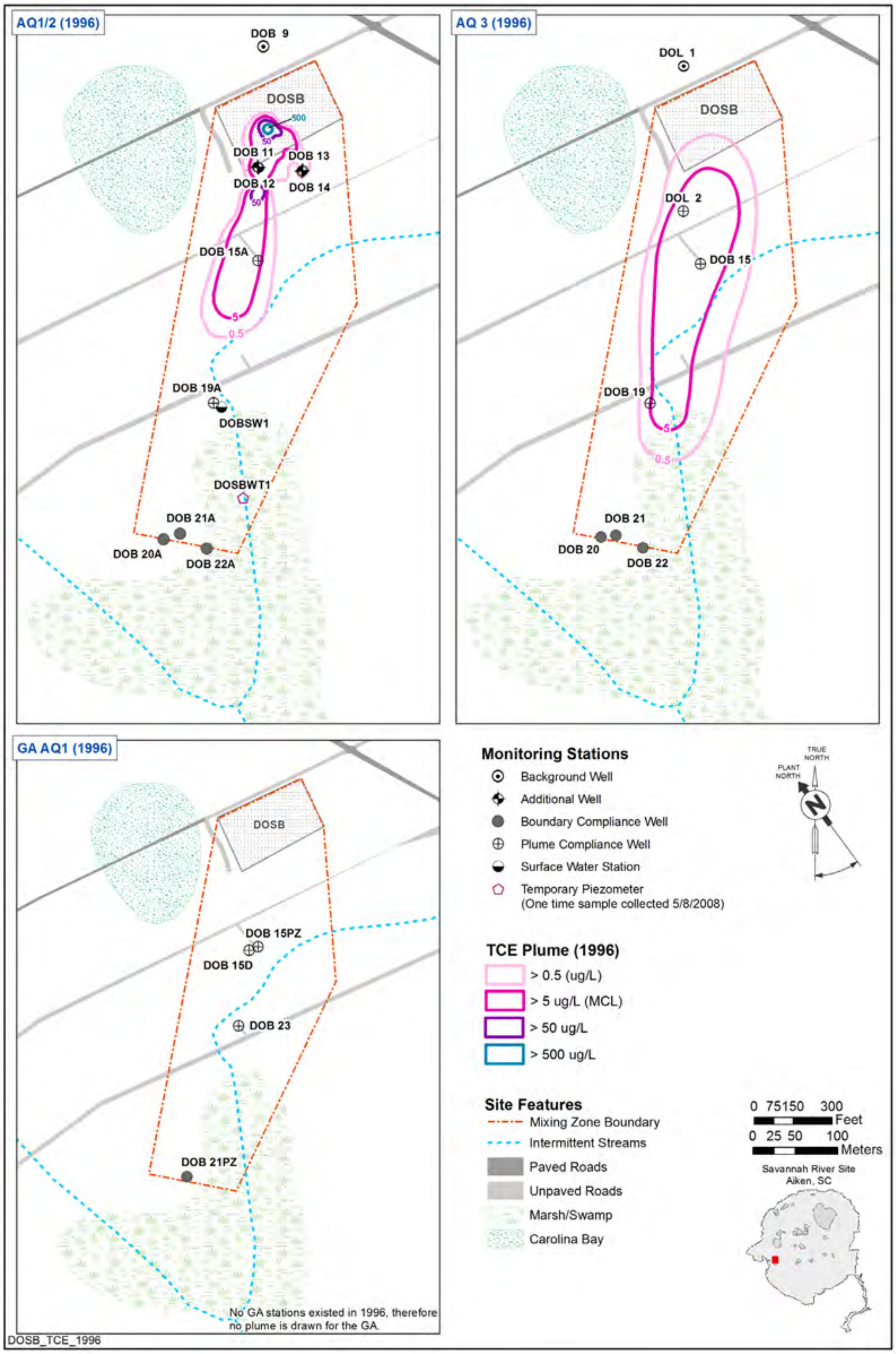


Figure E-6. DOSB PCE plume maps (2014 data) for Aquifers AQ1/2, AQ3, and GA-AQ1 (USDOE 2015)



No GA stations existed in 1996, therefore no plume is drawn for the GA.

Figure E-7. DOSB TCE plume maps (1996 data) for Aquifers AQ1/2, AQ3, GA-AQ1 (WSRC 1997a)

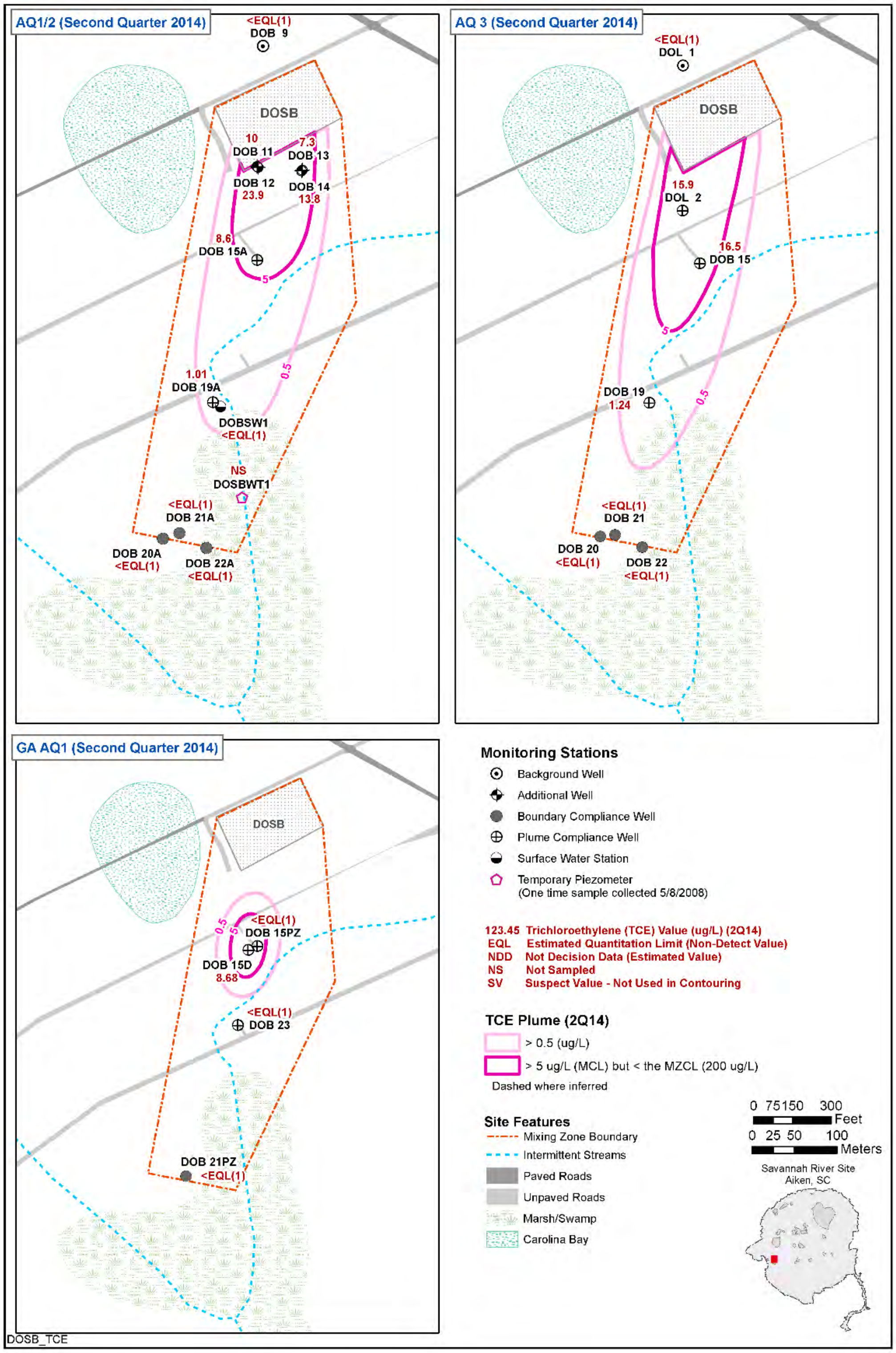


Figure E-8. **DOSB TCE plume maps (2014 data) for Aquifers AQ1/2, AQ3, and GA-AQ1 (USDOE 2015)**

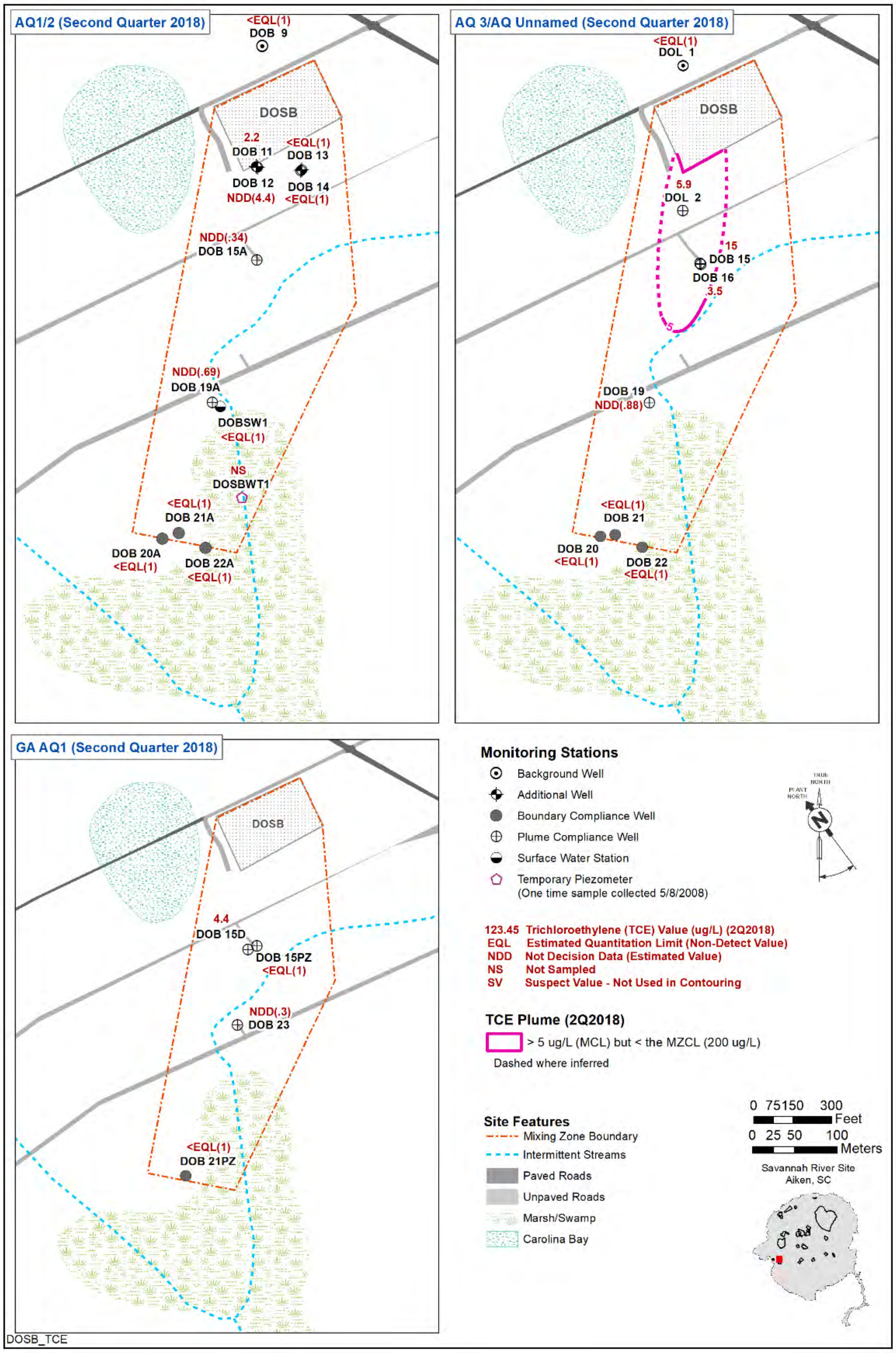


Figure E-9. DOSB TCE plume maps (2018 data) for Aquifers AQ1/2, AQ3, and GA-AQ1 (USDOE 2019)

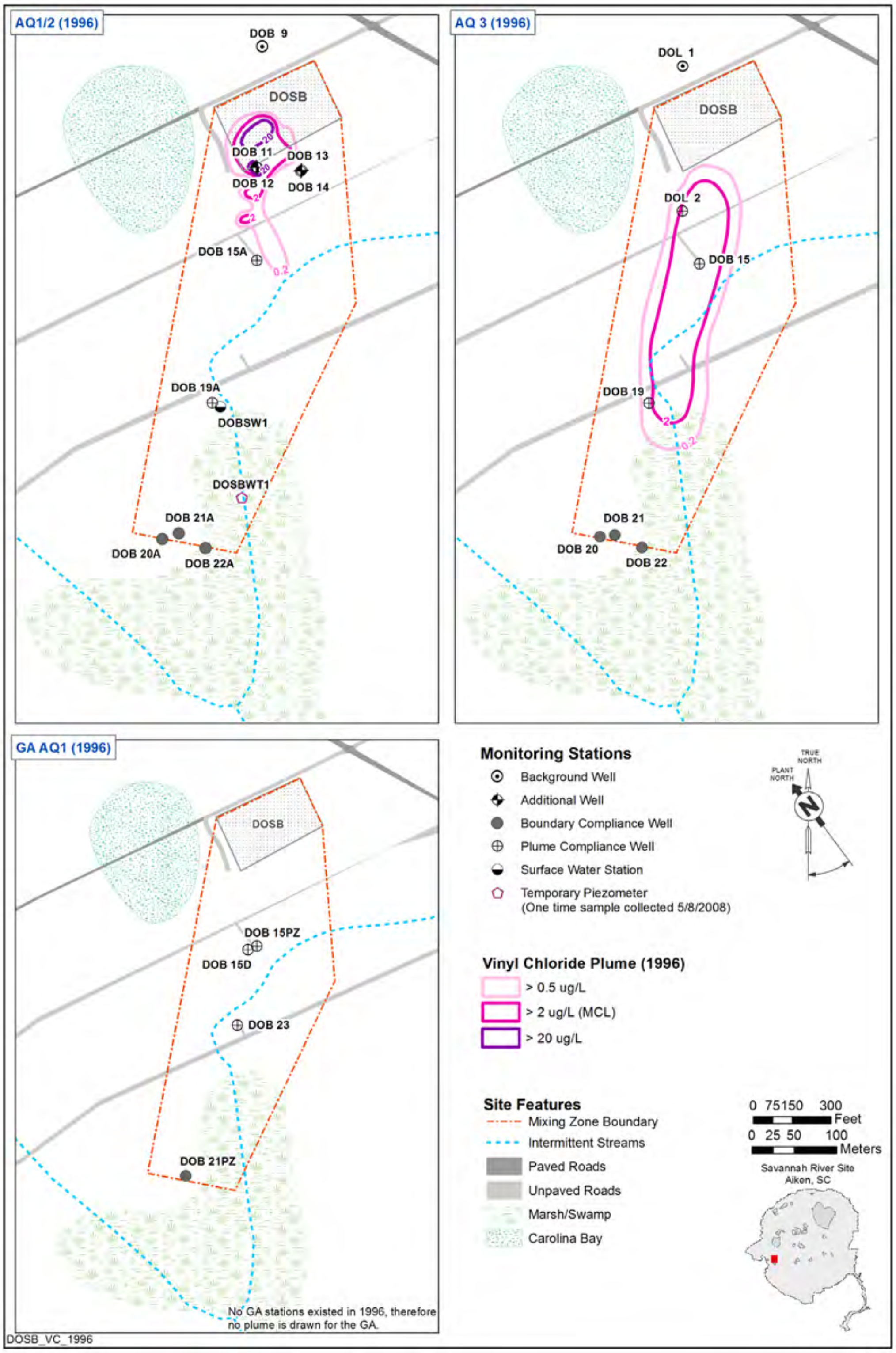


Figure E-10. DOSB Vinyl Chloride Plume Maps (1996 data) for Aquifers AQ1/2, AQ3, and GA-AQ1 (WSRC 1997a)

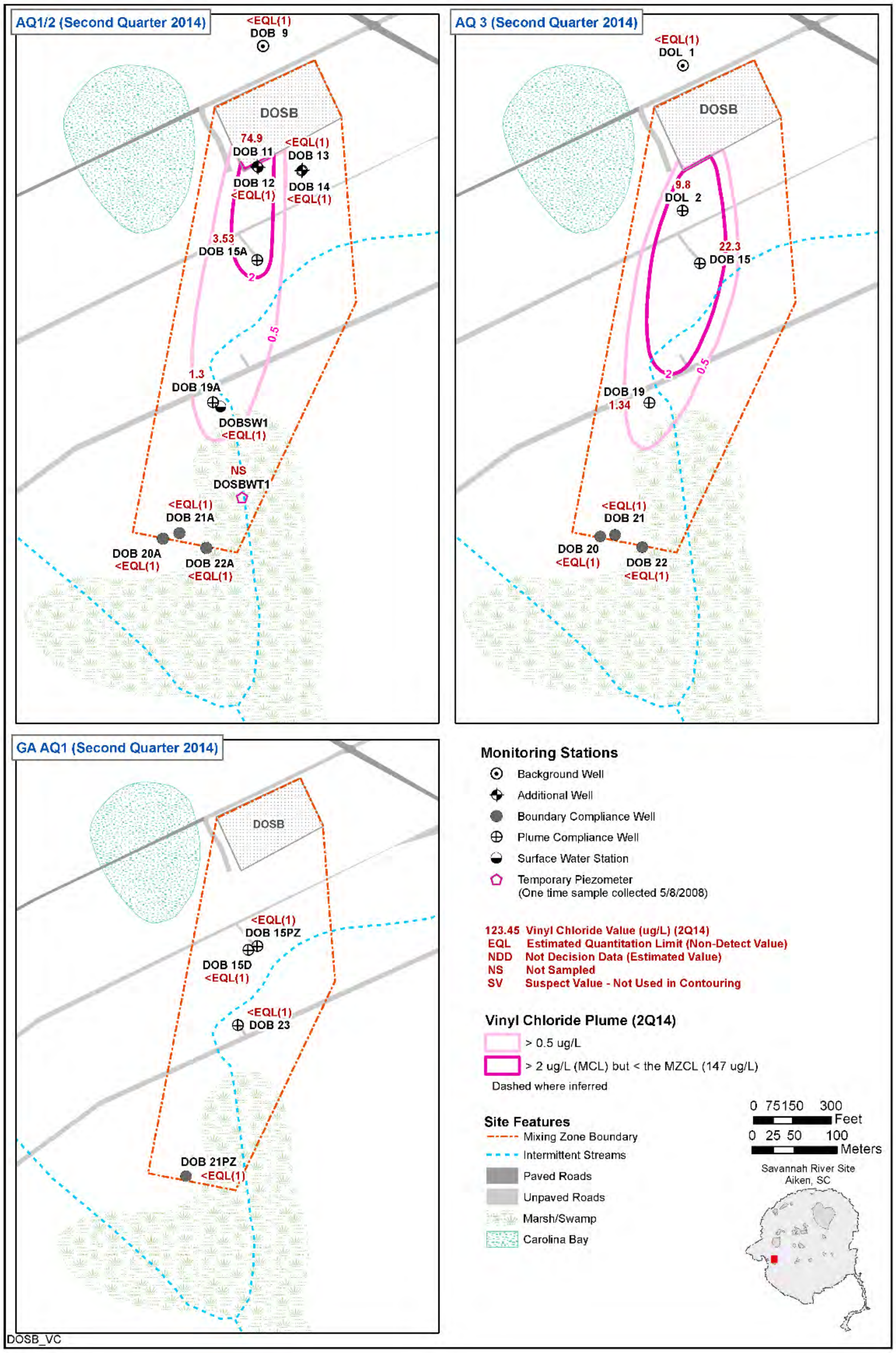


Figure E-11. DOSB Vinyl Chloride Plume Maps (2014 data) for Aquifers AQ1/2, AQ3 and GA-AQ1 (USDOE 2015)

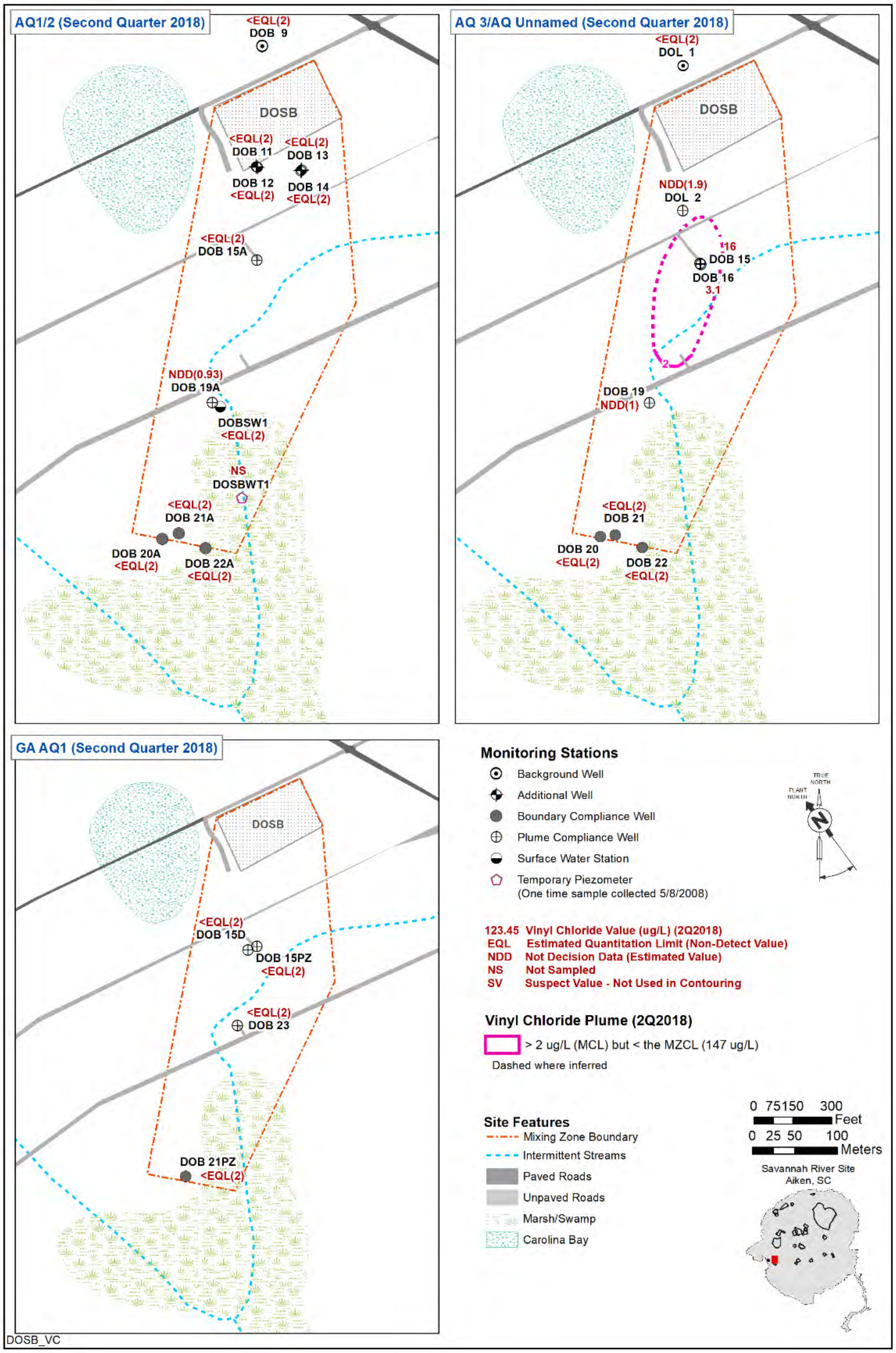


Figure E-12. DOSB Vinyl Chloride Plume Maps (2018 data) for Aquifers AQ1/2, AQ3 and GA-AQ1 (USDOE 2019)

