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Record of Decision
Remedial Alternative Selection for the
Lower Three Runs Integrator Operable Unit (U)

SEMS Number: 35

SRNS-RP-2020-00542

Revision 1

August 2021

DISCLAIMER

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

RECORD OF DECISION
REMEDIAL ALTERNATIVE SELECTION (U)

Lower Three Runs
Integrator Operable Unit (U)

SEMS Number: 35

SRNS-RP-2020-00542
Revision 1
August 2021

Savannah River Site
Aiken, South Carolina

Prepared by:
Savannah River Nuclear Solutions, LLC
for the
U.S. Department of Energy under Contract DE-AC09-08SR22470
Savannah River Operations Office
Aiken, South Carolina

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DECLARATION FOR THE RECORD OF DECISION

Unit Name and Location

Lower Three Runs Integrator Operable Unit, No Building Number
Superfund Enterprise Management System Identification Number: OU-SEMS 35
Savannah River Site
Comprehensive Environmental Response, Compensation and Liability Act
Aiken, South Carolina
United States Department of Energy

The Lower Three Runs (LTR) Integrator Operable Unit (IOU), No Building Number (NBN) is listed as a Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) unit in Appendix C of the Federal Facility Agreement (FFA) for the Savannah River Site (SRS).

The FFA is a legally binding agreement between regulatory agencies (United States Environmental Protection Agency [USEPA] and South Carolina Department of Health and Environmental Control [SCDHEC]) and regulated entities (United States Department of Energy ([USDOE]) that establishes the responsibilities and schedules for the comprehensive remediation of SRS. The media associated with this unit are sediment/soil, surface water and biota (e.g., fish). Stream channel/floodplain sediment and floodplain/wetland soil (i.e., sediment/soil) are combined as a single medium and referred to as "sediment/soil." Groundwater is not a subunit of the LTR IOU.

Statement of Basis and Purpose

This decision document presents the selected remedial action for the LTR IOU, located at the SRS near Aiken, South Carolina. This remedy was chosen in accordance with CERCLA, as amended by the Superfund Amendments Reauthorization Act, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the information contained in the Administrative Record File for this site.

The USEPA, SCDHEC and USDOE concur with the selected remedy.

Assessment of the Site

There has been a release of cesium-137 (Cs-137) and, to a lesser extent, cobalt-60 within the LTR IOU environment due to reactor discharges. Also, the use of river water that was pumped from the Savannah River for reactor cooling introduced mercury (Hg) to the LTR IOU stream system resulting in the presence of Hg, in addition to Cs-137 in fish tissue. The response action selected in this Record of Decision (ROD) is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

For administrative purposes, the LTR IOU is delineated into Upper, Middle, and Lower subunits. The Upper subunit is located upgradient of the PAR Pond Dam, while the Middle and Lower subunits are located below the PAR Pond Dam that includes an area with a narrow land buffer referred to as the "tail" section of the LTR IOU. Following a Non-time Critical Removal Action in 2012 involving excavation of Cs-137 contaminated sediment/soil in the Middle and Lower subunits, land use controls (LUCs) to install additional fencing and signage near the major road crossing and utility easements along the tail portion as well as additional signage on both sides of the entire length of the tail was selected as the remedial action for the Middle and Lower subunits. The selected remedial action for the Middle and Lower subunits is documented in the *Explanation of Significant Differences (ESD) for the Revision 0 Interim Action Record of Decision Remedial Alternative Selection: PAR Pond Unit (U); Lower Three Runs Integrator Operable Unit Tail Portion Middle and Lower Subunit*s. The remedial action implemented for the Middle and Lower subunits is protective of human health and the environment and is further documented in this ROD as the final remedial action for the Middle and Lower LTR IOU subunits.