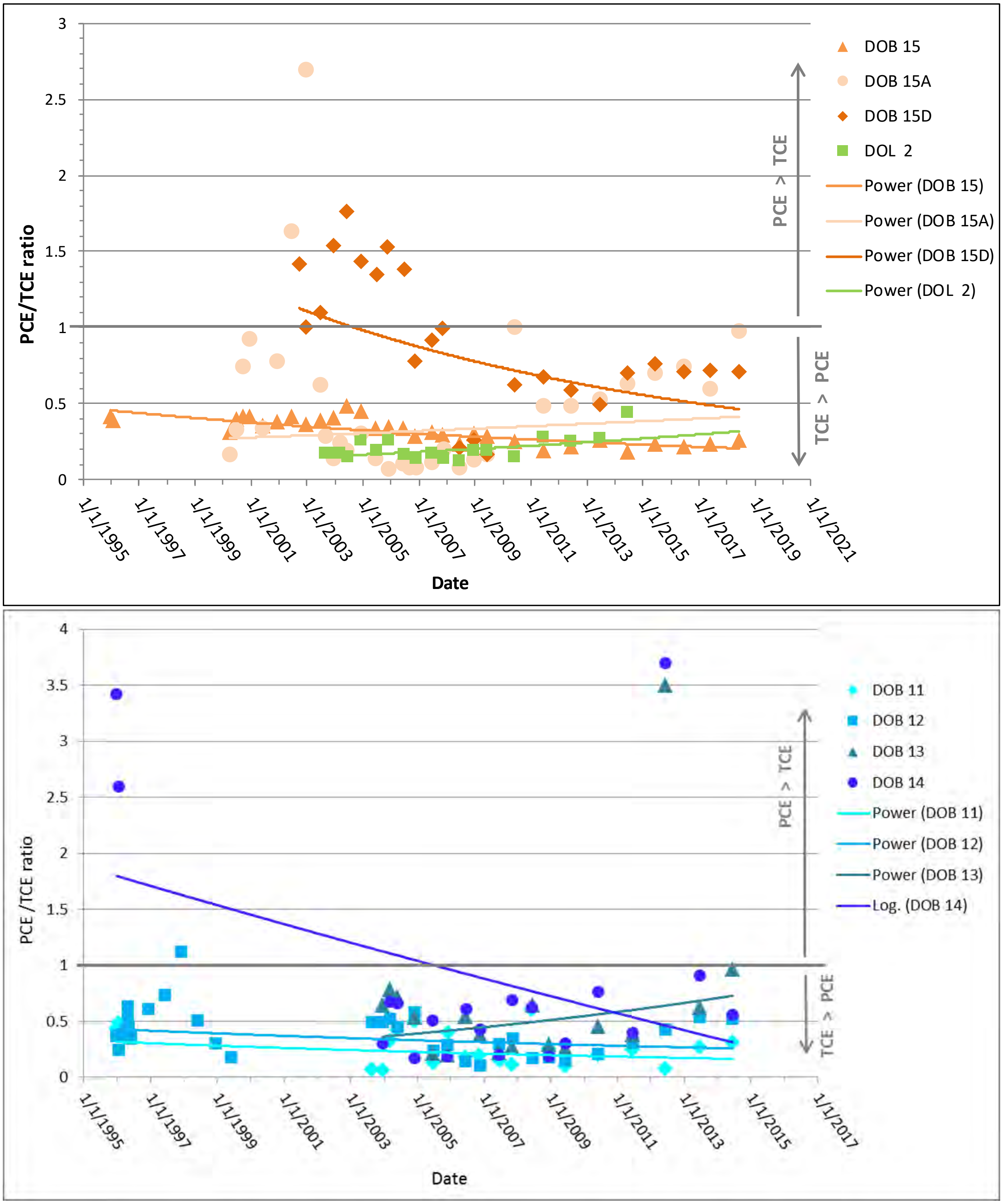


Figure E-13. Ratio of PCE verses TCE Concentrations for Plume Compliance Wells (DOB 15, 15A, 15D, and DOL 2) and Additional Wells (DOB 11, 12, 13, 14) at the DOSB OU

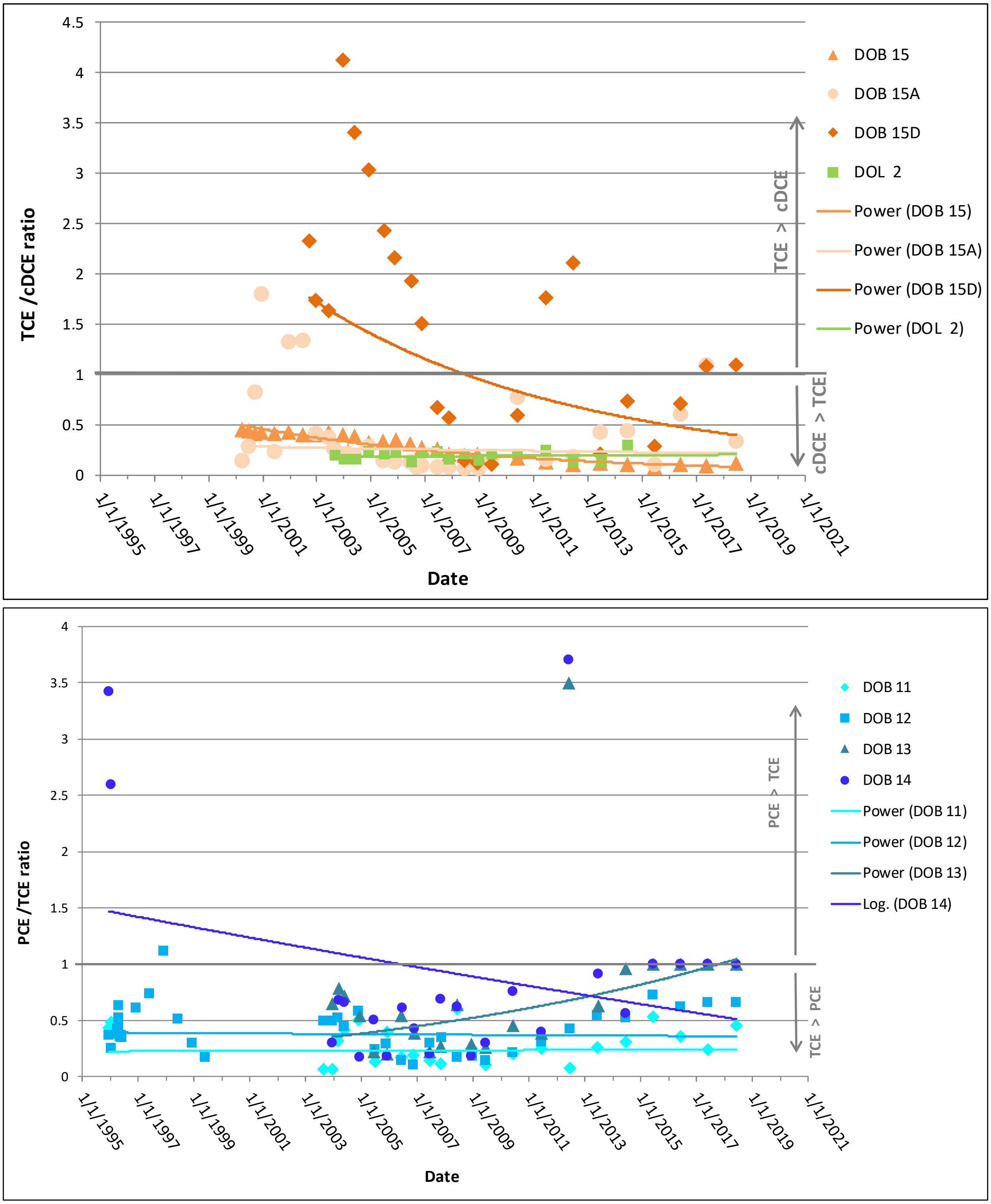


Figure E-14. **Ratio of TCE verses cDCE Concentrations for Plume Compliance Wells (DOB 15, 15A, 15D, and DOL 2) and Additional Wells (DOB 11, 12, 13, 14) at the DOSB OU**

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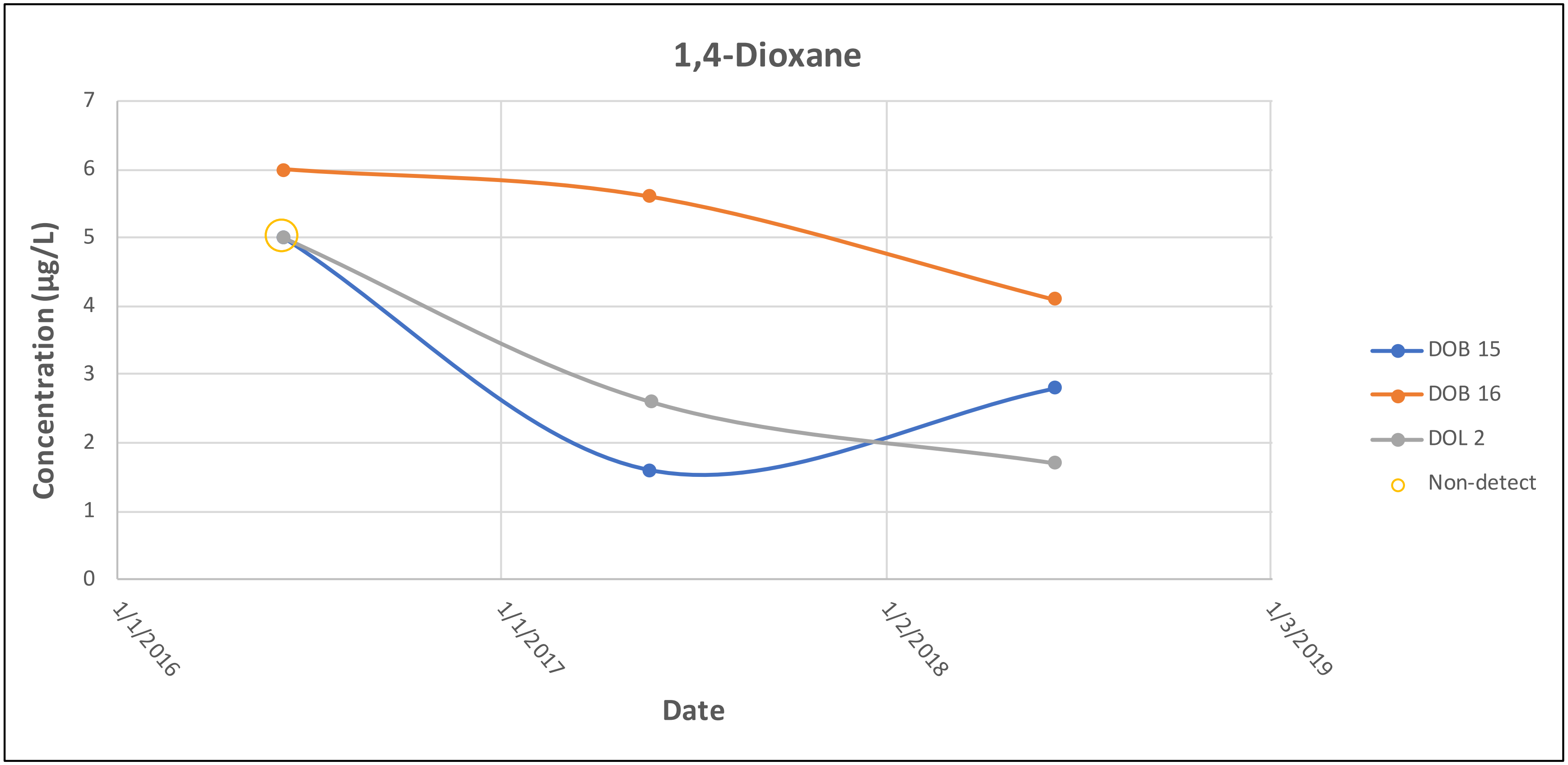

Figure E-15. Time Series Plots of 1,4-Dioxane at Wells DOB 15, DOB 16, and DOL 2 at the DOSB OU

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Table E-1. Chronology of OU Events

Event	Date
RFI/RI Field Start/Complete	December 1995 / April 24, 1998
IROD Signature	March 6, 1995
Interim Remedial Action Start/Complete	August 13, 1996 / December 31, 1999
Final ROD Issuance	May 7, 1999
Remedial Action Start/Complete	September 3, 1999/ January 13, 2000
Previous Five-Year Remedy Reviews	June 30, 1997 / February 12, 2004 / February 4, 2009 / February 4, 2014 / February 2, 2017

Table E-2. Final COCs with Selected RGs

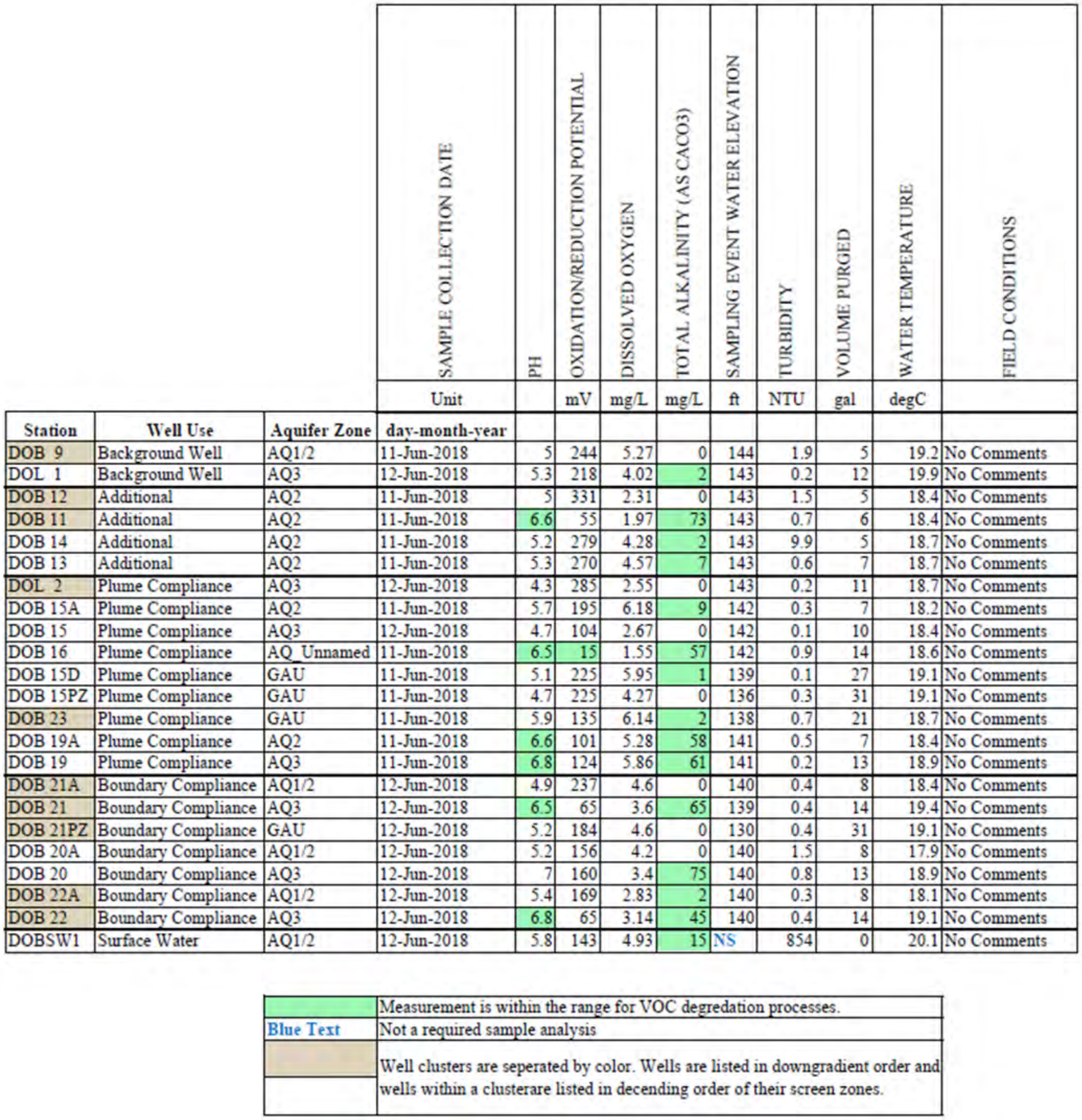
Final COCs	Maximum Concentration Detected (µg/L)	Average Concentration in Groundwater (1999-2015) (µg/L)	Selected RG (µg/L)
Tetrachloroethylene	96	6.9	5.0
Trichloroethylene	255	15.2	5.0
cis-1,2-Dichloroethene	2,270	64.7	70.0
1,1-Dichloroethene	4.8	0.8	7.0
Vinyl chloride	377	17.5	2.0
Benzene	7.8	0.7	5.0
Dichloromethane	1.7	0.9	5.0

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

	FY2015	FY2016	FY2017	FY2018	FY2019	Five-Year Total
Total Actual O&M Costs ($)	66,200	73,923	61,194	37,973	30,527	269,817
Total ROD Estimated Direct O&M Costs ($)	0	0	16,666[1]	0	0	16,666

[1] FY2017 estimated costs include costs associated with the fifth five-year remedy review. The costs for the fifth five-year remedy review document was accrued in FY2016.

Table E-4. 2018 DOSB OU Natural Attenuation Field Parameters



			SAMPLE COLLECTION DATE	PH	OXIDATION/REDUCTION POTENTIAL	DISSOLVED OXYGEN	TOTAL ALKALINITY (AS CACO3)	SAMPLING EVENT WATER ELEVATION	TURBIDITY	VOLUME PURGED	WATER TEMPERATURE	FIELD CONDITIONS
			Unit		mV	mg/L	mg/L	ft	NTU	gal	degC	
Station	**Well Use**	**Aquifer Zone**	**day-month-year**									
DOB 9	Background Well	AQ1/2	11-Jun-2018	5	244	5.27	0	144	1.9	5	19.2	No Comments
DOL 1	Background Well	AQ3	12-Jun-2018	5.3	218	4.02	2	143	0.2	12	19.9	No Comments
DOB 12	Additional	AQ2	11-Jun-2018	5	331	2.31	0	143	1.5	5	18.4	No Comments
DOB 11	Additional	AQ2	11-Jun-2018	6.6	55	1.97	73	143	0.7	6	18.4	No Comments
DOB 14	Additional	AQ2	11-Jun-2018	5.2	279	4.28	2	143	9.9	5	18.7	No Comments
DOB 13	Additional	AQ2	11-Jun-2018	5.3	270	4.57	7	143	0.6	7	18.7	No Comments
DOL 2	Plume Compliance	AQ3	12-Jun-2018	4.3	285	2.55	0	143	0.2	11	18.7	No Comments
DOB 15A	Plume Compliance	AQ2	11-Jun-2018	5.7	195	6.18	9	142	0.3	7	18.2	No Comments
DOB 15	Plume Compliance	AQ3	12-Jun-2018	4.7	104	2.67	0	142	0.1	10	18.4	No Comments
DOB 16	Plume Compliance	AQ_Unnamed	11-Jun-2018	6.5	15	1.55	57	142	0.9	14	18.6	No Comments
DOB 15D	Plume Compliance	GAU	11-Jun-2018	5.1	225	5.95	1	139	0.1	27	19.1	No Comments
DOB 15PZ	Plume Compliance	GAU	11-Jun-2018	4.7	225	4.27	0	136	0.3	31	19.1	No Comments
DOB 23	Plume Compliance	GAU	11-Jun-2018	5.9	135	6.14	2	138	0.7	21	18.7	No Comments
DOB 19A	Plume Compliance	AQ2	11-Jun-2018	6.6	101	5.28	58	141	0.5	7	18.4	No Comments
DOB 19	Plume Compliance	AQ3	11-Jun-2018	6.8	124	5.86	61	141	0.2	13	18.9	No Comments
DOB 21A	Boundary Compliance	AQ1/2	12-Jun-2018	4.9	237	4.6	0	140	0.4	8	18.4	No Comments
DOB 21	Boundary Compliance	AQ3	12-Jun-2018	6.5	65	3.6	65	139	0.4	14	19.4	No Comments
DOB 21PZ	Boundary Compliance	GAU	12-Jun-2018	5.2	184	4.6	0	130	0.4	31	19.1	No Comments
DOB 20A	Boundary Compliance	AQ1/2	12-Jun-2018	5.2	156	4.2	0	140	1.5	8	17.9	No Comments
DOB 20	Boundary Compliance	AQ3	12-Jun-2018	7	160	3.4	75	140	0.8	13	18.9	No Comments
DOB 22A	Boundary Compliance	AQ1/2	12-Jun-2018	5.4	169	2.83	2	140	0.3	8	18.1	No Comments
DOB 22	Boundary Compliance	AQ3	12-Jun-2018	6.8	65	3.14	45	140	0.4	14	19.1	No Comments
DOBSW1	Surface Water	AQ1/2	12-Jun-2018	5.8	143	4.93	15	NS	854	0	20.1	No Comments

🟩	Measurement is within the range for VOC degredation processes.
Blue Text	Not a required sample analysis
🟫	Well clusters are seperated by color. Wells are listed in downgradient order and wells within a clusterare listed in decending order of their screen zones.

GAU = Gordon Aquifer Unit

Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU

I. SITE INFORMATION

Site Name:	**D-Area Oil Seepage Basin (631-G) OU**	**Date of Inspection:**	**10/17/2019**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**SEMS #27**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**Sunny 70°F**

Remedy Includes: *(Click all that apply)*

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

☒ Other Groundwater Mixing Zone Monitoring

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

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** Brian Hanshew (Name) ACP Field Execution Team 2 (Title) 11/05/2019 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: (803)952-4949

Problems/Suggestions: ☐ Report Attached

2. **O&M Staff:** Phil Carter (Name) EC&ACP Post-Closure Waste Site Inspector/Maintenance Coordinator (Title) 11/05/2019 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.:(803)-952-4145

Problems/Suggestions: ☐ Report Attached

Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU *(continued)*

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

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

Agency: ____________________

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

Problems/Suggestions: ☐ Report Attached ____________________

Agency: ____________________

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

Problems/Suggestions: ☐ Report Attached ____________________

Agency: ____________________

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

Problems/Suggestions: ☐ Report Attached ____________________

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

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

1. **O&M Documents:**

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

Remarks: Site Inspections for the surface unit portion of DOSB are not required by the ROD or LUCIP since the DOSB currently meets unrestricted land use criteria for soils, sediment and surface water. Site inspections performed are for the monitoring wells and the Five-Year Remedy Review Reports.

Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU *(continued)*

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

2. Health and Safety Plans (HASPs):
☐ Site-Specific Health and Safety Plans ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Contingency Plan/Emergency Response Plan ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks: Routine O&M activities do not require a Site-Specific Health and Safety Plan (SSHASP) under 29 CFR 1910.1201, Hazardous Waste Operations. A SSHASP is prepared if needed.

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

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

4. Permits and Service Agreements:
☐ Air Discharge Permit ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Effluent Discharge ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Waste Disposal; POTW ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Other Permits ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

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

Remarks:

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

Remarks:

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

Remarks:

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

Remarks:

9. Discharge Compliance Records:
☐ Air ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Water (Effluent) ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

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

Remarks:

Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU *(continued)*

IV. O&M COSTS

1. O&M Organization:

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

2. O&M Cost Records:

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

Total annual cost by year for review period, if available

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

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

Describe costs and reasons: N/A

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

A. Fencing

1. Fencing Damage: ☐ Location shown on site map ☐ Gates secured ☐ N/A

Remarks: Gate and fencing around DOSB perimeter, although present, is not required. The fencing is a holdover from previous operations.

B. Signs

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

Remarks:

Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

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

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Once every five years
Responsible Party/Agent: USDOE Savannah River Field Office
Contact: Karen Adams (Name) Federal Project Director (Title) 12/17/19 (Date) 803-952-7871 (Phone No.)

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

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

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

D. General

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

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

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

Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU *(continued)*

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

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

Remarks:

B. Other Site Conditions

Remarks:

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

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

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

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

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

C. Treatment System ☐ Applicable ☒ N/A

D. Monitoring Data ☒ Applicable ☐ N/A

1. Monitoring Data:
☒ **Is routinely submitted on time** ☒ **Is of acceptable quality**

2. Monitoring Data Suggests:
☐ **Groundwater plume is effectively contained** ☒ **Contaminant concentrations are declining**

E. Monitored Natural Attenuation ☒ Applicable ☐ **N/A**

1. Monitoring Wells *(natural attenuation remedy)*:
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ All required wells located ☐ Needs maintenance ☐ N/A
Remarks:

X. OTHER REMEDIES

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

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

Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU *(continued)*

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

The remedial action for DOSB OU deep soil is considered no further action since RAOs have been achieved by the IRA and bioventing testing. The remedy for shallow soil, surface water, and sediment is no action because no COCs in those media were identified in the RFI/RI Report and Baseline Risk Assessment Report. The remedy for DOSB OU groundwater is monitored natural attenuation/groundwater mixing zone with institutional controls (i.e., LUCs). Results from the bioventing study indicate that the source of groundwater contamination (i.e., contaminants in the DOSB OU soil) was significantly reduced, as a result of the combined IRA and bioventing test, and no longer contributes to groundwater contamination. The remedy is fully established and functioning as designed.

B. Adequacy of O&M

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

Monitoring data indicates consistency with the modeling predictions from the GWMZ application. The concentrations should continue to decrease within the heart of the plume through natural attenuation to levels at or below MCLs. The O&M procedures consisting of site maintenance and site controls (SRS Site Use/Site Clearance Programs, which restrict invasive and permanent installation activities at the waste unit) have been implemented. The O&M procedures are adequately maintaining the DOSB OU. There are no issues requiring corrective actions.

C. Early Indicators of Potential Remedy Failure

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

N/A

D. Opportunities for Optimization

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

N/A

End of Checklist

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L-AREA SOUTHERN GROUNDWATER OPERABLE UNIT

I. Introduction

This report is the fourth five-year remedy review for the L-Area Southern Groundwater (LASG) Operable Unit (OU). The review was conducted from August 2019 through November 2019. Contaminants have been left in place at the LASG 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 LASG 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 LASG OU.

III. Background

The LASG OU is a Resource Conservation and 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 of concern is local groundwater. Surface water downgradient of the LASG OU is monitored to evaluate the effectiveness of the selected remedy.

Physical Characteristics

L Area is located in the southcentral portion of the SRS in Barnwell County, South Carolina (Figure F-1). LASG OU encompasses the groundwater from the L-Area groundwater divide south to L-Lake (Figure F-2). The original pre-work plan characterization outline for the LASG OU covered about 508 hectares (1,250 acres) and included several remediated/depleted source units, which supported past production activities (WSRC 2005). Groundwater characterization included the review of analytical data from 93 monitoring wells and 109 cone penetrometer technology (CPT) locations within the

LASG OU (Figure F-3) between January 2000 and January 2004. The majority of the sampling occurred in 2000.

Operation activities in L Area have resulted in three contaminant plumes in the local groundwater:

- Western tritium plume, which originated at the L-Area Emergency Retention Basin (LAERB);
- Southwest commingled volatile organic compounds (VOCs) and tritium plume, which originated in the vicinity of the L-Area Disassembly Basin (LADB); and
- Southeast commingled VOCs and tritium plume, with likely sources from the L-Area Reactor Seepage Basin (LRSB), L-Area Oil and Chemical Basin (LAOCB), and L-Area Hot Shop (LAHS).

There are no active sources of groundwater contamination in the LASG OU. Historical sources have been remediated, depleted, or reconditioned for new missions.

Land and Resource Use

The land use control boundaries for LASG OU are predominantly outside of the industrial area for L-Area. However, shallow groundwater and surface water at SRS are not used for drinking water, hygiene, recreation, or process water. According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The future land use for this OU is reasonably anticipated to be industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

The L-Area Reactor achieved criticality in August 1954 and operated from 1954 to 1968 and 1984 to 1988. Tritium was produced in the reactor and VOCs were used as solvents and degreasers. Past activities at or near the source units listed above (LAERB, LADB, LRSB, LAOCB, and LAHS) have resulted in groundwater contamination in LASG OU. The tritium and VOC plumes are shown in Figure F-2.

The primary historical sources of contamination in the groundwater in the LASG OU have been remediated or depleted. Subsurface soils beneath these remediated waste sites were the secondary sources of groundwater contamination. The contamination history of the source units is discussed below:

- The LAERB is no longer active and was never used as designed; however, tritiated water was released to the basin during testing in the 1980s. Rainwater flushed the original tritium source out of the unit into the groundwater through the permeable bottom of the basin.
- Groundwater in the vicinity of the LADB was previously contaminated by leaks and spills associated with previous operations. Upgrades to equipment and handling processes support its current mission as an active facility. Current data indicate the LADB is not an active source of groundwater contamination as tritium concentrations in adjacent wells have dramatically decreased from historical values. The LADB is being monitored for any new releases related to its new mission under a separate program.
- The LRSB is a L-shaped unlined earthen basin that was designed to hold contaminated wastewater from L-Area reactor operations that was not appropriate for discharge to local streams due to elevated radiological activity. Discharges to the LRSB were conducted from 1958 to 1968 and from 1985 to 1988. Contaminated soils posed a potential contaminant migration concern to groundwater. Contaminated soils and pipelines were consolidated in the basins and a low permeability soil cover was installed to reduce water infiltration while natural radioactive decay reduces the contaminant levels.
- The LAHS was primarily used for repairing equipment from the reactor areas, which may have been contaminated with radionuclides. Radionuclides deposited on the concrete floors of the LAHS buildings and the associated storage facilities and in the drain lines appear to be the primary source material. Remediation was completed in 2005, which consisted of the removal of contaminated drain lines, concrete floor slabs, and soils. Clean topsoil and vegetation were placed in the area.

- The LAOCB was constructed in 1961 as an unlined seepage basin to receive wastewater from the LAHS. The LAHS discharged decontamination wastewater containing radionuclides, detergents, and spent degreasing solvents through the pipeline to the basin. It also received wastewater from other areas of SRS that were transported in drums and tanker trucks, which included liquid wastes consisting of small volumes of slightly radioactive oil and chemical wastewater. The LAOCB remained active until 1979. Remediation of the LAOCB was completed in 2001 and included consolidation of contaminated material, in-situ stabilization by grouting soil, and installation of a low permeability soil cover system.

Initial Response

There was no initial response for the LASG OU. There are no active sources of groundwater contamination in the LASG OU. Historical sources have been remediated, depleted, or reconditioned for new missions.

Basis for Taking Action

The potential exposure to or ingestion of groundwater contaminated above maximum contaminant levels (MCLs) poses a potential increased risk of cancer to human receptors and is the basis for taking action at the LASG OU.

The refined constituents of concern (RCOCs) for groundwater at LASG OU are tritium, tetrachloroethylene (PCE), and trichloroethylene (TCE). The highest contaminant levels observed in local groundwater, broken into four groups (Pre-remedial investigation [RI], RI, Post-RI, present), are summarized in Table F-2. CPT data are included in the pre-RI data set and contain high tritium values that are not seen in the monitoring well network; therefore, the pre-RI and RI tritium concentrations vary significantly. The remedial goals (RGs) for LASG OU are the MCLs as listed in Table F-2.

The bulk of contaminated groundwater is confined to the portion of the Upper Three Runs aquifer above the tan clay. Figure F-2 shows the LASG OU plumes. The western plume is only contaminated with tritium while the two plumes directly downgradient southwest and southeast of L Area are contaminated with tritium, PCE, and TCE. The analytical results for these three constituents are summarized in Table F-2. Surface water sample stations are shown on Figure F-2 and the results for tritium at these stations are listed in Table F-3; SC26 and SC27 are at the L-Lake dam standpipe and spillway, respectively. PCE and TCE have not been detected in the surface water, except once in 2010 at station SC24 at levels below 1 µg/L.

Exposure of future industrial workers and/or residents to TCE, PCE, and tritium in groundwater above their respective MCLs could increase the risk of cancer. If land use controls (LUCs) are not maintained, exposure could occur through ingestion, dermal contact, and inhalation of contaminated groundwater. Groundwater contamination was evaluated against MCLs based on South Carolina Department of Health and Environmental Control (SCDHEC) groundwater regulation R.61-58.5, which is protective for both future residential and future industrial scenarios.

IV. Remedial Actions

Remedy Selection

As stated in the Record of Decision (ROD) (WSRC 2007a), the selected remedy for the LASG OU is monitored natural attenuation (MNA) with institutional controls (i.e., LUCs). The selected remedial action for the LASG OU will address both of the commingled VOCs and tritium plumes of L Area and the tritium plume west of L Area. LUCs will minimize the potential for human exposure to contaminated groundwater until MCLs are achieved.

The following remedial action objectives (RAOs) have been identified for the LASG OU:

- Prevent human exposure to groundwater above MCLs.
- Treat and/or mitigate groundwater contaminated above MCLs to reduce the discharge of groundwater exceeding MCLs to L-Lake.

These RAOs are intended to protect current workers and future industrial workers, minimize the impact of groundwater discharging to surface water, and return groundwater to usable conditions. The RGs for the LASG OU contaminants of concern are the MCLs.

Remedy Implementation

The remedial action is meeting the RAOs, by implementing the following activities:

- Established a groundwater monitoring network by installing ten new monitoring wells (WSRC 2007b).
- Established a MNA program to monitor natural attenuation processes (dispersion, dilution, and radioactive decay) which are occurring at the LASG OU and are effective in reducing contaminant concentrations below remedial goals. Twenty-six groundwater monitoring wells and five surface water monitoring stations (Figure F-2) make up the monitoring network. Details of the requirements for MNA monitoring at the LASG OU are presented in the Effectiveness Monitoring Plan (EMP) (WSRC 2008) and the subsequent addendum to the EMP (SRNS 2013).
- There are no active, continuing sources of groundwater contamination at the LASG OU. As stated in the EMP, one of the groundwater monitoring data quality objectives is ensuring that there are no releases of contaminants from unknown or existing sources and that remediated or depleted sources are under control. The ROD or post-ROD documents for LRSB (WSRC 2002) and LAOCB (WSRC 1999) both required that evaluation of the effectiveness of those remedies would be addressed through monitoring implemented as part of the LASG OU.
- Established LUCs for 387 hectares (952 acres), which includes implementing LUCs at LASG OU. This consists of general site access controls (gates, fences, and patrol at the site boundary), use restrictions via the SRS Site Use/Site Clearance program, and future deed restrictions and notifications to prevent exposure of human receptors to contaminated groundwater if property is transferred to non-federal ownership.

System Operations/Operation and Maintenance

There are no system operational requirements.

The following maintenance activities are ongoing:

- Long-term monitoring of groundwater conditions in the plumes and surface water conditions in L-Lake, including maintenance of the monitoring network. In 2014, an Explanation of Significant Differences (ESD) for the Revision 1 ROD Remedial Alternative Selection for the LASG OU (SRNS 2014) was issued. The ESD set a contained-in determination that groundwater concentrations within the LASG OU monitoring network at or below 56 µg/L for PCE and 54 µg/L for TCE would not be considered RCRA listed waste and purge water can be discharged to the ground. If levels are above the limits, then containerization of the groundwater will be required for treatment or disposal. The MNA monitoring results are reported via biennial Effectiveness Monitoring Reports (EMRs) or groundwater data summary report letters. MNA will be performed until RGs are achieved (estimated in approximately 2090).
- LUCs are being enforced for all groundwater contaminated above MCLs within the OU and under adjacent portions of L-Lake. Restrictions on the use of groundwater within the LUC outline will be enforced as long as contaminant levels exceed MCLs.

The estimated operation and maintenance (O&M) costs associated with the selected remedy for LASG includes long-term groundwater monitoring and reporting and LUCs (WSRC 2007a). The estimated O&M cost from the ROD since the last remedy review for these activities is $269,560 for Fiscal Year (FY) 2015 through FY2019. The actual O&M cost for FY2015 through FY2019 is $135,043. The actual costs are lower than expected because well redevelopment costs are significantly lower than estimated.

V. Progress Since Last Review

This is the fourth five-year remedy review for the LASG OU. The previous protectiveness statement concluded that because the remedial actions are protective, the LASG OU is protective of human health and the environment.

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 five-year remedy review:

- Reviewed the documents listed in Section XII, Documents Reviewed;
- Confirmed implementation of the remedial action;
- Reviewed all process and performance monitoring data provided by biennial EMRs and provided a technical assessment of whether MNA is functioning as intended by the ROD;
- Inspected the OU, interviewed maintenance personnel, and documented the results on the Inspection Checklist provided in Attachment F-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance.

Data Review

One biennial EMR has been submitted and reviewed since the last five-year remedy review (SRNS 2016). This report included all sample results for tritium, PCE, and TCE collected from monitoring wells and surface water stations during 2014 through 2015, time-series plots at each station since 1993, and plume maps. In 2018, a biennial data summary letter report was submitted and reviewed; the letter report presented the sampling results from 2016 and 2017 and included plume maps (SRNS 2018).

Summary of Inspections and Interviews

Interviews were conducted with Phil Carter, O&M staff member, and Brian Hanshew, O&M Site Manager, on November 5, 2019 at the O&M organization offices. No issues were identified for the LASG OU during these interviews. The LASG OU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) Environmental Compliance and Area Completion Projects (EC&ACP) on October 22, 2019. No issues were identified during these inspections.

The LASG OU was inspected by SRNS EC&ACP and USDOE personnel on December 9, 2019. No issues were identified for the LASG OU during this inspection.

A site inspection was conducted by U.S. Environmental Protection Agency (USEPA) and SCDHEC personnel, accompanied by USDOE and SRNS personnel February 27, 2020. No significant problems regarding this OU will be identified during the inspection.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The remedy is functioning as intended as demonstrated below:

- The selected remedy component of LUCs is effective in preventing human exposure to groundwater above MCLs. The Land Use Control Implementation Plan for LASG OU governs LUC implementation, maintenance, monitoring, reporting, and enforcement of LUCs (WSRC 2009). All LUC objectives are being met.
- The selected remedy (MNA) is effective in treating groundwater to reduce the amount of discharge of groundwater exceeding MCLs to L-Lake as reported in the biennial EMRs and groundwater data summary letter reports. The sources of the groundwater contamination have been depleted. The processes of dispersion, dilution, and radioactive decay are lowering contaminant levels at LASG OU, such that groundwater will be restored to concentrations below MCLs in a reasonable timeframe.

Tritium levels have decreased in source zone monitoring wells dramatically over the last 15 to 20 years with values dropping from over 1,000 pCi/mL to currently under the MCL of 20 pCi/mL. These decreasing tritium levels are shown in the time-series plot for well LAW 2 (Figure F-5). The surface water data from station SC27 in Table F-3 further demonstrates that contaminated groundwater discharging to L-Lake quickly mixes with the surface water and tritium levels exiting L-Lake are well below the MCL. All LUC boundary wells remain non-detect, or of low concentrations below the MCL. All three tritium plumes (Figure F-2) are shrinking and migrating as expected from modeling (WSRC 2004).

The PCE and TCE plumes have decreased in size over the last 15 years. Contaminant levels are not increasing (Figure F-6), and the plumes are progressing as expected from modeling (WSRC 2004). L-Lake surface water results have remained well below the MCL

(5 µg/L) for PCE and TCE, with the majority of the results being non-detect. These results are due to the rapid dispersion and volatilization of VOCs within the lake. LUC boundary wells remain non-detect for VOCs.

More detailed discussions on the tritium and VOC plumes can be found in the previous biennial EMR from 2016 (SRNS 2016) and the 2018 biennial data summary letter report (SRNS 2018).

Modeling predicted that groundwater would remain contaminated for approximately 90 years (until approximately 2090) (WSRC 2004). MNA remains the best option for the contaminated groundwater as contaminant levels are decreasing, the plumes are decreasing in size, and contaminant levels in L-Lake are not discharging above MCLs and are showing a decreasing trend.

Additionally, 2016 data results from the LRSB and LAOCB performance monitoring sampling showed there are no contaminant migration concerns associated with their associated surface units (Table F-5; Figure F-4).

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

The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection are still valid. There have been no changes in standards or physical conditions of the LASG OU that would affect the protectiveness of the remedy.

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 for the LASG OU from being protective.

IX. Recommendations and Follow-up Actions

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

X. Protectiveness Statement(s)

The remedy at the LASG 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. All threats to contaminated groundwater at LASG OU are being addressed through physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the LASG OU for industrial use only and use restrictions via the SRS Site Use/Site Clearance Program.

XI. Next Review

As shown in Appendix A, Table A-1, the next five-year remedy review for SRS OUs with Groundwater Remedies is scheduled for January 2026.

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. *Addendum to the Monitored Natural Attenuation Effectiveness Monitoring Plan for the L-Area Southern Groundwater Operable Unit (NBN)(U)*, SRNS-RP-2012-00857, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS 2014. *Explanation of Significant Differences for the Revision 1 Record of Decision Remedial Alternative Selection for the L-Area Southern Groundwater Operable Unit (NBN) (U)*, SRNS-RP-2012-00736, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2016. *Biennial Effectiveness Monitoring Report for Monitored Natural Attenuation at the L-Are Southern Groundwater Operable Unit (U) 2014 through 2015*, SRNS-RP-

2016-00413, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2018. *Biennial Effectiveness Monitoring Report (Sampling Summary) for the Monitored Natural Attenuation at the L-Area Southern Groundwater Operable Unit, 2016 through 2017*, IACD-18-156, dated June 20, 2018, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

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

WSRC, 1999. *Corrective Measures Implementation/Remedial Design Report/Remedial Action Work Plan (CMI/RDR/RAWP) for L-Area Oil and Chemical Basin (904-83G) (U)*, WSRC-RP-97-844, Revision 1.4, Westinghouse Savannah River Company, LLC, Savannah River Site, Aiken SC

WSRC, 2002. *Unit-Specific Plug-In Record of Decision Amendment for the C-Area Reactor Seepage Basin (904-67G) and L-Area Reactor Seepage Basin (904-64G) (U)*, WSRC-RP-2002-4063, Revision 1, Westinghouse Savannah River Company, LLC, Savannah River Site, Aiken, SC

WSRC, 2004. *Groundwater Flow and Transport Model of the L-Area Southern Groundwater Operable Unit (U),* WSRC-RP-2004-4082, Revision 0, Westinghouse Savannah River Company, Savannah River Site, Aiken SC

WSRC, 2005. *RCRA Facility Investigation/Remedial Investigation for the L-Area Southern Groundwater Operable Unit (U)*, WSRC-RP-2003-4171, Revision 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2007a. *Record of Decision for the L-Area Southern Groundwater Operable Unit (NBN) (U),* WSRC-RP-2006-4052, Revision 1.1, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2007b. *Corrective Measures Implementation/ Remedial Action Implementation Plan for the L-Area Southern Groundwater Operable Unit (NBN) (U),* WSRC-RP-2007-4050, Revision 0, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2008. *Monitored Natural Attenuation Effectiveness Monitoring Plan for the L-Area Southern Groundwater Operable Unit (NBN) (U),* WSRC-RP-2007-4048, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2009. *Land Use Control Implementation Plan for L-Area Southern Groundwater Operable Unit (NBN) (U),* WSRC-RP-2007-4049, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

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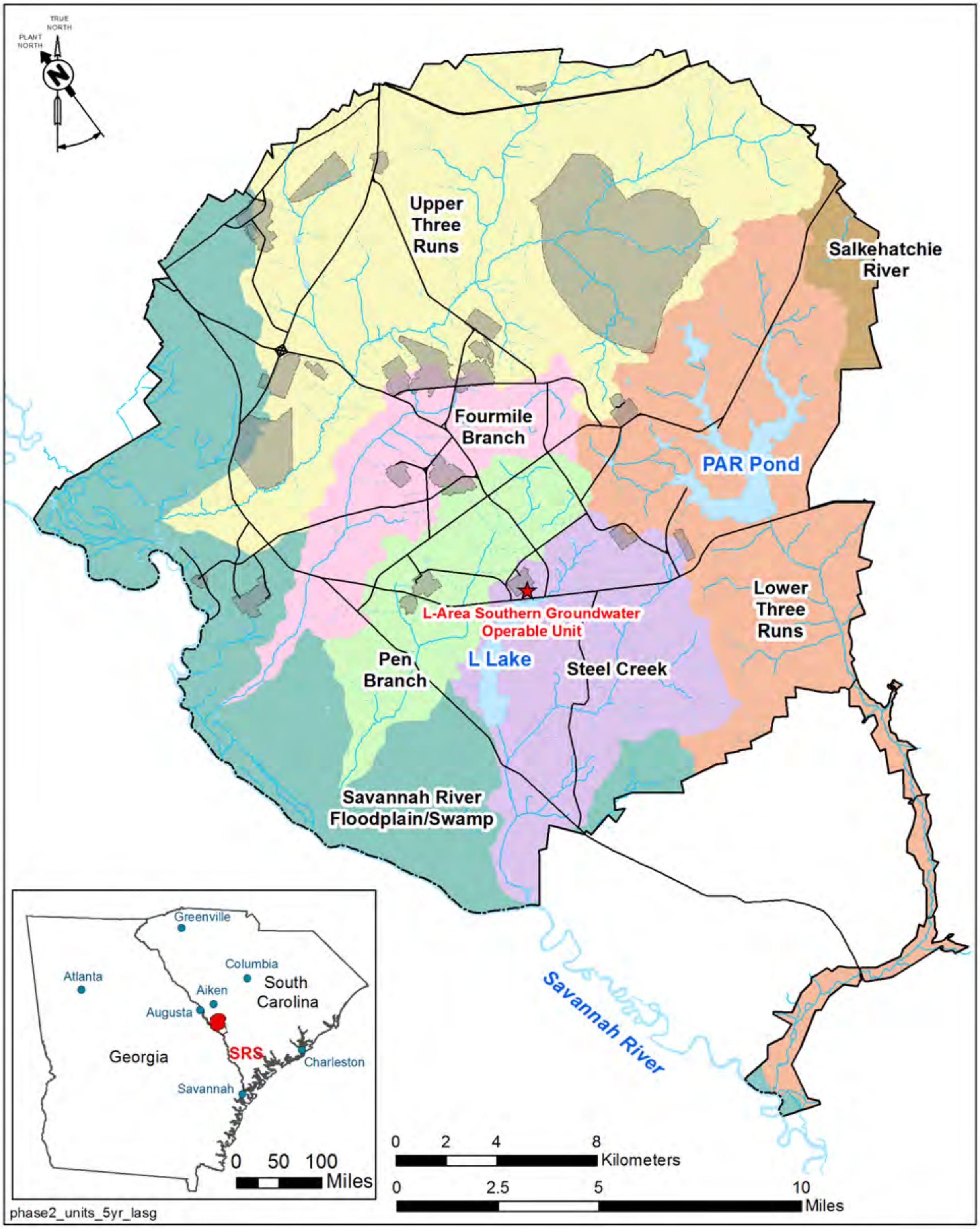