Additional actions are being taken for the Upper subunit as described in this ROD. Due to the variability of environmental conditions and large scale of the LTR IOU, the Upper subunit is segregated into the following nine individual exposure areas (EAs):

- EA1 includes Pond A and the R-Area Discharge Canal
- EA2 consists of the section of the canal system between Pond A and Pond B.
- EA3 includes Pond B and the overflow canal connecting Pond B to Pond C.
- EA4 consists of the section of the canal system between Pond B and the North Arm of PAR Pond.

- EA5 consists of Joyce Branch (also known as the Old R-Area Discharge Canal).
- EA6 consists of PAR Pond.
- EA7 includes Pond 2 and the Discharge Canal between P-Area and Ponds 4 and 5.
- EA8 includes Ponds 4 and 5 and the Discharge Canal between Ponds 4 and 5 to Pond C.
- EA9 consists of Pond C.

LTR IOU is currently designated for industrial use. No current or projected future development is planned, nor is the current land use expected to change. To support the risk management decision-making and remedy selection for the Upper subunit, an IOU onsite worker (wetland researcher) is selected as the most likely receptor scenario. A recreational fisherman scenario is also included for EAs that can sustain populations of consumable fish.

Description of the Selected Remedy

Due to the complexity of the Upper subunit, multiple remedies are needed to address the nature and extent of contamination within the LTR IOU system. LUCs selected as the remedial action for the Middle and Lower subunits in the *Explanation of Significant Differences (ESD) for the Revision 0 Interim Action Record of Decision Remedial Alternative Selection: PAR Pond Unit (U); Lower Three Runs Integrator Operable Unit Tail Portion Middle and Lower Subunit*s are documented as the final action for the Middle and Lower subunits in this ROD. No further action is needed for the Middle and Lower Subunits.

The selected remedy for the LTR IOU Upper subunit is *Land Use Controls (LUCs) with Monitored Natural Recovery (MNR)* (Alternative A-2) for all nine EAs (EA1 through EA9); *Excavation, Treatment and Disposal of Principal Threat Source Material (PTSM) Sediment*/*Soil* (Alternative A-5) in EA1 (Pond A – Including R Discharge Canal); and *Maintain Water in Ponds* (Alternative A-6) for EA3 (Pond B) and EA6 (PAR Pond). The future land use for the LTR IOU will be non-residential and primarily used for environmental/ecological research with USDOE maintaining control of the land. A five-year remedy review will be required.

LUCs with MNR (Alternative A-2)

The selected remedy, *LUCs with MNR,* involves the use of LUCs to limit access to the entire Upper subunit of the LTR IOU (EA1 through EA9) and MNR to monitor the decay of Cs-137 and Co-60

at all nine EAs. MNR also includes consideration of biological sampling and passive sampling techniques to assess bioavailability of Cs-137 and Hg. Monitoring data will be presented in the five-year remedy reviews and will be used to document the effectiveness of a remedial action or evaluate the need for further actions.

The LUCs component of the remedy includes engineering controls (i.e., signs, gates) and institutional controls (i.e., deed restrictions, worker protective programs) to limit inadvertent human exposure by restricting and controlling access to contaminated areas.

Excavation, Treatment and Disposal of PTSM Sediment/*Soil (Alternative A-5)*

The selected remedy is *Excavation, Treatment and Disposal of PTSM Sediment*/*Soil* (Alternative A-5) for EA1 because it is effective in reducing exposure, mobility, and toxicity of the most highly contaminated location at the R-Area Discharge Canal, and lowers the overall risk associated with EA1.

The subaqueous excavation/dredging will be controlled by implementing best management practices (e.g., silt curtains) as appropriate. Sediment/soil will be placed into large disposal bags or containers, dewatered and treated with a drying agent, and transported to an approved waste disposal facility (e.g., E-Area Low Level Waste Facility). This alternative will be combined with Alternative A-2 LUCs with MNR to achieve the remedial action objectives. This remedy requires five-year remedy reviews.