Figure F-1. Location of the L-Area Southern Groundwater OU at SRS

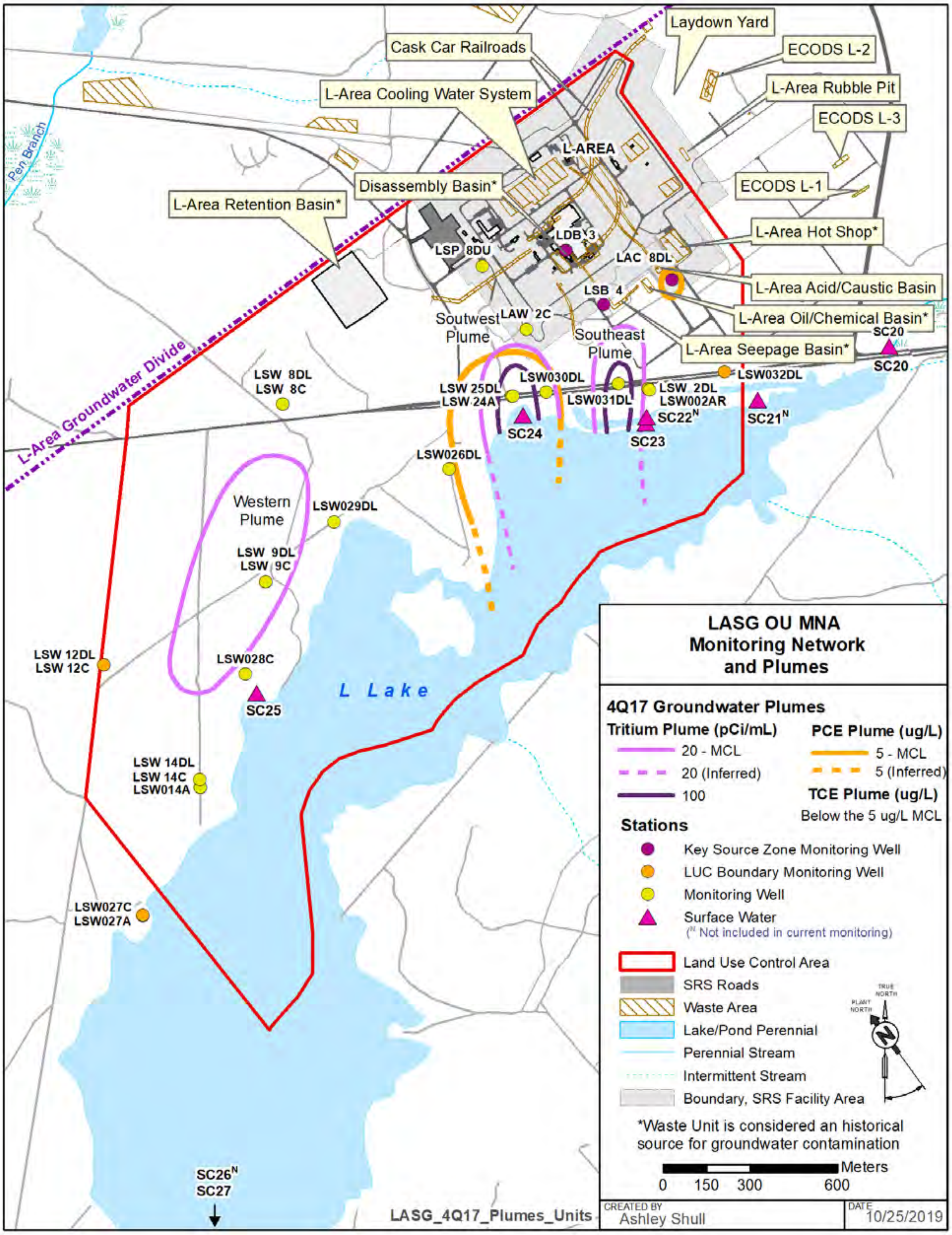

Figure F-2. Layout of the L-Area Southern Groundwater Operable Unit with Plumes

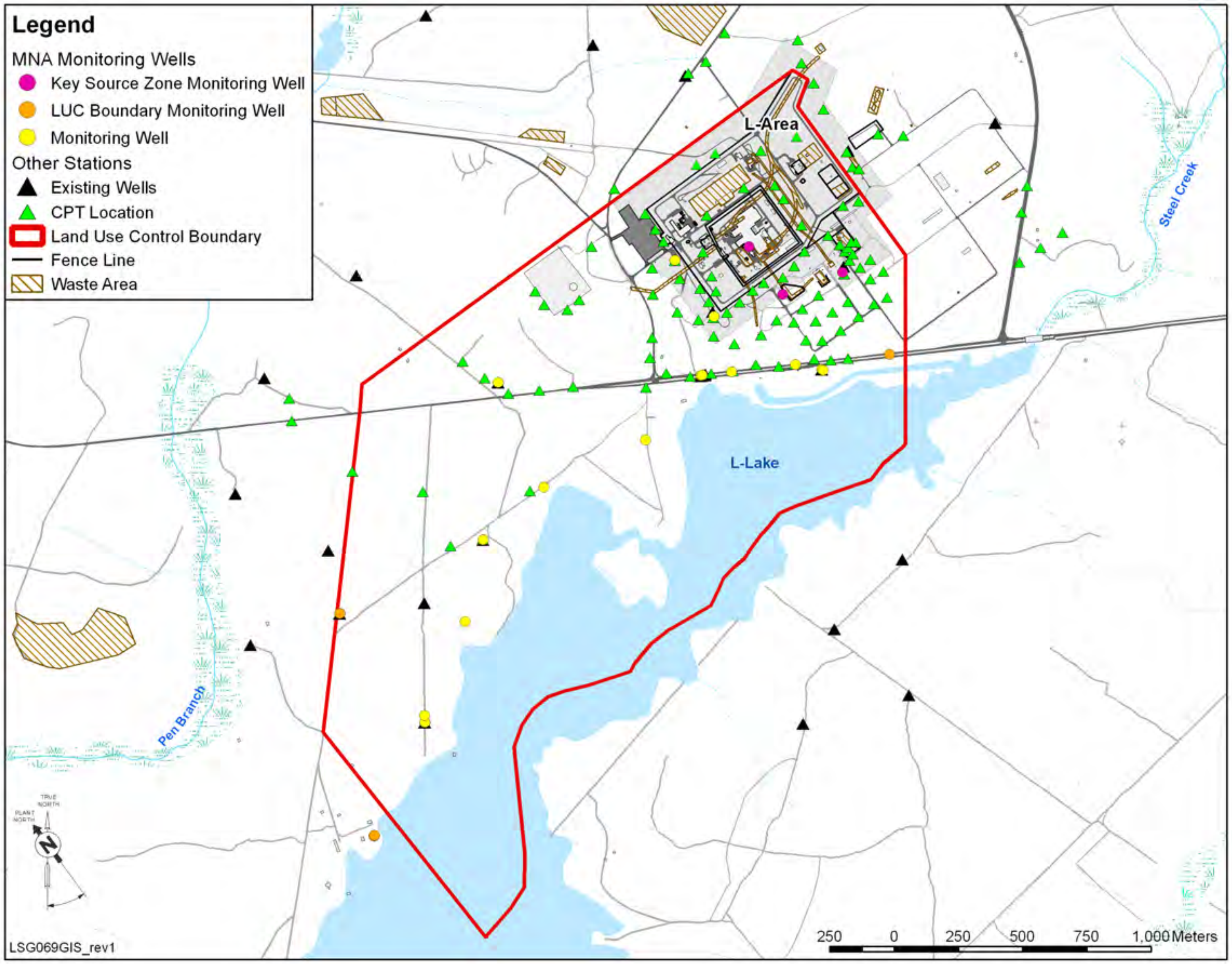

Figure F-3. Well and CPT Coverage Map

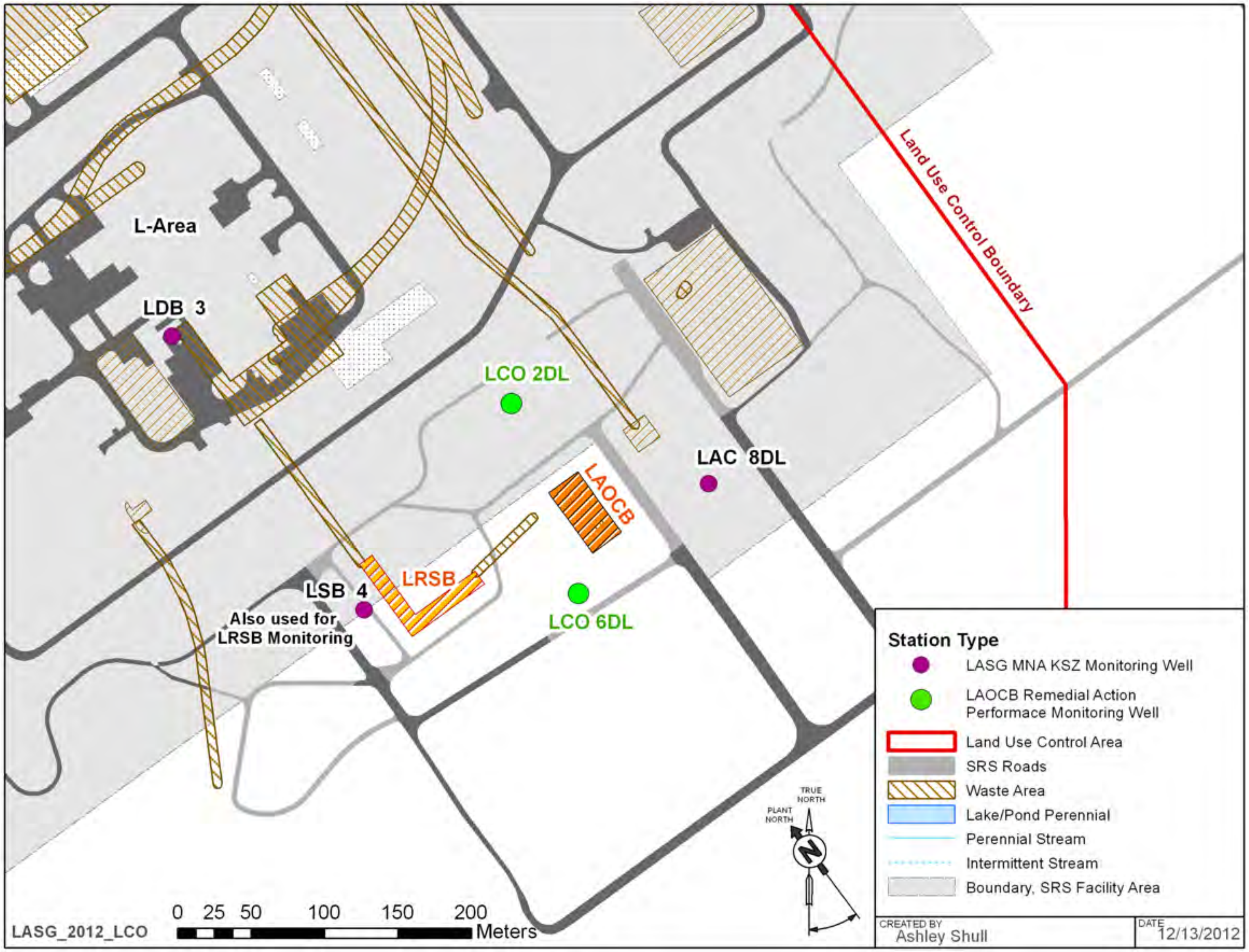

Figure F-4. LRSB and LAOCB Performance Monitoring Station Locations

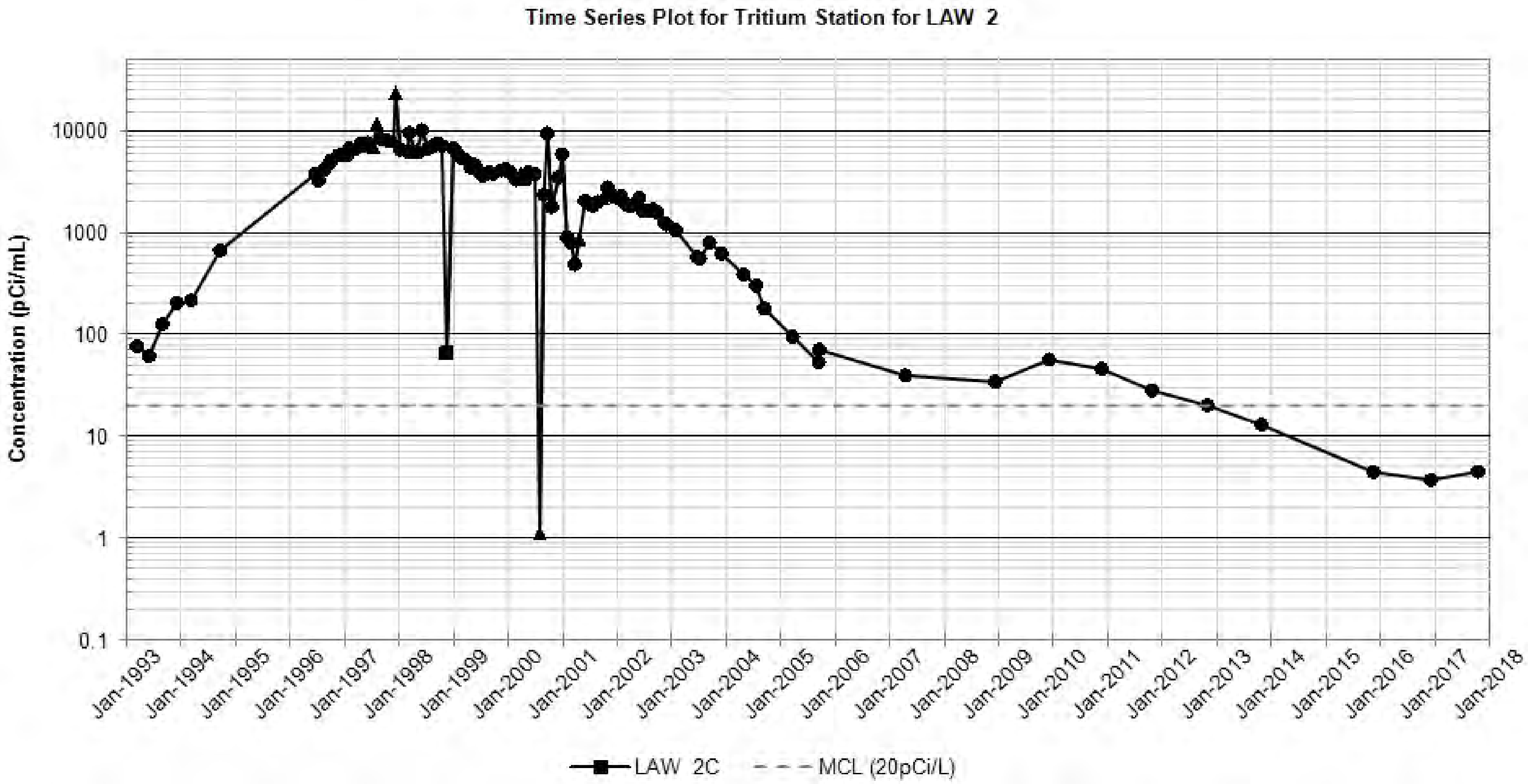

Figure F-5. Time Series Plot for Tritium for Source Zone Well LAW 2

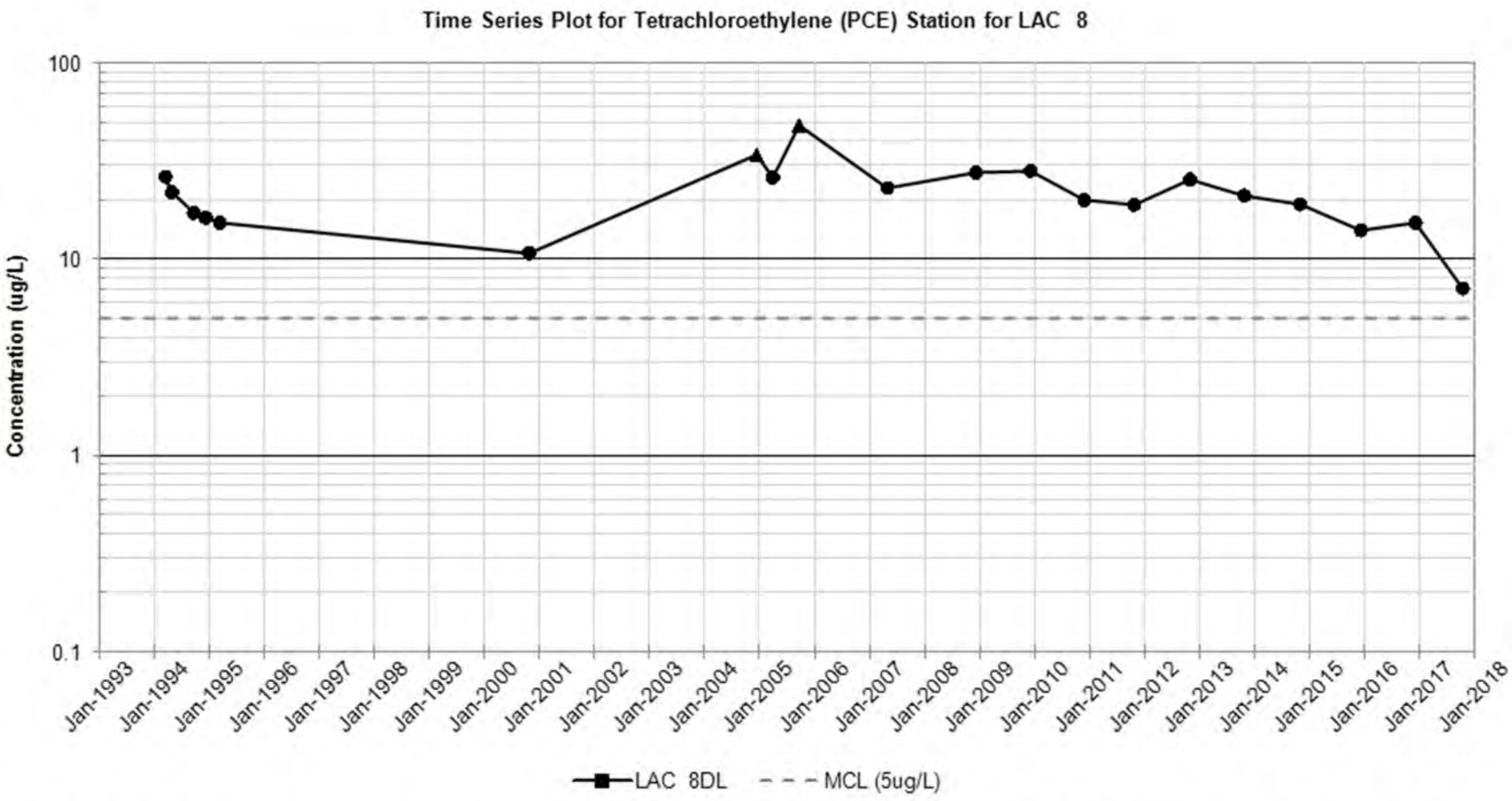

Figure F-6. Time Series Plot for PCE for Source Zone Well LAC 8DL

Table F-1. Chronology of Events

Event	Date
RI Start / Complete	August 2, 2000 / July 26, 2004
ROD Issuance	May 9, 2007
Remedial Action Construction Start / Complete	February 25, 2008 / May 7, 2008
Remedial Action Operations Start / Complete	December 8, 2008 / on-going
ESD Issuance	September 10, 2014
Previous Five-Year Remedy Review	February 4, 2009 / February 4, 2014 / February 2, 2017

Table F-2. MCL Listing for LASG and Maximum Groundwater Results Summary

RCOC	MCL	Pre-RI 1981 - 1999	RI Jan '00 – Jul '04	Post-RI Jul 26, 2004 – 2013	Present
Range of dates		**Prior to 2001**	**2001 - 2004**	**2005 - 2013**	**2017**
Tritium (ρCi/mL)	20	26,200	5,850	1,230	593
PCE (µg/L)	5	165	58	60	48.4
TCE (µg/L)	5	124	9	21	3.68

Table F-3. Analytical Results for Tritium (ρCi/mL) in L-Lake

Station ID	Oct 2005	Jun 2006	Dec 2006	May 2007	Dec 2007	Dec 2008	Dec 2009	Dec 2010	Oct 2011	Oct 2012	Nov 2013	Nov 2014	Nov 2015	Dec 2016	Oct/ Nov 2017
SC20	16.5	14.2	**58.1**	14.2	18.9	**20.5**	**58.2**	**49.2**	**54.5**	11.1	11.2	7.36	6.32	**21.7**	8.64
SC21	14.3	13.9	14.2	13.8	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SC22	J 0.984	2.14	J 2.1	4.27	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SC23	**30**	19.5	**234**	**33.5**	11.6	**54.9**	ND	J 0.558	1.34	ND	3.38	ND	NS	NS	2.36
SC24	**22.1**	**53.2**	**257**	**34.3**	**30.7**	**47.7**	**78.3**	**145**	**28.9**	**105**	7.24	4.63	5.78	J 0.753	3.95
SC25	13.3	9.8	12	11.9	8.98	5.17	6.41	7.2	6.49	5.11	3.93	4.06	3.14	1.87	3.43
SC26	11.3	12.9	12.8	12.7	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SC27	11.9	11.9	9.24	12	10	8.17	6.22	6.94	6.88	5.96	4.79	4.77	3.44	3.79	3.24

J: Qualifier on a value indicates that the analyte was positively identified in the sample at a concentration below the quantitation limit; the reported value is estimated. NS: Not Sampled. ND: Not Detected. Note: Results in bold face type exceed the 20 pCi/mL MCL for tritium.

Table F-4. Actual versus Estimated O&M Costs

	FY2015	FY2016	FY2017	FY2018	FY2019	Five-Year Total
Total Actual O&M Costs ($)	23,967	75,580	10,215	18,313	6,967	135,043
Total ROD Estimated Direct O&M Costs ($)	81,520	0	106,520[1]	0	81,520	269,560

[1] FY2017 estimated costs include costs associated with the fifth five-year remedy review.

Table F-5. LAOCB and LRSB Performance Monitoring Results (2016)

	CARBON-14	COBALT-60	GROSS ALPHA	NONVOLATILE BETA	STRONTIUM-90	TRITIUM
LAOCB Results						
Units	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/mL
MCL/PRG	2,000	100	15	50	8	20
LCO 2DL (8/24/2016)	ND	ND	ND	4.84 J	ND	ND
LCO 6DL (8/25/2016)	352	ND	2.81 J	ND	ND	1.5
LRSB Results						
LSB 4 (8/24/2016)	NA	NA	NA	NA	ND	NA

J: Qualifier on a value indicates that the analyte was positively identified in the sample at a concentration below the quantitation limit; the reported value is estimated.
NA: Not Applicable
ND: Not Detected

Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Southern Groundwater Operable Unit

I. SITE INFORMATION

Site Name:	**L-Area Southern Groundwater Operable Unit**	**Date of Inspection:**	**10/22/2019**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**SEMS #31**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**81°F and partly sunny**

Remedy Includes: *(Click all that apply)*

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

____

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

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** Brian Hanshew (Name) ACP Field Execution Team 2 (Title) 11/05/2019 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4949

Problems/Suggestions: ☐ Report Attached ______________________________

____

2. **O&M Staff:** Phil Carter (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 11/05/2019 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4145

Problems/Suggestions: ☐ Report Attached ______________________________

____

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

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

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

Agency: ______________________

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

Problems/Suggestions: ☐ Report Attached No issues identified.

Agency: ______________________

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

Problems/Suggestions: ☐ Report Attached ______

Agency: ______________________

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

Problems/Suggestions: ☐ Report Attached ______

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

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

1. **O&M Documents:**

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

Remarks: Monitoring wells are inspected per ER-SOP-011, “ACP Monitoring Well Inspection (U)”.

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

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

1. Health and Safety Plans (HASPs):

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

Remarks: Routine O&M activities do not require a Site-Specific Health and Safety Plan (SSHASP) under 29 CFR 1910.1201, Hazardous Waste Operations. A SSHASP is prepared if needed.

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

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

3. Permits and Service Agreements:

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

Remarks:

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

Remarks:

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

Remarks:

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

Remarks:

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

Remarks:

8. Discharge Compliance Records:

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

Remarks:

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

Remarks:

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

IV. O&M COSTS

1. O&M Organization:

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

2. O&M Cost Records:

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place

☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

Total annual cost by year for review period, if available

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

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

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

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

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

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

Describe costs and reasons: N/A

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

A. Fencing

1. Fencing Damage: ☐ Location shown on site map ☐ Gates secured ☒ N/A

Remarks: OU-specific fencing is not required by the remedial action.

B. Signs

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

Remarks:

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

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

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

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

Contact:	Phil Prater	DOE Program Manager	12/09/19	803-952-9333
	(Name)	(Title)	(Date)	(Phone No.)

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

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

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

D. General

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

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

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

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

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

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

Remarks:

B. Other Site Conditions

Remarks:

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

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

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

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

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

C. Treatment System ☐ Applicable ☒ N/A

D. Monitoring Data ☒ Applicable ☐ N/A

1. Monitoring Data:

☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring Data Suggests:

☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

E. Monitored Natural Attenuation ☒Applicable ☐N/A

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

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

Remarks: All MNA groundwater monitoring wells were inspected. All well identification signs were in good condition.

X. OTHER REMEDIES

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

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

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

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

The remedial action for the LASG OU is MNA with institutional controls (i.e., LUCs) to prevent exposure to contaminants in groundwater. The remedy is fully established and functioning as designed.

B. Adequacy of O&M

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

The protectiveness of the completed remedial action is being monitored by continued groundwater sampling. The O&M procedures are effectively maintaining the monitoring wells. The wells are properly secured/locked, functioning and are in good condition. Institutional controls (i.e., LUCs) effectively prevent unauthorized access to the groundwater and include physical access controls to SRS (fences, guards, security patrols, etc.); administrative controls (SRS is a secured government facility with land use restrictions); and land use controls (SRS Site Use/Site Clearance Program). There are no issues requiring corrective actions.

C. Early Indicators of Potential Remedy Failure

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

N/A

D. Opportunities for Optimization

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

N/A

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R-AREA OPERABLE UNIT

I. Introduction

This report is the third five-year remedy review for the R-Area Operable Unit (RAOU). Contaminants have been left in place at RAOU at levels that do not allow for unlimited use and unrestricted exposure. The review was conducted from August 2019 through November 2019. The purpose of this review is to determine whether the remedy in place at RAOU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table G-1 lists the chronology of site events for the RAOU.

III. Background

The RAOU is listed as a Resource Conservation and 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 of concern is surface soil, rail bed materials, metal components, concrete, sediment, and groundwater.

An area-based remedial strategy has been implemented in R Area, excluding prior remedial decisions for the following operable units (OUs) as presented in their respective Records of Decision (RODs) documents:

- R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, and 904-104G) and 108-4R Overflow Basin (108-4R),
- R-Area Acid/Caustic Basin (904-77G),
- R-Area Bingham Pump Outage Pits (643-8G, 643-9G, and 643-10G), R-Area Unknown Pit #1 (RUNK-1), Pit #2 (RUNK-2), and Pit #3 (RUNK-3) (No Building Number [NBN]), and

- R-Area Burning/Rubble Pits (131-R and 131-1R) and R-Area Rubble Pile (631-25G).

RAOU remedial actions are addressed by the Early Action ROD for the C-, K-, L-, and R-Reactor Complexes (SRNS 2009b) and the ROD for the RAOU (SRNS 2010a). Removal actions were completed for the following units within R Area and the actions described in Decommissioning Project Final Reports, Removal Site Evaluation Report/Engineering Evaluation/Cost Analysis (RSER/EE/CA), and EE/CA reports:

- R-Area Reactor Area Cask Car Railroad Tracks as Abandoned (SRNS 2009c),
- Grouting of the R-Reactor Disassembly Basin at the Savannah River Site (USDOE 2002),
- R-Reactor Building (105-R) Complex (SRNS 2009d),
- P-Area Ash Basin (Including Outfall P-007) (188-P) and the R-Area Ash Basin (188-R) (SRNS 2010d),
- R-Area Process Sewer Line (RPSL) Combined Subunit (SRNS 2010e), and
- Primary Substation (151-1R) (High Volt 115/13.8KV) (SRNS 2010f).

Physical Characteristics

The RAOU is located in east-central SRS approximately 5.0 km (3.1 mi) east of the geographical center of SRS and about 7.0 km (4.3 mi) west of the nearest site boundary (Figure G-1). RAOU is approximately 70.8 hectare (175 acre) and is located primarily in the Lower Three Runs watershed. The northwestern portion of the RAOU lies within the Upper Three Runs Watershed. Figures G-3 and G-4 show before (1999) and after (2018) remediation photos of R Area, respectively. The RAOU has a flat to gently rolling topography and is approximately 88.4 m (290 ft) above mean sea level.

The RAOU is comprised of the following subunits and potential source areas (PSAs) (Figure G-2):

- R-Reactor Building (105-R) Complex:
  - R-Reactor Building (105-R) including the Engine Houses (108-1R and 108-2R),

        - R-Reactor Vessel,
        - R-Reactor Disassembly Basin, and
        - R-Reactor Emergency Basin,
    - Area on the North Side of Building 105-R, Laydown Area North of 105-R, Release from the Decontamination of R-Area Reactor Disassembly Basin (NBN),
    - Combined Spills North of Building 105-R (NBN), and
    - Potential Release from the R-Area Disassembly Basin
- RPSL Combined Subunit:
    - R-Area Process Sewer Lines as Abandoned (NBN),
    - Process Water Storage Tank (106-R) PSA,
    - Cooling Water Effluent Sump (107-R), and
    - Purge Water Storage Basin (109-R)
- R-Area Reactor Area Cask Car Railroad Tracks as Abandoned (NBN),
- R-Area Ash Basin (188-R),
- R-Area Groundwater (RAGW) (NBN),
- R-Area Isolated Contamination Area (ICA) PSA (NBN),
- Process Storage Building (122-R),
- Potential Release of NaOH/H_2SO_4 from 183-2R,
- Power House (184-R) PSA,
- Cooling Tower (185-R) PSA,
- Former Coal Pile (NBN) PSA,
- Administrative and Maintenance Building (704-R) PSA,
- Maintenance Material Storage Building (711-R) PSA, and
- Eastern Volatile Organic Compound (VOC)/Tritium Groundwater Plume PSA.

- Eastern Volatile Organic Compound (VOC)/Tritium Groundwater Plume PSA.

Within the RAOU area are the following Deactivation and Decommissioning No Further Action (NFA) Facilities and Site Evaluation NFA Areas:

- Primary Substation (151-lR),
- Primary Substation (151-2R),
- Cooling Water Clarification Plant (183-1R),
- Filter and Softener Plant (183-2R),
- Cooling Water Reservoir (186-R),
- Cooling Water Pump House (190-R), and
- Potential Release from R-Area Concrete Lakes (183-1R/186-R)

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 much of RAOU as being within the site industrial support area. The land use control (LUC) boundaries for RAOU that encompass the groundwater plume are predominantly outside of the industrial area for R Area. However, shallow groundwater and surface water at SRS are not used for drinking water, hygiene, recreation, and process water. The future land use for RAOU is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

In December 1953, R-Reactor began operations, and the facility was placed in shutdown status in 1964 due to decreased demand for nuclear materials. The primary sources of radioactive contamination in R Area are activation products, fission products, and tritium, the majority of which were the consequence of R-Reactor operations. Spills, leaks, accidental releases, or simply the operation itself resulted in releases of hazardous and/or radioactive substances. Tritium and VOCs released from reactor operations have created four contaminated groundwater plumes in R Area (Figure G-2). A Northern Tritium Plume originates at the R-Reactor Seepage Basins, travels to the northwest, and discharges to surface water at Mill Creek. An Eastern Tritium Plume originates outside of the Purification Area of R-Reactor (105-R), travels to the northeast, and discharges to surface water at Joyce Branch. A Western Tritium Plume originates at the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned (NBN) at the western end of R-Reactor (105-R), migrates to the south, but decays to below detection concentrations prior to discharging to a surface water body. An Eastern VOC Plume originates outside the Assembly Area of R-Reactor (105-R), travels to the northeast, and discharges to surface water at Joyce Branch.