Maintain Water in Ponds (Alternative A-6)

The *Maintain Water in Ponds* (Alternative A-6) selected remedy consists of maintaining dam structures to sustain natural fluctuation of water levels. This alternative minimizes access to submerged PTSM locations in Pond B (EA3) and limits exposure to submerged, contaminated sediment/soil within PAR Pond (EA6) and Pond C (EA9) providing protection of human health and the environment through shielding. This remedy is applicable to Pond B (EA3) and PAR Pond (EA6). Pond C (EA9) is hydrologically connected to PAR Pond (EA6) and maintains an equivalent level with PAR Pond (EA6). The reverse riser structure associated with Pond C (EA9) allows water to flow from Pond C (EA9) into PAR Pond (EA6) using hydraulic pressure to stabilize water

elevation between the two ponds. Therefore, the water level in Pond C (EA9) will be maintained through implementation of Alternative A-6 at PAR Pond (EA6).

This remedy includes the monitoring of dam structures and water levels, annual inspections, and periodic maintenance of physical attributes that make water retention viable. This remedy is combined with Alternative A-2, *LUCs with MNR* to achieve the remedial action objectives.

Statutory Determinations

Based on the unit Remedial Investigation/Baseline Risk Assessment (BRA) (SRNS 2017), the LTR IOU poses a threat to human health and the environment. Therefore, Alternative A-2, *LUCs with MNR* for all nine EAs (EA1 through EA9); Alternative A-5, *Excavation, Treatment and Disposal of PTSM Sediment*/*Soil* in EA1; and Alternative A-6, *Maintain Water in Ponds* for EA3 and EA6 have been selected as the remedy for the LTR IOU. As part of the selected remedy, the future land use for the LTR IOU will be non-residential and primarily used for environmental/ ecological research with USDOE maintaining control of the land.

Because hazardous substances will remain at the site above levels that allow for unlimited exposure and unrestricted use, the USDOE will review the remedial action no less than every five years per CERCLA Section 121(c) and the NCP at 40 CFR 300.430(f)(4)(ii) until the levels of refined constituents of concern (RCOC) allow for unrestricted use and unlimited exposure of sediment/soil. If results of the five-year reviews reveal that remedy integrity is compromised and protection of human health and the environment is insufficient, then additional remedial actions will be evaluated by the USDOE, USEPA, and SCDHEC.

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action (unless justified by a waiver), is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. The remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduce the toxicity, mobility, or volume of materials comprising principal threats through treatment) for EA1.

In the long term, if the property, or any portion thereof, is ever transferred from USDOE, the U.S. Government and/or USDOE will take those actions necessary pursuant to Section 120(h)(1) of CERCLA. Those actions will include in any contract, deed, or other transfer document, notice of the type and quantity of any hazardous substances that were known to have been stored (for more than one year), released, or disposed of on the property. The notice will also include the time at which the storage, release, or disposal took place to the extent such information is available.

In addition, if the property, or any portion thereof, is ever transferred by deed, the U.S. Government will also satisfy the requirements of CERCLA 120(h)(3). The requirements include: a description of the remedial action taken, a covenant, and an access clause.

LUCs will be implemented through the following:

- The contract, deed, or other transfer document shall also include restrictions precluding residential use of the property. However, the need for these restrictions may be reevaluated at the time of transfer in the event that exposure assumptions differ and/or the residual contamination no longer poses an unacceptable risk under residential use. Any reevaluation of the LUCs will be done through an amended ROD with USEPA and SCDHEC review and approval.
- In addition, if the Site is ever transferred to nonfederal ownership, a survey plat of the operable unit will be prepared, certified by a professional land surveyor, and recorded with the appropriate county recording agency.

In the event of a property lease or interagency agreement, the equivalent restrictions will be implemented as required by CERCLA Section 120(h).