Initial Response

R-Reactor Building (105-R) and all other facilities within R Area have been decommissioned and/or are remnants that require no further action. The Early Action ROD for the C-, K-, L-, and R-Reactor Complexes (SRNS 2009b) documents the selected remedy for the R-Reactor Building (105-R) Complex as in situ decommissioning (ISD) with LUCs. Regulatory decisions were made previous to the RAOU ROD at selected RAOU subunits. Non-Time Critical Removal (NTCR) actions are documented in four RSER/EE/CAs and one EE/CA that include the following subunits and actions:

- R-Reactor Building (105-R) Complex (including the R-Reactor Building [105-R], the Engine Houses [108-lR and 108-2R], the R-Reactor Vessel, the R-Reactor Disassembly Basin, the R-Reactor Emergency Basin, the Area on the North Side of Building 105-R, Laydown Area North of 105-R, Release from the Decontamination of R-Area Reactor Disassembly Basin [NBN], Combined Spills North of Building 105-R (NBN), and the Potential Release from the R-Area Disassembly Basin [105-R]) – in situ decommissioning (SRNS 2009d),
- R-Reactor Disassembly Basin – evaporation and grouting (USDOE 2002),
- RPSL Combined Subunit (including the R-Area PSLs as Abandoned [NBN], Process Water Storage Tank [106-R], Purge Water Storage Basin [109-R], Cooling Water

Effluent Sump [107-R] Subunit, Septic Tank [607-lR], outfalls, manholes, miscellaneous weirs and boxes; sumps, etc.) – grouting access points and open structures (SRNS 2010e),

- R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit – excavation and disposal (SRNS 2009c), and
- R-Area Ash Basin (188-R) Subunit – soil cover (SRNS 2010d).

Basis for Taking Action

The nature and extent of contamination in soil, sediment, surface water, and groundwater at the RAOU were characterized. Results from the past characterization activities (SRNS 2009a) and recent monitoring have demonstrated that residual contaminants exceed the R-Reactor Building (105-R) Complex ISD remedial goals (RGs) at specific subunits. In addition, there are three tritium plumes and one VOC plume, which comprise the RAGW Subunit, that exceed the maximum contaminant levels (MCLs) (Table G-2). The shallow groundwater aquifers impacted by tritium and VOCs in R Area have never been used as drinking water; however, until tritium and VOCs are reduced below MCLs, the potential for human exposure requires action. ISD of the R-Reactor Building (105-R) left radionuclides, lead, and polychlorinated biphenyls (PCBs) in place at levels that present a potential for future contaminant migration to groundwater (SRNS 2010a). Therefore, monitoring of the R-Reactor Building (105-R) Complex ISD is required to ensure groundwater is not impacted by the residual contaminants. Table G-3 summarizes the refined constituents of concern (RCOCs) and remedial goals (RGs) determined for the RAOU subunits. RAOU subunits with contaminant levels that exceed 1.0E-06 risk for an industrial worker scenario required the following removal actions, LUCs, and monitoring to be protective of human health and the environment:

- The removal action for the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit (soil removal to 10 ρCi/g cesium-137) has been completed (SRNS 2012). This subunit will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.

- The removal action for the R-Reactor Disassembly Basin has been completed and radioactive contaminants have been grouted in place (SRNS 2012). This subunit will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.
- The removal action for the R-Reactor Building (105-R) Complex has been completed and radioactive contaminants have been grouted in place (SRNS 2012). This subunit will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.
- The removal action for the R-Area PSLs has been completed and radioactive contaminants have been left in place (SRNS 2012). This subunit will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.
- A contaminant migration analysis was performed to identify refined contaminant migration constituents of concern (COCs) (SRNS 2009a).
- A principal threat source material (PTSM) evaluation for the RAOU subunits determined refined COCs for the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned, R-Area PSLs, and R-Reactor Building (105-R) Complex subunits. The radioactive inventory located in the R-Reactor Building (105-R) has been estimated to be 6.39E+04 Ci (SRNS 2009d), and the cumulative risk for the R-Reactor Building (105-R) Complex was estimated at 5.61E+01 (SRNS 2009a).

IV. Remedial Actions

Remedy Selection

As stated in the ROD (SRNS 2010a), the selected remedy for the RAOU is monitored natural attenuation (MNA) with LUCs as follows:

- LUCs include: (1) institutional controls (i.e., administrative measures) and use restrictions 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 briefing of health and safety requirements; (2) engineering controls consisting of signage located at the RAOU LUC boundaries to discourage unauthorized entry and uses; and (3) SRS access controls to prevent exposure to trespasses including a 24-hour surveillance system, control entry systems, and warning signs in place at the SRS boundary, and

- MNA.

As stated in the ROD (SRNS 2010a), the Remedial Action Objectives (RAOs) for the RAOU are as follows:

- Eliminate or control all routes of exposure to residual radioactive or chemical contamination posing risks exceeding 1E-06 to the industrial worker or the resident in media or structures associated with the R-Reactor Building (105-R) Complex, the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned, the RPSL Combined Subunit, the R Area ICA PSA, the R-Area Ash Basin (188-R), and the RAGW,
- Prevent the migration of contaminants from residual water in the Process Water Storage Tank (106-R) PSA to groundwater at concentrations exceeding regulatory standards (MCLs),
- Prevent human exposure to tritium and VOCs in groundwater that exceed regulatory standards (MCLs) and restore contaminated groundwater to below regulatory limits (MCLs) for the RAGW Subunit, and
- Prevent exposure of potential contamination in media or structures to a residential receptor associated with the following subunits:
  - Process Storage Building (122-R) Subunit
  - Potential Release of NaOH/H_2SO_4 from 183-2R Subunit
  - Power House (184-R) PSA
  - Cooling Tower (185-R) PSA
  - Former Coal Pile (NBN) PSA
  - Administrative and Maintenance Building (704-R) PSA
  - Maintenance Material Storage Building (71 l-R) PSA

  - Eastern VOC/Tritium Groundwater Plume PSA

Remedy Implementation

The selected remedial action was based on successful completion of the NTCR actions as listed below:

- Removed 53.6 m^3 (70 yd^3) of contaminated media at the R-Reactor Cask Car Railroad Tracks by excavating and transporting to the E-Area Slit Trench Disposal Units for disposal. The excavated area was backfilled with structural fill material and approximately 10-cm (4-in) of crusher run was placed, graded, and compacted on the backfilled area.
- Placed a 6.1-hectare (15-acre), 0.6-m (2-ft) thick soil cover over the R-Area Ash Basin (188-R). The multi-layer cover system consisted of a 45-cm (18-in) thick compacted common fill, 10-cm (4-in) thick topsoil, and sod.
- Isolated/plugged the R-Area PSLs; grouted associated underground structures, manholes, weirs and boxes; select removal of process equipment external to the R-Area PSLs; sealed/plugged the outfalls; transported 60,000 gallons of radiologically contaminated water from the 106-R Process Water Storage Tank to R-Area Disassembly Basin for evaporation.
- ISD of the R-Reactor Building (105-R) Complex included:
  - Leaving the R-Reactor Building (105-R) (Process, Purification, and Assembly Areas) and the Actuator Tower in place,
  - Installing an evaporation system to treat the R-Reactor Disassembly Basin water; Grouting the below grade portions of the R-Reactor Building (105-R) including Disassembly Basin and the Purification Area (94,055 m^3 [122,948 yd^3] total) to stabilize contaminants,
  - Grouting the Reactor Vessel in place (109.4 m^3 [143 yd^3]) and placing a 1.2-m (4-ft) thick constructed concrete cover over the Reactor Vessel; cover is sloped to allow water runoff in the event of future rainwater ingress,

  - Demolishing the above-grade structure of the R-Reactor Disassembly Area to grade-level and transported 10,254 m^3 (13,404 yd^3) of debris to the E-Area Low-Level Waste Facility,
  - Placed a 0.57 hectare (1.4 acre), 17.5-cm (7-in) thick sloped 4000 psi reinforced concrete cover over the grouted R-Reactor Disassembly Basin, including the contaminated soil and slabs in the area north of the R-Reactor Building (105-R),
  - Removing the stack above the plus 16.8-m (55-ft) elevations,
  - Constructing a new partial roof over the shield door slots to prevent rainwater ingress,
  - Leaving the Process Room, an above-grade structure, in its current state,
  - Monitoring the groundwater adjacent to the R-Reactor Building (105-R) in order to verify the effectiveness of the ISD remedy, and
  - Sealing all R-Reactor Building (105-R) exterior openings.

The selected final remedy components met the RAOs at RAOU by implementing the following activities:

- MNA for the RAGW Subunit (SRNS 2010c),
- Performance evaluation groundwater monitoring for ISD of the R-Reactor Building (105-R) Complex, and
- LUCs for 183 hectares (450 acres) comprising the RAOU.

System Operations/Operation and Maintenance

Currently, there are no systems in operation at the RAOU. Operations are complete for the evaporators, which removed 17 to 18.9 million L (4.5 to 5 million gal) of R-Reactor Disassembly Basin water. The remaining 1.1 million L (380,000 gal) of shield water was absorbed/evaporated (through heat of hydration) by the grout.

The following maintenance activities are ongoing:

- Groundwater monitoring to ensure the ISD remedy is performing as expected and that no contaminant migration COCs have impacted groundwater. ISD monitoring is conducted every five years due to the long time-frame estimates for potential impacts to groundwater based on groundwater modeling. The first round of ISD groundwater monitoring was conducted in 2012; the second round of sampling occurred in 2017.
- Annual groundwater and surface water monitoring will be part of the MNA remedy for tritium and VOC plumes. The estimated time frames for MNA to restore contaminated groundwater to below MCLs based on data collected in 2007 to 2008 (SRNS 2010c) are:
    - Northern Tritium Plume - 124 years,
    - Eastern Tritium Plume - 77 years,
    - Western Tritium Plume 37 years, and
    - Eastern VOC Plume - 26 years.

Annual site inspections and maintenance activities include:

- The roof structure of the R-Reactor Building (105-R) Complex to ensure that it is functioning properly. Herbicides will be applied as necessary to prevent the growth of woody vegetation on the roof structure,
- The doors into the R-Reactor Building (105-R) Complex to ensure that they remain sealed,
- The R-Reactor Disassembly Basin cover to ensure that excessive deterioration has not occurred, and that no woody vegetation is growing on the cover,
- The R-Area Ash Basin (188-R) cover to verify that significant erosion has not occurred (60.9 cm [2 ft] thickness maintained), to ensure that no woody vegetation is growing on the cover, and to ensure that no burrowing or mounding animals are present,
- The RAOU to ensure no unauthorized excavations, digging, or construction activities within the LUC boundaries have occurred, and
- Inspection and maintenance of access control warning signs

Since implementation of the remedy, SRS has optimized surveillance/maintenance of the closed R-Reactor Building (105-R) Complex by employing aerial drones to perform these activities.

The operation and maintenance (O&M) costs associated with the selected remedy for RAOU include maintenance costs, as described above, groundwater monitoring, and LUCs. These activities have a ROD estimated total present worth of $5,466,429 discounted at 2.7% per year for 200 years of maintenance activities (SRNS 2010a). The O&M cost estimated in the ROD that are applicable for Fiscal Year (FY)2015 to FY2019 is $286,500. The actual O&M cost for this same period is $1,023,392. Table G-4 shows the annual comparison of O&M actual and ROD estimated costs. The actual costs are higher than expected because groundwater monitoring reports are being submitted annually. The ROD estimate only included reporting in an Effective Monitoring Report every five years to coincide with the remedy review. Additionally, based on inspections conducted from FY2015 through FY2019, various maintenance activities completed at the RAOU included cutting vegetation around waste unit warning signs, vegetation removal from stone armament, vegetation removal from roofs, and repairing soil damage from feral hog rutting.

V. Progress Since Last Review

This is the third five-year remedy review for the RAOU. The previous protectiveness statement concluded that because the remedial actions are protective, the RAOU is protective of human health and the environment.

In the previous five-year remedy review, it was recommended that 1,4-dioxane be analyzed at the RAOU. SRS performed a comprehensive round of 1,4-dioxane monitoring in 2015, 2016 at one new well, and found this compound was not present in the RAOU groundwater (SRNS 2016). SRS recommended in the 2016 EMR to discontinue 1,4-dioxane analyses at the RAOU, and the Core Team accepted this recommendation. The U. S. Environmental Protection Agency (USEPA) provided comments and the South Carolina Department of Health and Environmental Control (SCDHEC) conditionally approved the *R-Area Groundwater (NBN) Effectiveness Monitoring Report in Support of R Area Operable Unit*

(U) (SRNS 2016) on October 27, 2016. The SRS provided responses to the regulators on January 9, 2017. The USEPA and SCDHEC approved the responses on January 13, 2017 and February 7, 2017, respectively. Therefore, 1,4-dioxane monitoring is no longer required at the RAOU.

An addendum to the EMP for the RAOU was initiated in 2017 and submitted and approved in 2019 (SRNS 2019a). The original 2011 RAOU EMP specified the ISD monitoring plan to sample and analyze ten contaminant constituents of concern (CMCOCs) with the potential to exceed maximum contaminant levels (MCLs) in groundwater under a No Action scenario. These ten CMCOCs (carbon-14, chlorine-36, potassium-40, nickel-59, niobium-94, molybdenum-93, silver-108m, iodine-129, lead, and PCBs) and tritium, were to be sampled at ten monitoring wells around the R-Reactor Building (105-R) Complex starting in 2012 (Figure G-5). The addendum to the EMP for the RAOU revised the ISD groundwater monitoring plan to monitor only the most mobile constituents (iodine-129, carbon-14, and chlorine-36) and tritium every five years rather than all ten CMCOCs and tritium. The first CMCOC predicated to exceed an MCL is groundwater is iodine-129 in 200 years. Tritium is included as a large increase in groundwater tritium concentrations may be an early indicator or potential contamination. Field parameters (e.g., pH, conductivity, and alkalinity) are also measured as they may be early indicators of potential contamination. The RAOU EMP addendum was approved by SCDHEC on August 07, 2019 and by USEPA on August 19, 2019.

As recommended in the June 2017 EMR, and per the EMP approved by the Core Team (SRNS 2010), after five years of annual reporting (2013-2017), the reporting frequency changed to biennial. The last RAOU EMR was submitted in June 2019. The next report is due in June 2021.

Monitoring activities since the last review indicate tritium and TCE concentrations are continuing to decrease in the groundwater and are not impacting surface water.

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 remedial actions;
- Reviewed groundwater monitoring data to determine if MCLs were exceeded;
- Inspected the OU, interviewed maintenance personnel and documented the results on the Inspection Checklist, provided in Attachment G-1, with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance.

Data Review

Recent data (2015 to 2019) have been reviewed for the RAOU Groundwater subunit and ISD monitoring of the R-Reactor Building (105-R) Complex. The Eastern VOC, Eastern Tritium, Western Tritium, and Northern Tritium plumes all indicate decreasing concentrations over this time period.

ISD monitoring is conducted every five years due to the long time-frame estimates for potential impacts to groundwater based on groundwater modeling. The first round of ISD groundwater sampling was conducted in 2012. In 2017, ISD monitoring identified carbon-14 (141 pCi/L) above its sampling quantitation limit (78.9 pCi/L) for the first time in the R-Area groundwater at well RDB 3D, but below the carbon-14 MCL (2,000 pCi/L). Additionally, well RDB 3D also had the highest tritium result (1,930 pCi/L) sampled to date. The results were verified by reanalysis and resampling. The Core Team was notified on January 18, 2018 and decided carbon-14 and tritium should be monitored annually for five years at RDB 3D and four other nearby wells (RDB 1D, RDB 2D, RDB003DU, and RDB005C) (Figure G-6). The elevated tritium appears to be from a small historic spill near the R-Reactor Disassembly Basin as carbon-14 has only been detected at well RDB 3D and groundwater concentrations have remained about the same for both carbon-14 and tritium at well RDB 3D.

Wells RDB 1D, RDB 2D, RDB 3D, RDB003DU, and RDB005C will continue to be sampled annually and analyzed for carbon-14 and tritium until 2022 to ensure the observed carbon-14 is only an isolated problem.

Summary of Inspections and Interviews

Interviews were conducted with Phil Carter, O&M staff member, and Brian Hanshew, O&M Site Manager, on November 5, 2019 at the O&M organization offices. No issues were identified for the RAOU during these interviews. The RAOU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) Environmental Compliance and Area Completion Projects (EC&ACP) on September 12, 2019. No issues were identified during these inspections.

The RAOU was inspected by SRNS EC&ACP and USDOE personnel on December 9, 2019. No issues that impact the protectiveness of the remedy were identified for the RAOU during this inspection.

A site inspection was conducted by USEPA and SCDHEC personnel, accompanied by USDOE and SRNS personnel on February 27, 2020. No significant problems regarding this OU were identified during the inspection.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The remedies selected for the RAOU are functioning as intended, as demonstrated below:

The closure of the RAOU by ISD and maintaining a protective cover system over the R-Reactor Building (105-R) is meeting the remedial objectives of preventing physical exposure of contaminants as indicated by the following:

- Site inspection and maintenance data do not indicate problems or potential remedy failure, which could place protectiveness at risk (Attachment G-1).
- Based on the results of the second ISD sampling event in March 2017, tritium (nine of ten samples) and carbon-14 (one of ten samples) were detected, no other radionuclide results were above detection limits (Table G-2). Nine of the ten tritium samples had concentrations exceeding the MCL (20 ρCi/ml) with the maximum concentration being 1,930 ρCi/ml. The 2017 carbon-14 result (141 ρCi/ml) at well RDB 3 was the first time carbon-14 was detected in the groundwater near the R-Reactor Building (105-R)

Complex, but below the MCL (2000 ρCi/ml). SRS notified the Core Team and agreed to sample for carbon-14 and tritium annually for five years at five monitoring wells (RDB 1D, RDB 2D, RDB 3D, RDB003DU, RDB005C) near the R-Reactor Building (105-R) Complex. The next round of ISD sampling is scheduled for 2022.

- The annual site inspection confirmed that the roof structure and R-Area Disassembly Basin cover are functioning properly, the doors are sealed, and the R-Area Ash Basin cover is in good condition (Attachment G-1).
- LUCs are preventing human health exposure and include the following: institutional controls (i.e., administrative measures) and use restrictions for on-site workers via the Site Use/Site Clearance Program; other administrative controls to ensure worker safety, including work controls, worker training, and worker briefing of health and safety requirements; engineering controls consisting of signage located at the RAOU LUC boundaries to discourage unauthorized entry and uses; and SRS access controls to prevent exposure to trespassers, including a 24-hour surveillance system, control entry systems, and warning signs in place at the SRS boundary. The Land Use Control Implementation Plan for RAOU governs LUC implementation, maintenance, monitoring, reporting, and enforcement of LUCs (SRNS 2010b). All LUC objectives are being met.

For groundwater contaminated with VOCs and tritium, MNA is the selected remedy. The last two Effectiveness Monitoring Reports were reviewed to support this assessment (SRNS 2017, SRNS 2019b). This remedy continues to be an effective remedy based on the following:

- Per the EMP (SRNS 2010c) and subsequent recommendation in the EMRs, groundwater monitoring takes place annually at thirty-seven wells and nine surface water/seep locations for the RAGW (Figure G-7). These stations monitor four contaminant plumes (one VOC and three tritium). Source well concentrations are decreasing, no exceedances of the source well action limits have ever occurred. Surface water concentrations in 2015 to 2018 were non-detect for VOCs, and well below the MCL (20 ρCi/ml) for tritium (maximum value in 2017 was 4.82 ρCi/ml at MCSW-04).

The results indicate that the plumes are still on track to be below MCLs in the time frames predicted.

- A new boundary well was added in 2014 to monitor the eastern VOC plume in the deeper aquifer. The maximum TCE result this well was 1.69 µg/L in 2014, and has decreased to less than 1 µg/L since then, indicating limited migration of the TCE plume.
- As discussed earlier, LUCs are preventing any human health exposure to contaminated groundwater.

Overall the early remedial actions, removal actions, and final remedial action are meeting the RAOs established for the RAOU, as discussed in Section IV, by eliminating or controlling all routes of exposure to residual radioactive or chemical contamination to the industrial worker, eliminating water flow through the R-Area PSLs, preventing the migration of VOCs from the vadose zone to the groundwater, preventing the exposure of contaminated media or structures to residential receptors, and demonstrating that the plume concentrations are trending downward without impact to surface water.

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

The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection are still valid. There have been no changes in standards or physical conditions of the RAOU that would affect the protectiveness of the remedy.

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 for the RAOU from being protective.

IX. Recommendations and Follow-up Actions

There are no recommendations or follow-up actions for the RAOU.

X. Protectiveness Statement(s)

The remedy at the RAOU 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 soil at the RAOU have been addressed through implementation of soil covers, ISD, physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the RAOU for industrial use only, and warning signs and use restrictions via the SRS Site Use/Site Clearance Program.

XI. Next Review

As shown in Appendix A, Table A-1, the next five-year remedy review for SRS OUs with Groundwater Remedies is scheduled for January 2026.

XII. Documents Reviewed

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

SRNS, 2009a. RCRA Facility Investigation / Remedial Investigation (RFI/RI) Report with Baseline Risk Assessment and Corrective Measures Study / Feasibility Study (CMS/FS) for R-Area Operable Unit (U), WSRC-RP-2008-4035, Revision 1.1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2009b. *Early Action Record of Decision Remedial Alternative Selection for the C-, K-, L-, and R-Reactor Complexes (U),* SRNS-RP-2009-00707, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2009c. Removal Site Evaluation Report / Engineering Evaluation / Cost Analysis (RSER/EE/CA) for the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned (U), WSRC-RP-2008-4090, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2009d. Removal Site Evaluation Report / Engineering Evaluation / Cost Analysis (RSER/EE/CA) for the R-Reactor Building (105-R) Complex (U), SRNS-RP-2009-00801, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010a. *Record of Decision Remedial Alternative Selection for the R-Area Operable Unit (RAOU) (U)*, SRNS-RP-2010-01062, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010b. *Land Use Control Implementation Plan (LUCIP) for the R-Area Operable Unit (RAOU) (U)*, SRNS-RP-2010-01208, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010c. *Effectiveness Monitoring Plan for the R-Area Operable Unit (U)*, SRNS-RP-2010-01259, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010d. Removal Site Evaluation Report / Engineering Evaluation / Cost Analysis (RSER/EE/CA) for the P-Area Ash Basin (Including Outfall P-007) (188-P) and the R-Area Ash Basin (188-R) (U), SRNS-RP-2009-01064, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010e. Removal Site Evaluation Report / Engineering Evaluation / Cost Analysis (RSER/EE/CA) for the R-Area Operable Unit (RAOU) R-Area Process Sewer Line (RPSL) Combined Subunit (NBN) (U), SRNS-RP-2009-01341, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010f. *Decommissioning Project Final Report 151-1R, Primary Substation (High Volt 11KV5/13.8KV)*, V-PCOR-R-00016, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2012. *Post Construction Report (PCR) for the R-Area Operable Unit (U)*, SRNS-RP-2011-01574, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2017. *R-Area Groundwater (NBN) Effectiveness Monitoring Report Submittal in Support of R Area Operable Unit (U)*, January 2016 through December 2016, SRNS-RP-2017-00232, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2019a. *Addendum to the Effectiveness Monitoring Plan (EMP) for the R-Area Operable Unit (U)*, SRNS-RP-2019-00211, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2019b. *R-Area Groundwater (NBN) Effectiveness Monitoring Report in Support of R-Area Operable Unit (U)*, January 2017 through December 2018, SRNS-RP-2019-00267, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, *Stakeholder Recommendations for SRS Land and Facilities*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

USDOE, 2002. Engineering Evaluation/Cost Analysis for the Grouting of the R-Reactor Disassembly Basin at the Savannah River Site, DOE/EE/CA-0001, U.S. Department of Energy, Savannah River Operations Office

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

Various – Inspection Data Sheets – *Field Inspection Checklists for the R-Area Operable Unit Ash Basin 188-R*, ER-IDS-019-051, Inspections conducted 2015 through 2018 (annually)

Various – Inspection Data Sheets – *Field Inspection Checklists for the R-Area Operable Unit (RAOU)*, ER-IDS-019-064, Inspections conducted 2015 through 2019 (annually)

Various – Inspection Data Sheets – *Field Inspection Checklists for the R-Area Operable Unit Reactor Building and Disassembly Basin*, ER-IDS-019-063, Inspections conducted 2015 through 2018 (annually)

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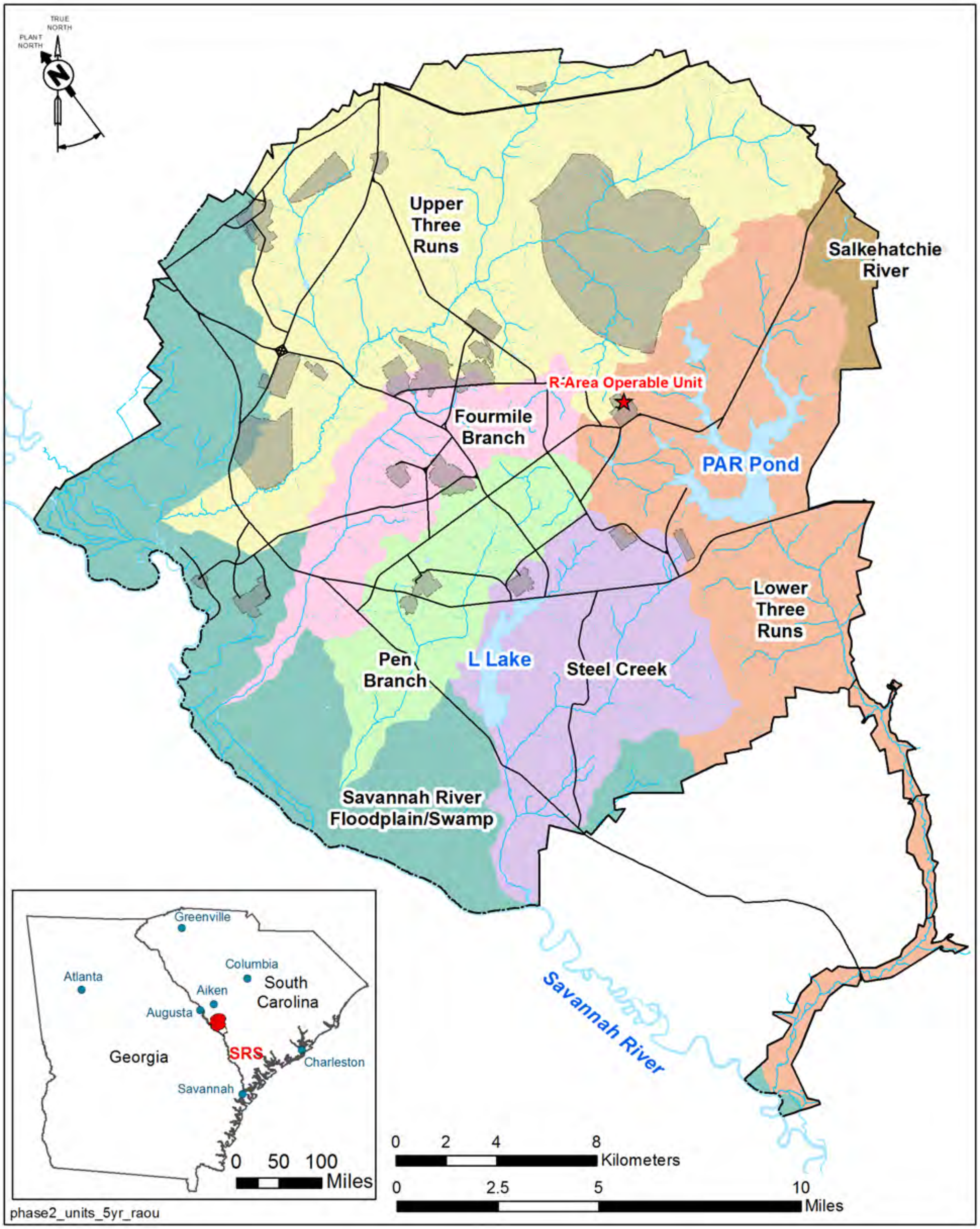
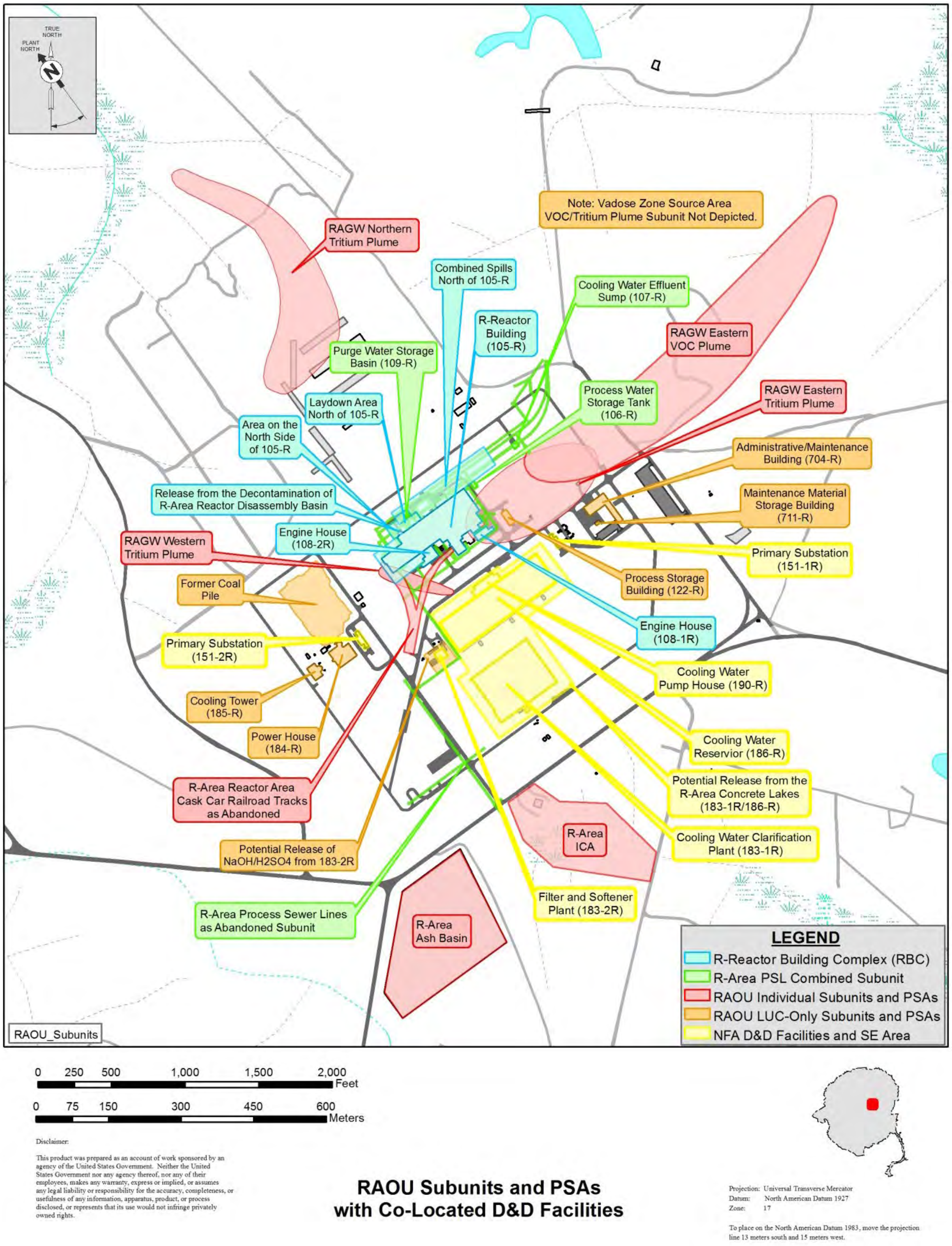


Figure G-1. Location of RAOU at Savannah River Site



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RAOU Subunits and PSAs with Co-Located D&D Facilities

Projection: Universal Transverse Mercator
Datum: North American Datum 1927
Zone: 17

To place on the North American Datum 1983, move the projection line 13 meters south and 15 meters west.

Figure G-2. Location of RAOU Subunits

Figure G-3. Photo of RAOU before Remediation Activities (1999)

Figure G-4. Current Photos of RAOU (2018)

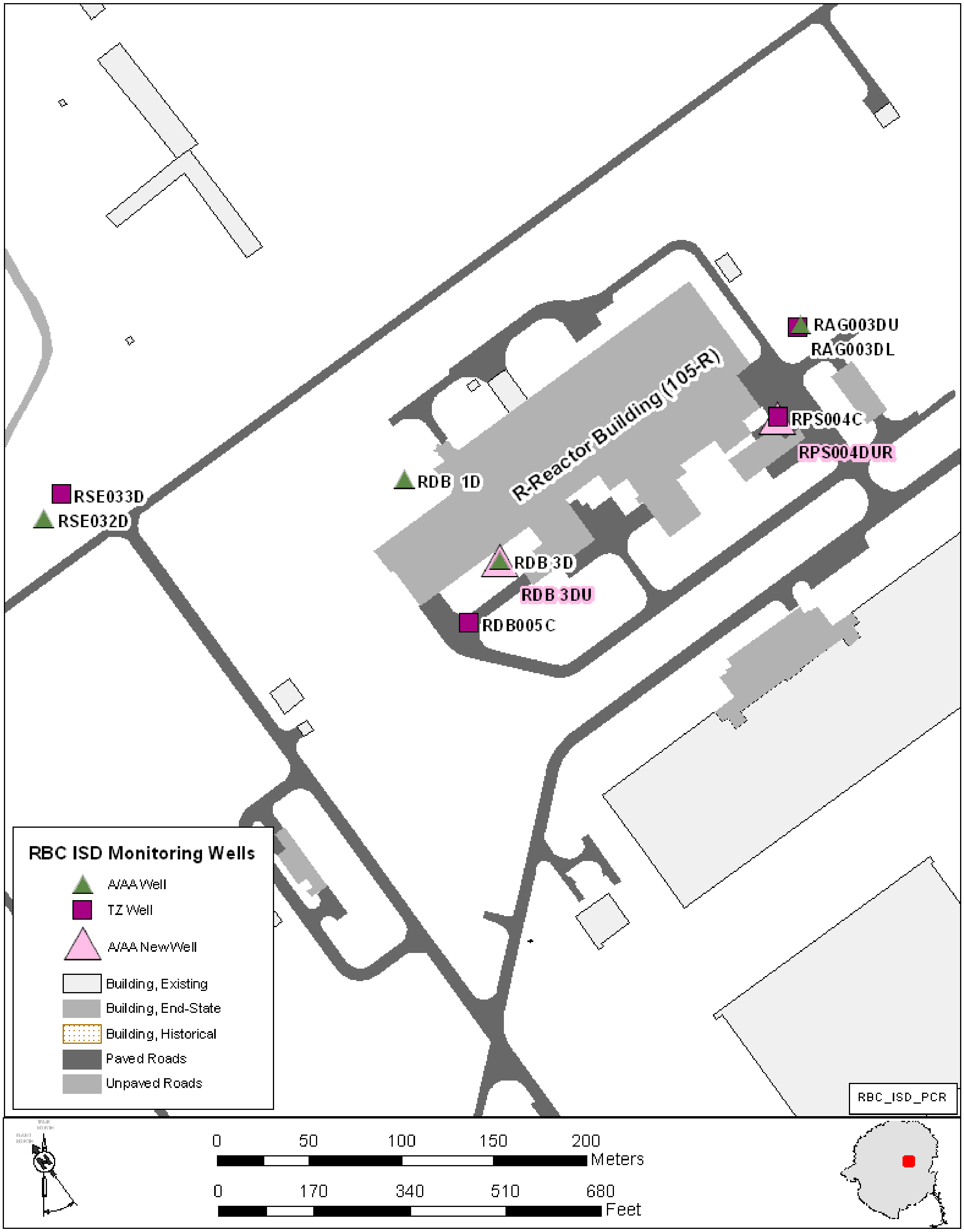

Figure G-5. ISD Monitoring Stations for R-Reactor Building (105-R) Complex

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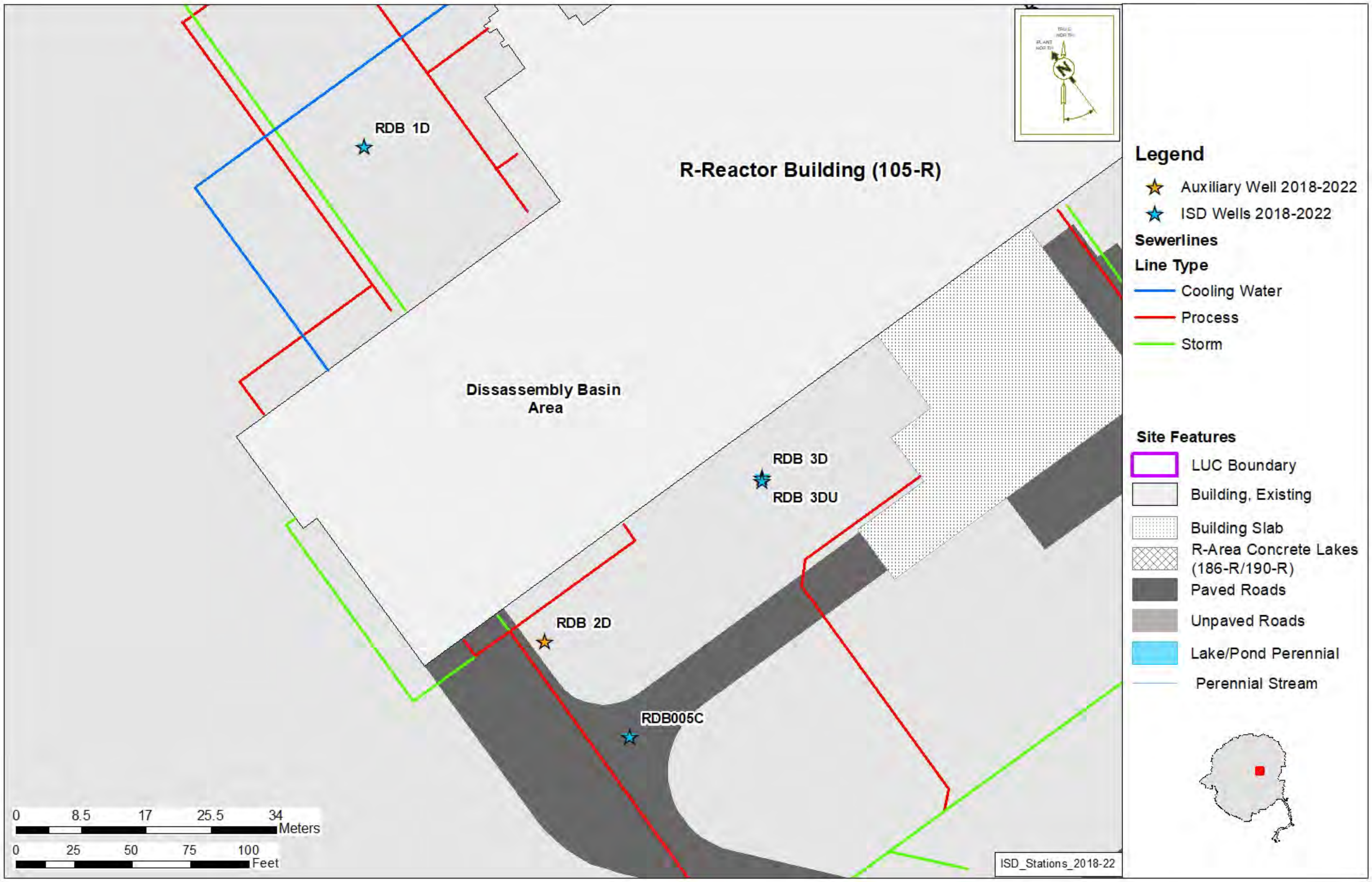

Figure G-6. **Annual ISD Monitoring Stations (2018-2022)**

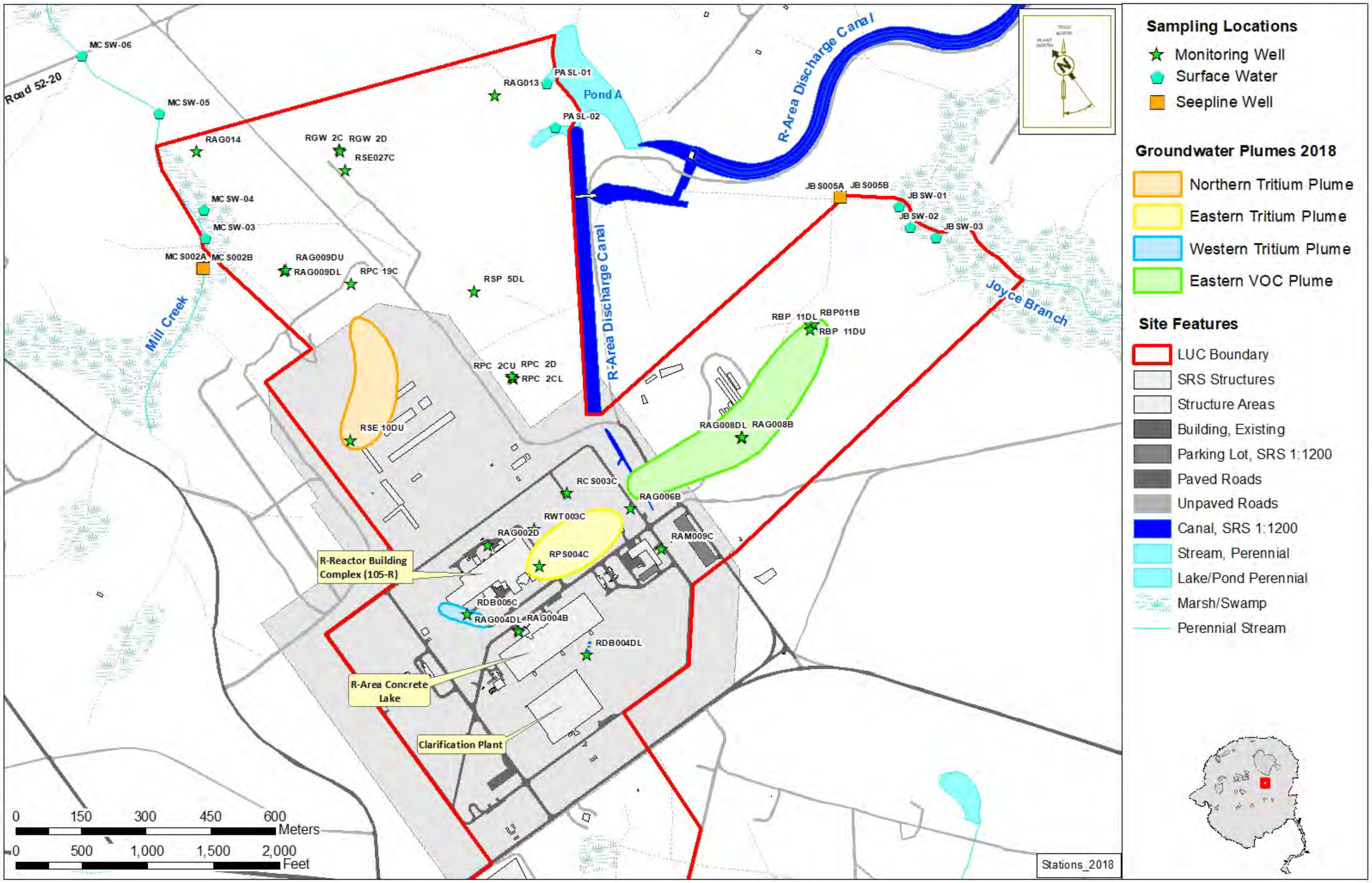

Figure G-7. MNA Monitoring Stations for RAGW Plumes (2018)

Table G-1. Chronology of OU Events

Event	Date
Early Action R-Reactor Disassembly Basin Grouting Start / Finish	October 1, 2002 / April 29, 2003
Early Action R-Reactor Disassembly Basin (Forced Evaporation and Grouting) Start / Finish	April 29, 2003 / November 30, 2010
Issue Early Action ROD for the C-, K-, L-, and R-Rx Complexes	December 8, 2009
Issue Record of Decision Remedial Alternative Selection for RAOU	April 20, 2011
Remedial Action Start / Finish	May 25, 2011 / September 22, 2011
Final Regulatory Walk down – LUCIP and EMP Implementation	September 22, 2011
Previous Five-Year Remedy Reviews	February 4, 2014 / February 2, 2017

Table G-2. RAGW and R-Reactor Building (105-R) Complex ISD Groundwater Monitoring RGs

RAGW Refined COCs	**2018 Maximum Concentration**	**RG (MCL)**	**Units**
Tritium	2.64E+02	2.0E+01	ρCi/mL
TCE	2.2E+01	5.0E00	µg/L
Cis-1,2-Dichloroethylene	17.2E+01	7.0E+01	µg/L
Vinyl Chloride	2.69E00	2.0E+00	µg/L
Carbon Tetrachloride	All Results < Detection Limit	5.0E+00	µg/L
Chloroform	1.5E00	7.0E+01	µg/L
R-Reactor Building Complex ISD Refined Contaminant Migration COCs	**2017 Maximum Concentration**	**RG (MCL or PRG)[c]**	**Units**
Carbon-14	1.41E+02 pCi/L[a]	2.0E+03	ρCi/L
Chlorine-36	All Results < Detection Limit	7.0E+02	ρCi/L
Iodine-129	All Results < Detection Limit	1.0E+01	ρCi/L
Lead	Not Sampled[b]	1.5E+01	µg/L
Molybdenum-93	Not Sampled[b]	1.58E+01[b]	ρCi/L
Nickel-59	Not Sampled[b]	3.0E+02	ρCi/L
Niobium-94	Not Sampled[b]	6.81E00[b]	ρCi/L
Potassium-40	Not Sampled[b]	2.14E00[b]	ρCi/L
PCBs	Not Sampled[b]	5.0E-01	µg/L
Silver-108m	Not Sampled[b]	6.5E00[b]	ρCi/L
Tritium	1.93E+03[d]	2.0E00	ρCi/mL

a = Carbon-14 result observed for the first time in R Area at well RDB 3D near R-Reactor Disassembly Basin.

b = The RAOU EMP Addendum (SRNS 2019a) limited monitoring to the most mobile constituents (carbon-14, chlorine-36, iodine-129, and tritium), which would be the first indications of contamination to the groundwater from R-Reactor post-ISD.

c = EPA Preliminary Remediation Goal (PRG) for Radionuclides Residential Tap Water (December 2016).

d = Highest tritium concentration observed for R-Reactor monitoring wells, previous maximum tritium result for ISD wells was 1,740 ρCi/mL on 3/19/08 at well RPS004C.

COC = Constituent of Concern

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Table G-3. RAOU RCOCs and RGs

RAOU Subunit or PSA		RCOC	Human Health (HH)	Ecological	PTSM	CM	RG	Units	RG Source
R-Reactor Building (105-R) Complex	R Reactor Building (105-R) and Engine Houses (108-1R and 108-2R)	Arsenic	X				1.59E00	mg/kg	PRG
		Aroclor 1254	X			X	5.0E-01	µg/L	MCL
		Americium-241 (+D)	X				7.76E00	ρCi/g	PRG
		Americium-243 (+D)	X				3.44E-01	ρCi/g	PRG
		Cesium-137 (+D)	X		X		1.13E-01	ρCi/g	PRG
		Cobalt-60	X		X		6.02E-02	ρCi/g	PRG
		Lead				X	1.5E+01	µg/L	MCL
		Strontium-90 (+D)	X				1.43E+01	ρCi/g	PRG
	R-Area Disassembly Basin[1]	Cesium-137 (+D)	X		X		1.13E-01	ρCi/g	PRG
		Cobalt-60	X		X		6.02E-02	ρCi/g	PRG
		Europium-154	X		X		8.5E-02	ρCi/g	PRG
		Tritium	X		X		4.23E00	ρCi/g	PRG
	R-Reactor Emergency Basin	Iodine-129				X	1.0E00	ρCi/L	MCL
	R-Reactor Vessel[1]	Barium-133	X		X		3.06E-01	ρCi/g	PRG
		Cesium-137	X		X		1.13E-01	ρCi/g	PRG
		Chlorine-36				X	7.00E+02	ρCi/L	MCL
		Cobalt-60	X		X		6.02E-02	ρCi/g	PRG
		Europium-152	X		X		7.37E-02	ρCi/g	PRG
		Lead				X	1.5E+01	µg/L	MCL
		Molybdenum-93				X	1.42E+01	ρCi/L	PRG
		Nickel-59				X	3.0E+02	ρCi/L	MCL
		Nickel-63	X		X		5.55E+04	ρCi/g	PRG
		Niobium-94	X		X	X	6.13E00	ρCi/L	PRG
		Potssium-40				X	1.93E00	ρCi/L	PRG
		Silver-108m	X		X		3.26E-02	ρCi/g	PRG
Area on North Side of Building 105-R, Laydown Area North of 105-R, and Combined Spills North of Building 105-R (NBN), and Release from the Decontamination of R- Area Reactor Disassembly Basin (NBN), and Potential Release from the R-Area Disassembly Basin Subunits		Cesium-137 (+D)	X				1.0E+01	ρCi/g	Other[2]
R-Area Process Sewer Lines as Abandoned (NBN) Subunit		Radionuclides[3]	X		X		NA	ρCi/g	PRG

Table G-3. RAOU RCOCs and RGs (continued/end)

RAOU Subunit or PSA	RCOC	Human Health (HH)	Ecological	PTSM	CM	RG	Units	RG Source
R-Area Reactor Area Cask Car Railroad Tracks as Abandoned (NBN) Subunit	Cesium-137 (+D),	X		X		1.0E+01	ρCi/g	Other[2]
	Uranium-235 (+D)	X				3.94E-01	ρCi/g	PRG
R-Area Ash Basin (188-R) Subunit	Arsenic	X				1.59E00	mg/kg	PRG
	Potassium-40	X				2.71E-01	ρCi/g	PRG
	Radium-226 (+D)	X				2.55E-02	ρCi/g	PRG
	Uranium-235 (+D)	X				3.94E-01	ρCi/g	PRG
	Uranium-238 (+D)	X				1.79E00	ρCi/g	PRG
R-Area Reactor Groundwater Subunit[4]	Trichloroethylene	X				5.0E00	µg/L	MCL
	cis-1,2-Dichloroethylene	X				7.0E+01	µg/L	MCL
	Vinyl chloride	X				2.0E00	µg/L	MCL
	Carbon tetrachloride	X				5.0E00	µg/L	MCL
	Chloroform	X				7.0E+01	µg/L	MCL
	Tritium	X				2.0E+01	ρCi/mL	MCL
R-Area Isolated Contamination Area PSA	Arsenic	X				1.59E00	mg/kg	PRG
	Cesium-137 (+D)	X				1.12E-01	ρCi/g	PRG
	Cobalt-60	X				5.96E-02	ρCi/g	PRG
	Potassium-40	X				2.71E-01	ρCi/g	PRG
	Radium-226 (+D)	X				2.55E-02	ρCi/g	PRG

1. The HH Risk Assessment and PTSM discussions identify several radiological and hazardous constituents as HH RCOCs or PTSM, but only the major risk drivers for the individual subunits are presented in this table.
2. A concentration of 10 ρCi/g and LUCs established as RG based on Core Team agreement.
3. Radiological constituents are qualitatively identified as HH and PTSM RCOCs based on process history and the potential for fixed residual contamination on the inside surfaces of the R-Area Process Sewer Lines as Abandoned (NBN).
4. These are based on MCLs rather than a HH Risk Assessment evaluation. Only the constituents forming plumes are listed in Table G-3.

MCL = Maximum Contaminant Level
PRG = Preliminary Remediation Goal
NA = Not Applicable
RG = Remedial Goal
CM = Contaminant Migration
PTSM = Principal Threat Source Material

Table G-4. Actual versus Estimated O&M Costs

	FY2015	FY2016	FY2017	FY2018	FY2019	Five-Year Total
Total Actual O&M Costs ($)	307,347	224,923	177,931	123,851	189,340	1,023,392
Total ROD Estimated Direct O&M Costs ($)	62,300	47,300	82,300[1]	47,300	47,300	286,500

[1] FY2017 estimated costs include costs associated with the fifth five-year remedy review. Actual costs were accrued in FY2016.

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Attachment G-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit

I. SITE INFORMATION

Site Name:	**R-Area Operable Unit**	**Date of Inspection:**	**09/12/2019**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**SEMS # 95**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**80°F and clear**

Remedy Includes: *(Click all that apply)*

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

☒ Other ISD by grouting, grouting R-Area PSLs, forced evaporation

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

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** Brian Hanshew (Name) ACP Field Execution Team 2 (Title) 11/05/2019 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4949

Problems/Suggestions: ☐ Report Attached

2. **O&M Staff:** Phil Carter (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 11/05/2019 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4145

Problems/Suggestions: ☐ Report Attached

Attachment G-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued)*

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

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

Agency: ______________________

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

Problems/Suggestions: ☐ Report Attached ______________________

____

Agency: ______________________

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

Problems/Suggestions: ☐ Report Attached ______________________

____

Agency: ______________________

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

Problems/Suggestions: ☐ Report Attached ______________________

____

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

____

____

____

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

1. **O&M Documents:**

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

Remarks: See *Waste Unit Inspection and Maintenance*, ER-SOP-019, *Field Inspection Checklist for RAOU Ash Basin 188-R*, ER-IDS-019-051, *Field Inspection Checklist for the RAOU Reactor Building and Disassembly Basin*, ER-IDS-019-063, and *Field Inspection Checklist for R-Area Operable Unit*, ER-IDS-019-064.

Attachment G-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued)*

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

2. Health and Safety Plans (HASPs):

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

Remarks: Routine O&M activities do not require a Site-Specific Health and Safety Plan (SSHASP) under 29 CFR 1910.1201, Hazardous Waste Operations. A SSHASP is prepared if needed.

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

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

4. Permits and Service Agreements:

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

Remarks:

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

Remarks:

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

Remarks:

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

Remarks:

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

Remarks:

9. Discharge Compliance Records:

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

Remarks:

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

Remarks:

Attachment G-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued)*

IV. O&M COSTS

1. O&M Organization:

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

2. O&M Cost Records:

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place

☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

Total annual cost by year for review period, if available

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

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

Describe costs and reasons: N/A

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

A. Fencing

1. Fencing Damage: ☐ Location shown on site map ☐ Gates secured ☒ N/A

Remarks: OU-specific fencing is not required by the remedial action.

B. Signs

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

Remarks: Signs at this site are in good condition.

Attachment G-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

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

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Once every five year
Responsible Party/Agent: USDOE Savannah River Field Office
Contact: Phil Prater (Name) RCRA/Remedial Program Manager (Title) 12/09/19 (Date) 803-952-9333 (Phone No.)

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

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

2. Adequacy: ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks: The ICs are adequately maintaining the RAOU protective systems. When maintenance activities are identified during inspections (e.g., woody vegetation removal from the roof), repairs are scheduled and performed.

D. General

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

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

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

Attachment G-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued)*

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

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

B. Other Site Conditions

Remarks:______________________________
.______________________________

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

A. Landfill Surface

1. Settlement (Low spots)**:** ☐ Location shown on site map ☒ Settlement not evident
Areal extent__________ Depth__________
Remarks:______________________________

2. Cracks: ☐ Location shown on site map ☒ Cracking not evident
Lengths__________ Widths__________ Depths__________
Remarks: No cracking evident that would impact the low-permeable barrier. Cracking evident in the concrete cover of the disassembly basin does not impact the protectiveness of the remedy.

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

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

5. Vegetative Cover: ☐ Grass ☒ Cover properly established ☐ No signs of stress
Areal extent__________ Depth__________
Remarks:______________________________

Attachment G-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued)*

VII. LANDFILL COVER/CONTAINMENT *(Continued)*

6. Alternative Cover (armored rock, concrete, etc.): ☒ Applicable ☐ N/A
Remarks: Concrete Cover system

7. Bulges: ☐ Location shown on site map ☒ Bulges not evident
Areal extent__________________ Depth_____________________
Remarks:____

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

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

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

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

D. Cover Penetrations ☐ Applicable ☒ N/A

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

F. Cover Drainage Layer ☐ Applicable ☒ N/A

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

H. Retaining Walls ☐ Applicable ☒ N/A

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

Attachment G-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued)*

VIII. VERTICAL BARRIER WALLS ☐ **Applicable** ☒ **N/A**

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

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

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

C. Treatment System ☐ Applicable ☒ N/A

D. Monitoring Data ☒ Applicable ☐ N/A

E. Monitored Natural Attenuation ☒ Applicable ☐ N/A

1.

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

Remarks:____

____

X. OTHER REMEDIES

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

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

Attachment G-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued/end)*

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

The remedial action for RAOU includes MNA, ISD, cover system, and LUCs to prevent exposure to contaminated groundwater above MCLs. The remedy is fully established and functioning as designed.

B. Adequacy of O&M

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

The O&M procedures consisting of annual site inspections and site maintenance (vegetation removal, structures integrity and warning signs) and site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the waste unit) have been implemented. The O&M procedures are adequately maintaining the RAOU and the condition of its warning signs is good. There are no issues that impact the protectiveness of the remedy that require corrective actions.

C. Early Indicators of Potential Remedy Failure

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

N/A

D. Opportunities for Optimization

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

N/A

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R-AREA REACTOR SEEPAGE BASINS (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) AND 108-4R OVERFLOW BASIN OPERABLE UNIT

I. Introduction

This report is the fourth five-year remedy review for the R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin (RRSB) Operable Unit (OU). Contaminants have been left in place at the RRSB OU at levels that do not allow for unlimited use and unrestricted exposure. The review was conducted from August 2019 through November 2019. The purpose of this review is to determine whether the remedy in place at the RRSB OU is protective of human health and the environment. This report documents the results of the review.

II. OU Chronology

Table H-1 lists the chronology of site events for the RRSB OU.

III. Background

RRSB OU is listed as a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) unit in Appendix C of the Federal Facility Agreement (FFA) for Savannah River Site (SRS) (FFA 1993). The media associated with the RRSB OU are soil and groundwater.

The RRSB OU consists of the following: six seepage basins, process sewer lines, sanitary sewer system (sewer lines and sanitary discharge lagoon), an area of contaminated vegetation north of R-Reactor Building (105-R), surface water and sediment, RRSB groundwater, and the 108-4R Overflow Basin.

Physical Characteristics

R Area is located in the east-central portion of SRS, west of PAR Pond (Figure H-1). The RRSB OU is located north of the R-Reactor Building (105-R) (Figure H-2) and straddles the boundary between the Upper Three Runs and Lower Three Runs watersheds. Prior to initiation of remedial actions, the entire area, 11 hectares (27 acres), was fenced and approximately 45%, 5 hectares (12 acres), was paved.

Six unlined earthen basins were constructed to receive radioactively contaminated purge water from R-Reactor's spent fuel storage process. All six basins were constructed between June 1957 and March 1958. The basins varied in depth from 2 to 4.9 m (6.6 ft to 16.4 ft) below ground surface. Basin 1 was L-shaped, with each leg approximately 60 m (200 ft) long by 12 m (40 ft) wide. Basin 2 was 60 m (200 ft) long by 15 m (50 ft) wide. Basin 3 was 90 m (300 ft) long by 9 m (30 ft) wide. Basin 4 was 97.5 m (325 ft) long by 9 m (30 ft) wide. Basin 5 was 112.5 m (375 ft) long by 12 m (40 ft) wide. Basin 6 was 165 m (550 ft) long by 15 m (50 ft) wide (WSRC 1997).

Process sewer lines conveyed process water from the R-Reactor disassembly basin to the six seepage basins. The pipelines to Basins 1 through 5 were 7.5-cm (3-in) polyvinyl chloride (554 m [1,848 ft] in total length) and the pipeline to Basin 6 was 10-cm (4-in) steel (340.5 m [1,135 ft] in total length) (WSRC 1997).

A 15-cm (6-in) and 30-cm (12-in) terra cotta sanitary sewer line that supported a housing camp during construction of the R-Reactor extended through the RRSB OU to convey wastewater to a sanitary discharge lagoon (WSRC 1997).

Three small surface areas, called the eastern, western, and northern contamination areas, were contaminated near the basins ranging in size respectively [6 x 12 m (20 x 40 ft), 4.5 x 9 m (15 x 30 ft), and 3.6 x 4.5 m (12 x 15 ft)] (SRNS 2008).

The 108-4R Overflow Basin is located 75 m (250 ft) southwest of the R-Reactor and approximately 150 m (500 ft) southwest of R-Reactor Seepage Basins. The basin was constructed to collect overflow from two adjacent underground storage tanks (USTs) within a vault (108-3R) that stored diesel fuel for standby generators in the R Reactor. The unlined basin was approximately 18 m x 18 m x 2.4 m (60 ft x 60 ft x 8 ft) deep. A soil berm up to 0.6 m (2 ft) above grade was placed around the basin's perimeter. The USTs were removed in March 1990 and the associated piping was abandoned in place after being flushed and purged as directed by South Carolina Department of Health and Environmental Control (SCDHEC).

The RRSBs lie north of and adjacent to R-Reactor on an elevated divide between Mill Creek and the primary discharge canal northeast of the R-Area perimeter fence (Figure H-2). The OU is situated between drainage to PAR Pond located 2.7 km (1.7 mi) to the southeast (beyond the boundaries of the figure) and the headwaters of Mill Creek located 0.4 km (0.25 mi) to the northwest. The western edge of the basin area slopes towards the west. Surface water drainage from the RRSB OU flows north and west into Mill Creek or east into the R-Area Discharge Canal and Pond A.

Groundwater in the shallow water table aquifer, a horizon of the Upper Aquifer Zone of the Upper Three Runs Aquifer, has been contaminated. Historically, large fluctuations in the water table elevation occur as a result of changes in precipitation, resulting in occurrences of groundwater coming close to or in contact with contamination in the bottom of the basins. Groundwater flow is primarily vertical from the A to AA horizon to the Transmissive Zone, where flow becomes more lateral and moves radially away from the basins. A review of water table elevations from the currently monitored wells indicate increasing levels since the last five-year remedy review, which is consistent with the increased rainfall since then.

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 RRSB OU as being within the site industrial support area. The future land use for RRSB OU is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

History of Contamination

The six basins received an estimated 5-million gallons of purge water, containing approximately 3,276 Ci total activity, from the R-Reactor disassembly basin. Primary radionuclides present were strontium-90, cesium-137, and tritium. A non-routine discharge, due to a calorimeter test failure in 1957, released approximately 2,700 Ci of radionuclides primarily to Basin 1 with Basins 2 through 5 receiving a lesser amount. A sanitary sewer system was breached during the construction of Basins 1 and 5 and received the contaminated water discharged to the basins (WSRC 1997).

Basins 1 through 5 were retired and backfilled during the period 1958 through 1959. The backfill operation involved placement of clean soil followed by a cover of a thin asphalt emulsion to restrict the infiltration of surface water and to inhibit the growth of vegetation. Between 1960 and 1963, clay dikes were placed around Basin 1 and the northwest end of Basin 3. The dikes extended down to a clay layer at an approximate depth of 4.5 m (15 ft) and 2.4 m (8 ft) at Basins 1 and 3, respectively. Clay caps were then placed over the diked areas to control exposure to radioactively contaminated surface soils and infiltration of surface water (WSRC 1997). Basin 6 was retired in 1964, when operations at R-Reactor ceased. In 1977, this basin was backfilled with soil and covered with a thin asphalt emulsion (WSRC 1997).

In 1996, the asphalt emulsion over all the basins was determined to be contaminated with radioactive soil, vegetation, and fire ant mounds. The surface contamination was being spread by surface water runoff and wind (WSRC 1997). Figure H-3 shows a photograph of one of the basins prior to any remedial action.

The 108-4R Overflow Basin was in operation from 1953 to 1964. The USTs were removed in March 1990, and associated piping was abandoned in place after being flushed and purged to less than 20 percent of the lower explosive limit as directed by SCDHEC. Soil and groundwater samples taken during excavation of the USTs indicated no detectable levels of contamination. The groundwater samples were collected from groundwater that seeped into the excavation (WSRC 1990).

Initial Response

The *Removal Site Evaluation Report for the R-Reactor Seepage Basin, Erosion Control Activities and Asphalt Cover Refurbishment* (WSRC 1996) determined that the spread of contamination due to the deteriorated condition of the asphalt emulsion cover warranted action. A removal action was performed during the summer of 1996, which included a

4.34-hectare (10.7-acre) cover system over the existing asphalt emulsion. The cover system consisted of a 10-cm (4-inch) thick layer of asphalt over 0.45 m (1.5 ft) minimum thick layer of clean soil. Prior to the cover system installation, the surfaces of the basins were treated with herbicides and insecticides, and the surface was recontoured to promote drainage.

Basis for Taking Action

Because of the large quantity of radioactivity in the historical releases, it was concluded that the subsurface soil associated with the basin bottoms, the process sewer lines, and the contaminated sections of the sanitary sewer line should be considered principal threat source material (PTSM). Final contaminants of concern (COCs) and associated remedial goals (RGs) were developed for the RRSB (WSRC 2002, 2003) (Table H-2).

The 108-4R Overflow Basin, Surface Water, and Sediment subunits were characterized under a separate soil investigation from February to April 1996. No final COCs were identified for soil or groundwater. Therefore, there is no problem warranting action at the 108-4R Overflow Basin, surface water, and sediment. With approval of SCDHEC and U.S. Environmental Protection Agency (USEPA), this subunit was backfilled and covered by a vegetative layer.

The basis for taking action was due to potential exposure of residents or industrial workers to unacceptable levels of carcinogenic contaminants in soils and groundwater, and due to the potential continuing impact to groundwater due to leaching from contaminated soils. Risks were highest for exposures to soils attributable to the presence of multiple radionuclides, including cesium-137 and strontium-90. Potential risks associated with exposure to groundwater are attributed to the presence of strontium-90. No ecological risks were associated with this OU.

IV. Remedial Actions

Remedy Selection

As stated in the Record of Decision (ROD) (WSRC 2003), the selected remedial action for the RRSB OU is placement of a reinforced concrete intruder barrier system with granite monuments over the PTSM, excavation of PTSM outside of the boundary fence and disposal on-unit, excavation and on-unit disposal of contaminated vegetation, installation of an asphalt bioturbation barrier, mixing zone for groundwater, and institutional controls. The RGs for groundwater COCs are based on achieving their respective maximum contaminant level (MCL) values in all monitoring wells.

As stated in the ROD (WSRC 2003), the remedial action objectives (RAOs) for the four RRSB OU subunits that require remedial actions include the following:

Seepage Basins

- Minimize transport of soil contaminants to groundwater above MCLs;
- Prevent industrial worker exposure to contamination (including contaminated vegetation) in the long-term;
- Consider treatment or removal to address PTSM to the extent practicable; and
- Prevent residential development within the RRSB OU and any exposure to basin contents.

Abandoned Process Sewer Lines

- Prevent industrial worker exposure to the pipelines;
- Consider treatment alternatives to address PTSM (pipelines) to the extent practicable; and
- Prevent residential development within the OU and any exposure to the pipelines.

Sanitary Sewer System

- Prevent industrial worker exposure to the sanitary sewer lines and associated subsurface soil contaminants;

- Prevent industrial worker exposure to contaminated vegetation;
- Prevent future transfer of subsurface soil contaminants towards the surface through biotic uptake or bioturbation;
- Consider treatment alternatives to address PTSM (sanitary sewer line) to the extent practicable; and
- Prevent residential development within the OU and any exposure to the sewer lines.

Groundwater

- Prevent industrial worker exposure to groundwater contaminated above MCLs.
- Reduce strontium-90 concentrations in groundwater to below MCLs.
- Minimize the spread of groundwater contamination and prevent discharge of contaminated groundwater to surface water; and
- Prevent residential development within the OU and any exposure to contaminated groundwater.

Remedy Implementation

Implementation of these remedial actions included the following activities (SRNS 2008):

- Consolidated PTSM in a PTSM Waste Trench, which included excavation of all contaminated process and sanitary sewer lines, and associated soil located outside of the OU boundary, and contaminated soils in the contamination areas (Cas). The PTSM consisted of approximately 230 m^3 (300 yd^3) of process pipes and associated soil, 54 m^3 (70 yd^3) of soil from the three CAs, seven 208-L (55-gallon) drums of solidified residual water collected from the process sewer lines and five thrust blocks (0.6 m x 0.6 m x 0.6 m [2 ft x 2 ft x 2 ft]). The CAs were backfilled using adjacent soils (in two CAs) or common fill (in one CA). Where practical, the pipes were grouted prior to removal to contain contaminants. The excavated areas were backfilled with clean fill material.

- Consolidated contaminated trees from the RRSB OU and the Warner's Pond OU, secondary waste and track hoe in areas where contaminated vegetation had grown. The contaminated trees were cut down, chipped, stockpiled, composted, and blended with the first foot of soil where contaminated vegetation had previously grown. The secondary waste consisted of pre-existing concrete markers, galvanized corrugated metal pipe and miscellaneous job control waste and personal protective equipment.
- Installed a concrete intruder barrier covering 2.2 hectares (5.5 acres) over all PTSM located in all six basins, the PTSM Waste Trench, and the process sewer lines inside the boundary fence (Figures H-2 and H-4). The barrier consisted of a 15-cm (6-in) minimum reinforced concrete placed directly on the existing asphalt cover or over a 15-cm (6-in) minimum thick layer of clean, compacted structural fill on soils and newly placed asphalt. The barrier extended 3 m (10 ft) beyond the edge of the PTSM.
- Installed an asphalt bioturbation barrier covering 5.1 hectares (12.6 acres) where contaminated vegetation had previously grown (Figures H-2 and H-4). The barrier consists of a 10-cm (4-in) minimum thick asphalt layer over a 15-cm (6-in) minimum thick layer of clean, compacted structural fill. The barrier extended 6 m (20 ft) beyond the edge of the area.
- Installed five granite monuments on the concrete intruder barrier to warn future inadvertent intruders.
- Established a mixing zone monitoring well network by installing 15 monitoring wells and abandoning 30 existing monitoring wells.
- Installed 23 access control warning signs and fencing along the perimeter of the RRSB OU.
- Established land use controls (LUCs) for 15.3 hectares (37.8 acres) including: 1) requiring a Site Use and Site Clearance Permit for any proposed use of land within the OU area, which is applicable to all activities and personnel on site; 2) maintaining the site access controls (24-hour surveillance system, artificial and

natural barriers, control entry systems, and warning signs) in place at the SRS boundary to comply with the security requirements for a Resource Conservation and Recovery Act-permitted facility; and 3) in the long-term, if the property ever is transferred to non-federal ownership, the US Government will take those actions necessary pursuant to Section 120(h) of CERCLA. Those actions will include a deed notification disclosing former waste management and disposal activities as well as remedial actions taken on the site (WSRC 2003).

System Operations/Operation and Maintenance

There are no system operational requirements.

The following maintenance activities are ongoing:

- Groundwater mixing zone monitoring program has been implemented. Groundwater Mixing Zone Reports were being issued biennially through 2014, with the first report submitted in August 2010 (SRNS 2010, SRNS 2012, SRNS 2014). After 2014, reports are to be submitted every four years (2018, 2022, etc.), with letter reports submitted in between (2016, 2020, etc.). One letter report (SRNS 2016) and one Groundwater Mixing Zone Report (SRNS 2018) have been submitted since the last five-year remedy review. Groundwater is being monitored for strontium-90, americium-241 (well RSE 26DL), and water elevation.
- Annual site inspections and site maintenance (i.e., intruder and bioturbation barriers maintenance, repair of erosion damage, fencing and warning signs) (WSRC 2008). Minor repairs (e.g., seal small cracks, remove vegetation growth) to the RRSB bioturbation asphalt barrier are completed soon after discovery. Major repairs (e.g., complete asphalt resurfacing) are anticipated approximately every fifth year.
- Site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the waste unit) have been implemented.

Costs associated with the selected remedy for RRSB include operation and maintenance (O&M) costs of the cover, groundwater mixing zone monitoring, and institutional controls (i.e., LUCs). The ROD estimated O&M cost, including Five-Year Remedy Review costs, associated with the selected remedy is $19,145,000, which was discounted at 3.9% per year (WSRC 2003). This is a present worth cost, including 30 years of maintenance activities. The estimated O&M costs applicable to FY2015 through FY2019 are $2,652,242. The actual O&M cost from FY2015 to FY2019 is $503,459. The actual O&M costs (Table H-3) are less than estimated costs due to optimization of the groundwater monitoring. Based on inspections conducted from FY2015 through FY2019, the various maintenance activities completed at RRSB OU included sealing asphalt, applying herbicide to vegetation (i.e., on fence, in expansion joints on cover, and both sediment basins), cutting vegetation in sediment basins, and treating active ant mounds.

V. Progress Since Last Review

This is the fourth five-year remedy review for the RRSB OU. The previous protectiveness statement concluded that because the remedial actions of LUCs is protective, the RRSB OU is protective of human health and the environment.

There were no recommendations for 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;
- Evaluated the mixing zone to ensure that the contamination has not migrated beyond its established boundaries and the progress of radioactive decay in bringing contamination below MCLs. This process is calculated to take approximately 300 to 400 years (WSRC 2003);
- Confirmed the implementation of the remedial action;
- 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

- Reviewed changes in standards and to-be-considered guidance

Data Review

Per the approved 2012/2013 Groundwater Mixing Zone Report (SRNS 2014) and subsequent modifications (USEPA 2014) groundwater is monitored for strontium-90, americium-241 (well RSE 26DL), and water elevation. Concentrations of strontium-90 in all wells have been below their mixing zone concentration limits since the mixing zone was established in 2007, except for one result at well RSE 10 (Figure H-5). However, that elevated result is attributed to excessive turbidity in the well. Americium-241 was non-detect during the last two sampling events. If the concentration of americium-241 in well RSE 26DL remains non-detect during the 2019 sampling event, the next groundwater mixing zone report for RRSB will include a recommendation to remove americium-241 from the list of monitored analytes. Removal of americium-241 from the analyte list will occur with concurrence by USEPA and SCDHEC.

The boundary well data was reviewed and no confirmed MCL exceedances for strontium-90 have been evaluated since the previous five-year remedy review. This is consistent with the groundwater modeling predictions and uncertainty analysis that were the basis for the groundwater mixing zone application that predicted the strontium-90 plume to diminish over time, be relatively stationary, and not move significantly in any direction (WSRC 2004). The selected remedy of monitored natural attenuation (MNA) by radioactive decay is effective in reducing strontium-90 concentrations in the groundwater. The mixing zone groundwater data verifies that groundwater does not exceed MCLs at the compliance points (boundary monitoring wells). Per the ROD, the mixing zone is monitored to ensure that the contamination does not migrate beyond its established boundaries and to follow the progress of radioactive decay in bringing contamination to MCLs. This process is calculated to take approximately 300 to 400 years (WSRC 2003).

Summary of Inspections and Interviews

Interviews were conducted with Phil Carter, O&M staff member, and Brian Hanshew, O&M Site Manager, on November 5, 2019 at the O&M organization offices. No issues were identified for the RRSB OU during these interviews. The RRSB OU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) Environmental Compliance and Area Completion Projects (EC&ACP) on October 22, 2019. No issues were identified during these inspections.

The RRSB OU was inspected by SRNS EC&ACP and USDOE personnel on December 9, 2019. No issues that impact the protectiveness of the remedy were identified for the RRSB OU during this inspection.

A site inspection was conducted by USEPA and SCDHEC personnel, accompanied by USDOE and SRNS personnel on February 27, 2020. No significant problems regarding this OU were identified during the inspection.

VII. Technical Assessment

Is the Remedy Functioning as Intended by the Decision Document?

The remedies selected for the RRSB OU are functioning as intended, as demonstrated below:

The review of documents, applicable or relevant and appropriate requirements, risk assumptions, and the results of the site inspection indicates that the remedy is functioning as intended by the ROD. The consolidation of PTSM and contaminated trees and materials from RRSB OU and Warner’s Pond OU, followed by placement of a concrete intruder barrier over PTSM contaminated materials and process sewer lines within the boundary fence is effective in preventing industrial worker exposure to contamination. This remedy component is minimizing rainwater infiltration, thus preventing the mobilization of contaminant migration COCs to groundwater above MCLs. The remedy component of MNA by radioactive decay is effective in reducing strontium-90 concentrations in the groundwater. The mixing zone groundwater data verifies that groundwater has not exceeded MCLs at the compliance points (boundary monitoring wells). The remedial action has achieved the RAOs for this OU. The effective implementation of institutional controls (i.e., LUCs) has prevented exposure to contaminated materials (i.e., soil, pipelines, vegetation) that remain beneath the cover system.

The LUCs that are in place include (1) physical access controls to prevent unauthorized entry to SRS and the OU (fences, guards, security patrols, etc.); (2) administrative controls that maintain the OU for industrial use only (SRS is a secured government facility with land use restrictions); and (3) fencing, warning signs and LUCs (SRS Site Use/Site Clearance Program). The *Land Use Control Implementation Plan for RRSB OU* governs LUC implementation, maintenance, monitoring, reporting, and enforcement of LUCs (WSRC 2008). 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, toxicity data, cleanup levels, and RAOs used at the time of remedy selection are still valid. There have been no changes in standards or physical conditions of the RRSB OU that would affect the protectiveness of the remedy.

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 at the RRSB OU from being protective.

IX. Recommendations and Follow-up Actions

There are no recommendations and follow-up actions concerning RRSB OU

X. Protectiveness Statements

The remedy at the RRSB 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 soil at the RRSB OU have been addressed through excavation, consolidation, backfilling of excavated areas, and implementation of physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the RRSB OU for industrial use only, and warning signs and use restrictions via the SRS Site Use/Site Clearance Program.

XI. Next Review

As shown in Appendix A, Table A-1, the next five-year remedy review for SRS OUs with Groundwater Remedies is scheduled for January 2026.

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, 2008. *Post-Construction Report for the R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) Operable Unit (U)*, WSRC-RP-2005-4070, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010. *2009 Biennial Groundwater Mixing Zone Report for the R-Area Reactor Seepage Basins and 108-4R Overflow Basin Operable Unit (U),* SRNS-RP-2010-00999, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2012. *2011 Biennial Groundwater Mixing Zone Report for the R-Area Reactor Seepage Basins and 108-4R Overflow Basin Operable Unit (U),* SRNS-RP-2012-00349, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2014. *2012/2013 Groundwater Mixing Zone Report for the R-Area Reactor Seepage Basins and 108-4R Overflow Basin Operable Unit (U),* SRNS-RP-2014-00318, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2016. *Groundwater Mixing Zone Sampling Summary Report for the R-Area Reactor Seepage Basin / 108-4R Overflow Basin Operable Unit 2015 (U),* IACD-16-133, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2018. *Groundwater Mixing Zone Report for the R-Area Reactor Seepage Basins and 108-4R Overflow Basin Operable Unit (U)*, SRNS-RP-2018-00625, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

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

USEPA, 2014. Letter, J. Richards (USEPA) to B.T. Hennessey (USDOE), dated September 10, 2014, *SUBJECT: EPA Review of 2012/2013 Groundwater Mixing Zone Report for the R-Area Reactor Seepage Basins / 108-4R Overflow Basin OU, CERCLIS Number: 25, SRNS-RP-2014-00318, Revision 0, dated June 2014, Savannah River Site NPL Site, South Carolina SC1 890 008 989*, U.S. Environmental Protection Agency, Atlanta, GA

WSRC, 1990. *Site Assessment of the 108-R Underground Storage Tank System at the Savannah River Site*, under cover from J.V. Odum to J.R. Hess (SCDHEC), ESH-FSG-900260, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC.

WSRC, 1996. *Removal Site Evaluation Report for the R Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) Erosion Control Activities and Asphalt Cover Refurbishment (U)*, WSRC-RP-96-141, Revision 1, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 1997. *Preliminary Characterization Report Phase 1 RFI/RI for the R-Reactor Seepage Basins/108-4R Overflow Basin (U)*, WSRC-RP-97-196, Revision 0, Westinghouse Savannah River Company 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 revision, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC, 2002. *RCRA Facility Investigation/Remedial Investigation Report with Baseline Risk Assessment for the R-Area Reactor Seepage Basins/ 108-4R Overflow Basin Operable Unit (U)*, WSRC-RP-98-314, Revision 1.2, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2003. *Record of Decision for the R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin Operable Unit (U)*, WSRC-RP-2003-4093, Revision 1, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2004. *R-Area Reactor Seepage Basins and 108-4R Overflow Basin Operable Unit Mixing Zone (U)*, WSRC-RP-2002-4053, Revision 1.2, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2008. *Land Use Control Implementation Plan for the R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) Operable Unit (U)*, WSRC-RP-2004-4032, Revision 1.1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

Various - Inspection Data Sheets – *Field Inspection Checklist, R-Reactor Seepage Basins 904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G (U)*, ER-IDS-019-048, Inspection period 2015 through 2018 (annually)

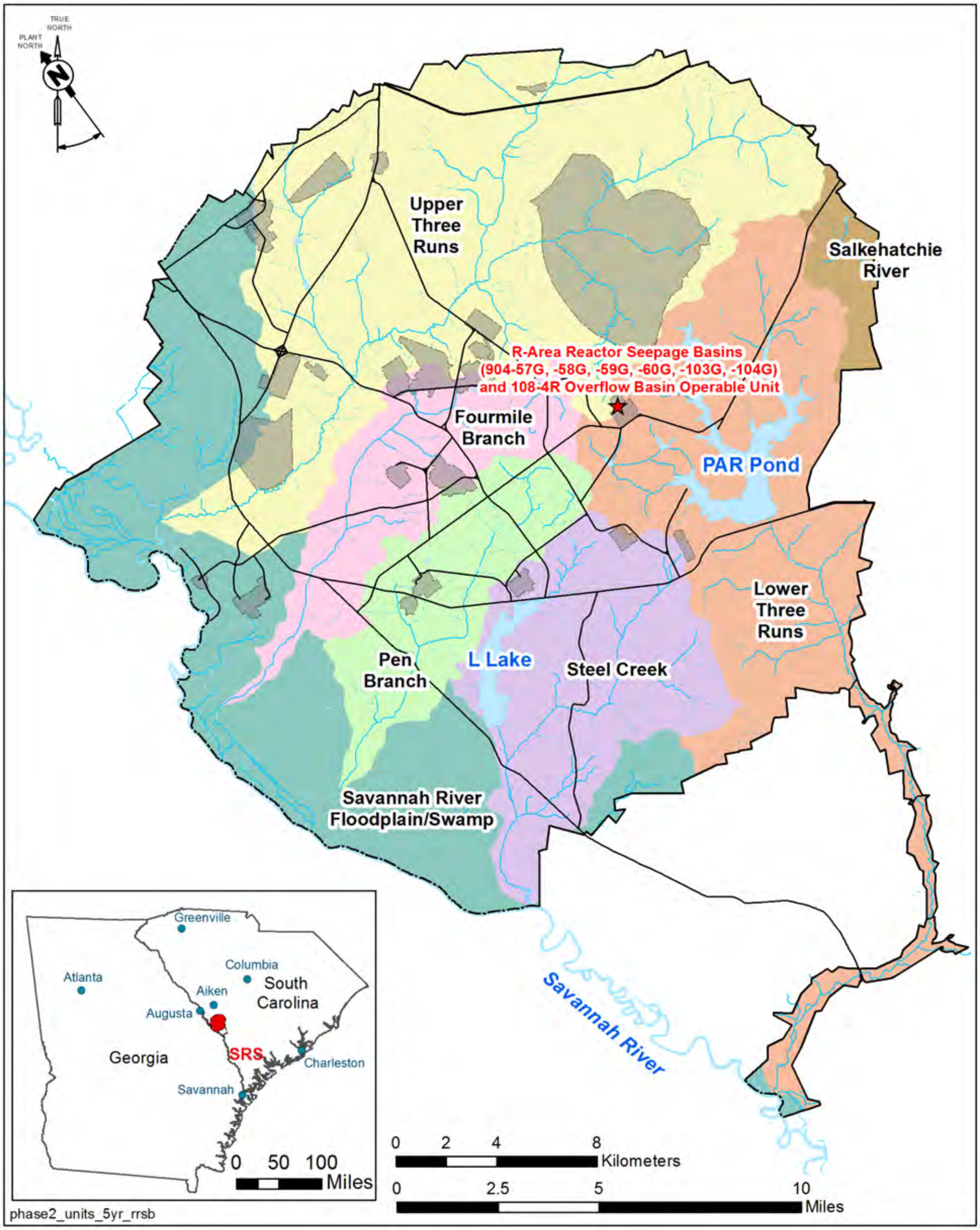

Figure H-1. **Location of R-Area Reactor Seepage Basins Operable Unit at SRS**

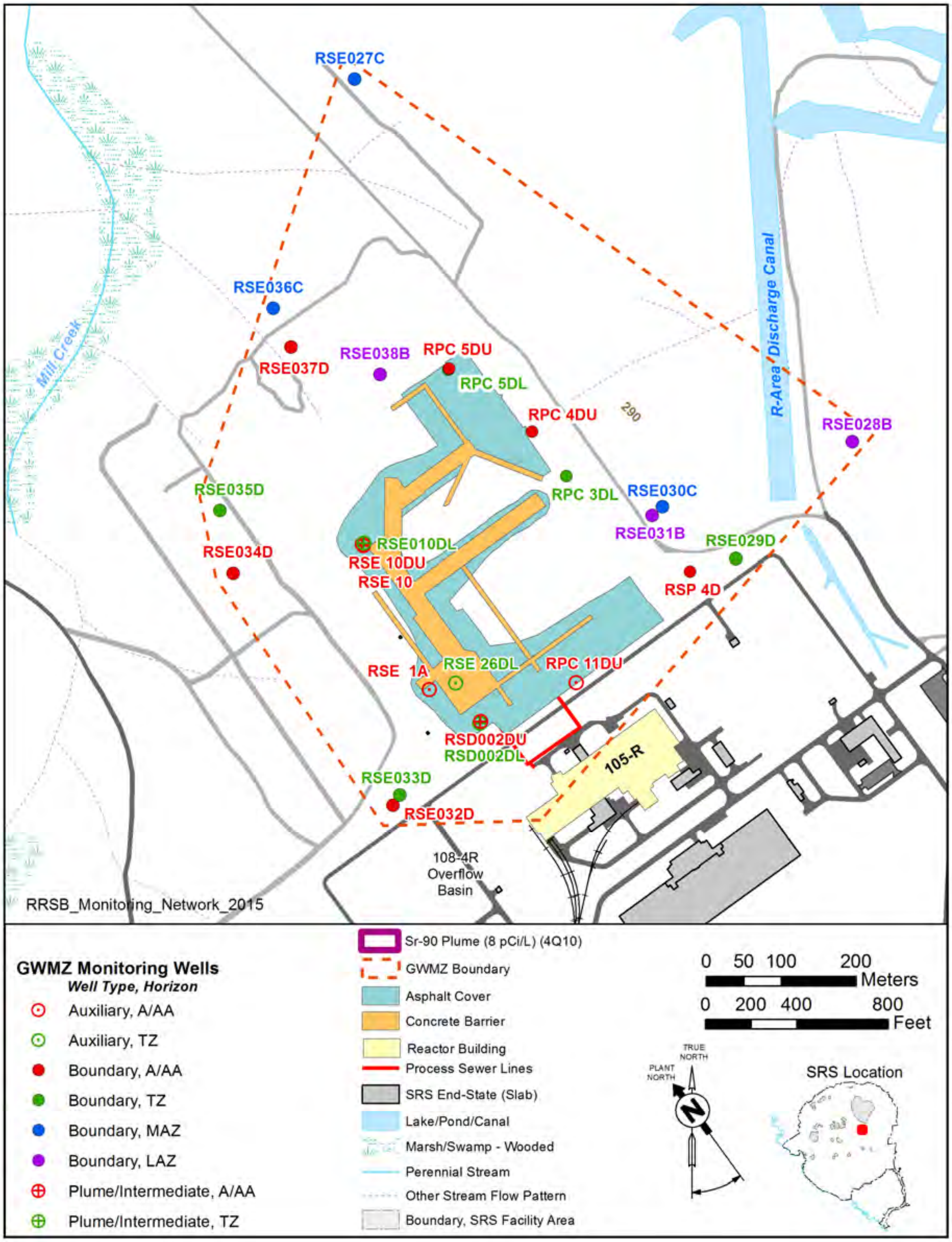

Figure H-2. Current Layout of the RRSB OU with Monitoring Well Network

Figure H-3. Photograph of the R-Reactor Seepage Basins Prior to ROD Approved Remedial Action (exact date unknown)

Figure H-4. Current Aerial Photo of the R-Reactor Seepage Basins OU (2017)

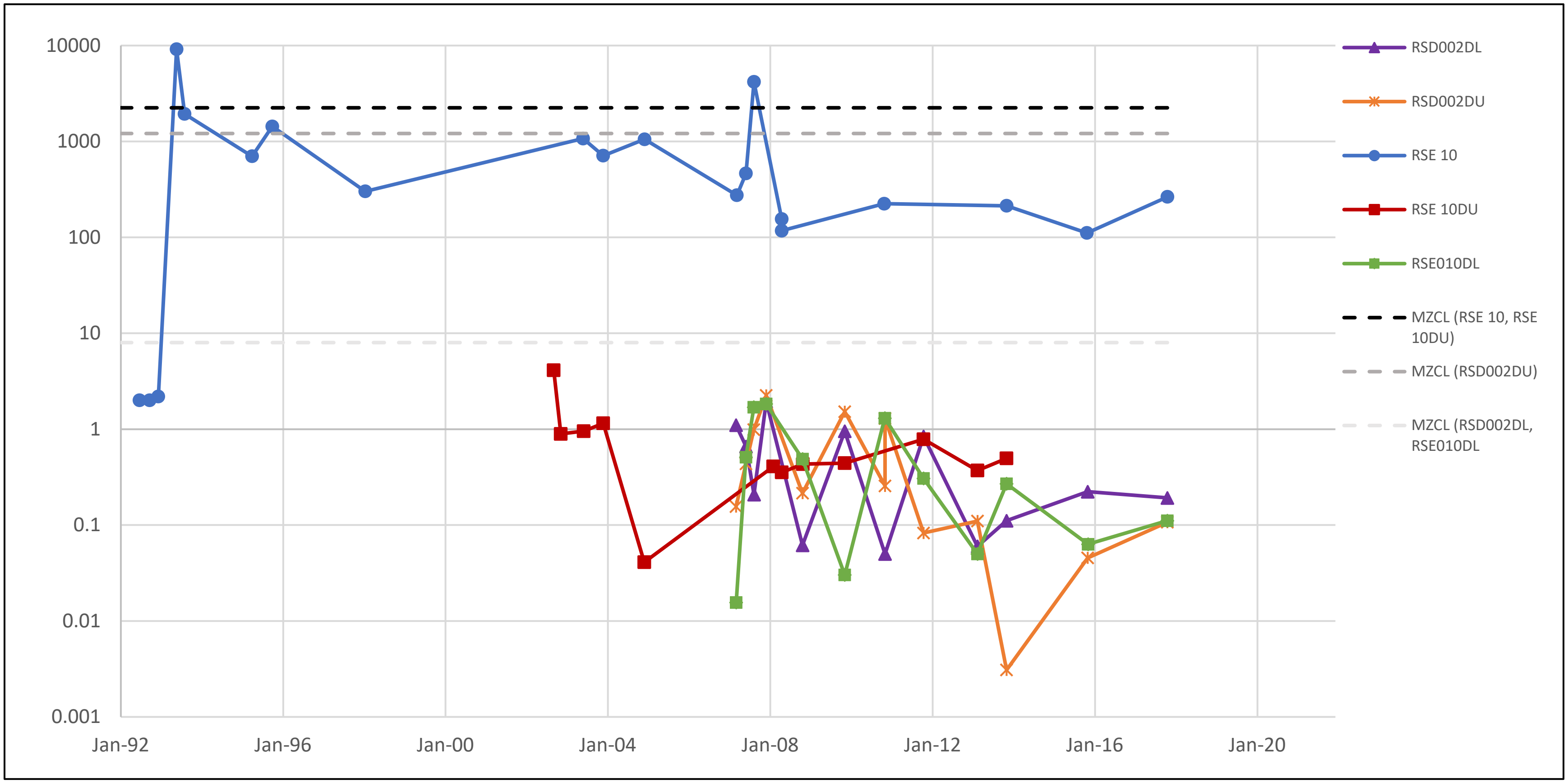

Figure H-5. Strontium-90 Time Trend Data for RRSB Plume/Intermediate Wells

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Table H-1. Chronology of OU Events

Event	Date
RFI/RI Field Start / Complete	1995 / 2000
Removal Action and Asphalt Cover Completed	1996
Corrective Measures Study /Feasibility Study Rev 1 Submittal	January 30, 2003
ROD Issuance	March 18, 2004
Remedial Action Start / Complete	March 4, 2005 / January 30, 2008
Previous Five-Year Remedy Review	February 4, 2009 / February 4, 2014 / February 2, 2017

Table H-2. Final COCs and RGs for 1E-06 Risk to Industrial Worker at RRSB OU

Medium	Final COC	CM RG	HH RG	ECO RG (Earthworm)
Surface Soil	Cesium-137	none	1.05E-01 ρCi/g	none
Subsurface Soil	Americium-241	none	7.75E00 ρCi/g	3.32E00 ρCi/g
	Cesium -137	none	1.05E-01 ρCi/g	2.22E+03 ρCi/g
	Cobalt-60	none	2.25E-02 ρCi/g	none
	Plutonium-238	none	1.04E+01 ρCi/g	none
	Plutonium -239/240	none	9.69E00 ρCi/g	none
	Strontium-90	none	5.65E+01 ρCi/g	2.42E+03 ρCi/g
Total Soil Profile	Americium-241	5.32E-02 ρCi/g	none	none
	Carbon-14	4.08E00 ρCi/g	none	none
	Plutonium -239/240	1.38E-02ρCi/g	none	none
	Strontium-90	5.32E-02 ρCi/g	none	none
Groundwater	Americium-241	none	4.88E-01 ρCi/L	none
	Strontium-90	none	2.86E00 ρCi/L	none

Notes: CM – Contaminant Migration
HH – Human Health
ECO - Ecological

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

	FY2015	FY2016	FY2017	FY2018	FY2019	Five-Year Total
Total Actual O&M Costs ($)	269,127	91,208	28,739	65,063	49,322	503,459
Total ROD Estimated Direct O&M Costs ($)	527,786	527,786	541,098[1]	527,786	527,786	2,652,242

[1] FY2017 estimated costs include costs associated with the fifth five-year remedy review. Actual costs for the fifth five-year remedy review occurred in 2017.

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Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin Operable Unit

I. SITE INFORMATION

Site Name:	**R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin Operable Unit**	**Date of Inspection:**	**10/22/2019**
Location and Region	**SRS, USEPA Region 4**	**EPA ID:**	**SEMS #25**
Agency, Office, or Company leading the Five-Year Review	**USDOE**	**Weather/ Temperature**	**91°F and partly sunny**

Remedy Includes: *(Click all that apply)*

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

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

☒ Other Mixing Zone (groundwater); Excavation/Consolidation of process and sanitary sewer lines

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

II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** Brian Hanshew (Name) ACP Field Execution Team 2 (Title) 11/05/2019 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4949

Problems/Suggestions: ☐ Report Attached

2. **O&M Staff:** Phil Carter (Name) ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 11/05/2019 (Date)

Interviewed: ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4145

Problems/Suggestions: ☐ Report Attached

Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin Operable Unit *(continued)*

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

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

Agency: ______________________

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

Problems/Suggestions: ☐ Report Attached ______________________

____

Agency: ______________________

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

Problems/Suggestions: ☐ Report Attached ______________________

____

Agency: ______________________

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

Problems/Suggestions: ☐ Report Attached ______________________

____

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

____

____

____

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

1. **O&M Documents:**

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

Remarks: Annual site inspections are performed per SRS procedure ER-SOP-019, *Waste Unit Inspection and Maintenance*, and ER-IDS-019-048, *Field Inspection Checklist for the RRSB.*

Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin Operable Unit *(continued)*

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

2. Health and Safety Plans (HASPs):

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

Remarks: Routine O&M activities do not require a Site-Specific Health and Safety Plan (SSHASP) under 29 CFR 1910.1201, Hazardous Waste Operations. A SSHASP is prepared if needed.

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

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

4. Permits and Service Agreements:

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

Remarks:

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

Remarks:

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

Remarks:

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

Remarks:

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

Remarks:

9. Discharge Compliance Records:

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

Remarks:

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

Remarks:

Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin Operable Unit *(continued)*

IV. O&M COSTS

1. O&M Organization:

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

2. O&M Cost Records:

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

Total annual cost by year for review period, if available

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

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

Describe costs and reasons: N/A

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

A. Fencing

1. Fencing Damage: ☒ Location shown on site map ☒ Gates secured ☐ N/A

Remarks: OU-specific perimeter fencing is required by the remedial action. Perimeter fencing is in good condition.

B. Signs

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

Remarks: Signs at this site are in good condition.

Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin Operable Unit *(continued)*

V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)*

C. Institutional Controls

1. Implementation and Enforcement

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

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Once every five years
Responsible Party/Agent: USDOE Savannah River Field Office
Contact: Phil Prater (Name) DOE Program Manager (Title) 12/09/19 (Date) 803-952-9333 (Phone No.)

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

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

2. Adequacy: ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks: The ICs are adequately maintaining the RRSB protective systems. When maintenance activities are identified during inspections (e.g., repairing holes and concrete spalling, vegetation removal from the cover system), repairs are scheduled and performed.

D. General

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

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

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

Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin Operable Unit *(continued)*

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

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

B. Other Site Conditions: Annual site inspections conducted from 2015 and 2018 identified the presence of overgrown vegetation, dead tree on fence, depression in asphalt near pipe to sediment basin, gap at bottom of perimeter fence, and ant mounds. These findings were documented on the field inspection checklist and resolved soon after discovery.

Remarks: Site vegetation is mowed routinely.

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

A. Landfill Surface

1. Settlement (Low spots)**:** ☐ Location shown on site map ☒ Settlement not evident
Areal extent__________ Depth__________
Remarks:____________________

2. Cracks: ☐ Location shown on site map ☒ Cracking not evident
Lengths__________ Widths__________ Depths__________
Remarks: No cracking evident in the low-permeable barrier. Cracking evident in the bioturbation (asphalt) and intruder (concrete) barrier does not impact the protectiveness of the remedy.

3. Erosion: ☐ Location shown on site map ☒ Erosion not evident
Areal extent__________ Depth__________
Remarks:____________________

4. Holes: ☐ Location shown on site map ☒ Holes not evident
Areal extent__________ Depth__________
Remarks:____________________

5. Vegetative Cover: ☐ Grass ☐ Cover properly established ☐ No signs of stress
Areal extent__________ Depth__________
Remarks: NA.

Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin Operable Unit *(continued)*

VII. LANDFILL COVER/CONTAINMENTS *(Continued)*

6. **Alternative Cover (armored rock, concrete, etc.):** ☐ N/A

Remarks: The cover system includes a concrete intruder barrier, an asphalt bioturbation barrier, and the original asphalt cover installed in 1996.

7. **Bulges:** ☐ Location shown on site map ☒ Bulges not evident

Areal extent__________ Depth__________

Remarks:__________

8. **Wet Areas / Water Damage:** ☒ Wet areas/water damage not evident

☐ Wet areas ☐ Location shown on site map Areal extent__________
☐ Ponding ☐ Location shown on site map Areal extent__________
☐ Seeps ☐ Location shown on site map Areal extent__________
☐ Soft subgrade ☐ Location shown on site map Areal extent__________

Remarks:__________

9. **Slope Instability:** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability

Areal extent__________

Remarks:__________

B. Benches ☐ Applicable ☒ N/A

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

C. Letdown Channels ☐ Applicable ☒ N/A

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

D. Cover Penetrations ☒ Applicable ☐ N/A

1. **Gas Vents:** ☐ Active ☐ Passive

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A

Remarks:__________

2. **Gas Monitoring Probes:**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A

Remarks:__________

Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin Operable Unit *(continued)*

VII. LANDFILL COVER/CONTAINMENTS *(Continued)*

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

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

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

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

F. Cover Drainage Layer ☐ Applicable ☒ N/A

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

H. Retaining Walls ☐ Applicable ☒ N/A

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

1. Siltation: ☐ Location shown on site map ☒ Siltation not evident
Areal extent________________ Depth________________
Remarks:____

2. Vegetative Growth: ☐ Location shown on site map ☐ N/A
☒ Vegetation does not impede flow
Areal extent________________ Type________________
Remarks:____

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

4. Discharge Structure: ☐ Location shown on site map ☒ N/A
Remarks:____

Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin Operable Unit *(continued)*

VIII. VERTICAL BARRIER WALLS ☐ **Applicable** ☒ **N/A**

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

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

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

C. Treatment System ☐ Applicable ☒ N/A

D. Monitoring Data ☒ Applicable ☐ N/A

1. Monitoring Data:
☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring Data Suggests:
☐ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

E. Monitored Natural Attenuation ☒Applicable ☐ N/A

1. Monitoring Wells *(natural attenuation remedy)***:**
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs maintenance ☐ N/A
Remarks:____
____

X. OTHER REMEDIES

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

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

Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin Operable Unit *(continued)*

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

The remedial action for RRSB OU is installation of a reinforced concrete intruder barrier system over PTSM with granite monuments, installation of an asphalt bioturbation barrier over contaminated vegetation areas, excavation and consolidation on-unit of PTSM outside boundary fence, monitored natural attenuation (MNA) by radioactive decay with mixing zone for groundwater, and institutional controls (i.e., LUCs). The remedy is fully established and functioning as designed.

B. Adequacy of O&M

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

The O&M procedures consisting of annual site inspections and site maintenance (repair of erosion damage, cover system, fencing and warning signs) and land use controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the waste unit) have been implemented. The O&M procedures are adequately maintaining the RRSB OU and the condition of the fencing and warning signs is good. When maintenance activities are identified during inspections (e.g., repairing holes, concrete spalling, asphalt cracking, vegetation removal from the cover system), repairs are scheduled and performed. There are no issues that impact the protectiveness of the remedy that require corrective actions.

C. Early Indicators of Potential Remedy Failure

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

N/A

D. Opportunities for Optimization

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

N/A

End of Checklist