The selected remedy for the LTR IOU leaves hazardous substances in place that pose a potential future risk and will require land use restrictions for as long as necessary to keep the selected remedy fully protective of human health and the environment. As agreed on March 30, 2000, among the USDOE, USEPA, and SCDHEC, SRS is implementing a Land Use Control Assurance Plan (LUCAP) to ensure that the LUCs required by numerous remedial decisions at SRS are properly maintained and periodically verified. The unit-specific Land Use Control Implementation Plan (LUCIP) incorporated by reference into this ROD will provide details and

specific measures required to implement and maintain the LUCs selected as part of this remedy. The USDOE is responsible for implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs selected under this ROD. The LUCIP, developed as part of this action, will be submitted concurrently with the Remedial Action Implementation Plan, as required in the FFA for review and approval by USEPA and SCDHEC. Upon final approval, the LUCIP will be appended to the LUCAP and is considered incorporated by reference into the ROD, establishing LUC implementation and maintenance requirements enforceable under CERCLA. The approved LUCIP will establish implementation, monitoring, maintenance, reporting, and enforcement requirements for the unit. The LUCIP will remain in effect unless and until modifications are approved by the USEPA and SCDHEC as needed to be protective of human health and the environment. LUCIP modification will only occur through another CERCLA document.

Data Certification Checklist

This ROD provides the following information:

- COC and their respective concentrations (Section V)
- Current and reasonably anticipated future land use assumptions used in the BRA and ROD (Section VI)
- Potential land use that will be available at the site as a result of the selected remedy (Section VI)
- Baseline risk represented by the COC (Section VII)
- Cleanup levels established for the RCOC and the basis for the levels (Section VIII)
- Estimated capital, operation and maintenance, and total present worth cost; discount rate; and the number of years over which the remedy cost estimates are projected (Section IX)
- Key decision factor(s) that led to selecting the remedy (i.e., describe how the selected remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria) (Section X)

Jimmy E. McMillian Digitally signed by Jimmy E. McMillian
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Date

Jimmy E. McMillian
Assistant Manager for Infrastructure and Environmental Stewardship
U. S. Department of Energy
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10-29-2021

Date

Henry J. Porter, Chief
Bureau of Land and Waste Management
S.C. Department of Health and Environmental Control

CAROL MONELL Digitally signed by CAROL MONELL
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Date

Carol J. Monell, Director
Superfund and Emergency Management Division
U. S. Environmental Protection Agency - Region 4

DECISION SUMMARY
REMEDIAL ALTERNATIVE SELECTION (U)

Lower Three Runs
Integrator Operable Unit (U)

SEMS Number: 35

SRNS-RP-2020-00542
Revision 1
August 2021

Savannah River Site
Aiken, South Carolina

Prepared by:
Savannah River Nuclear Solutions, LLC
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U.S. Department of Energy under Contract DE-AC09-08SR22470
Savannah River Operations Office
Aiken, South Carolina

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LIST OF ABBREVIATIONS AND ACRONYMS

~	approximate, approximately
>, ≥	greater than, greater than or equal to
<	less than
ac	acre
ARAR	applicable or relevant and appropriate requirement
ARF	Administrative Record File
bgs	below ground surface
BMP	best management practices
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulation
COC	constituent of concern
COPC	constituents of potential concern
CSM	conceptual site model
EA	Exposure Area
ESD	explanation of significant difference
EPC	exposure point concentration
ERA	ecological risk assessment
ERDMS	Environmental Restoration Data Management System
FFA	Federal Facility Agreement
FS	Feasibility Study
ft	feet
ha	hectare
Hg	mercury
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IOU	Integrator Operable Unit
IROD	Interim Record of Decision (Interim ROD)
km	kilometer
km^2	square kilometer
LaBr	lanthanum bromide
LANL	Los Alamos National Laboratory
LLC	Limited Liability Company
LLWF	Low Level Waste Facility
LTR	Lower Three Runs

LIST OF ABBREVIATIONS AND ACRONYMS *(Continued)*

LUC	Land Use Controls
LUCAP	Land Use Control Assurance Plan
LUCIP	Land Use Control Implementation Plan
m	meter
mg/kg	milligram per kilogram
MCL	Maximum Contaminant Level
mi^2	square mile
MNR	monitored natural recovery
msl	mean sea level
NBN	no building number
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	non-detect
NEPA	National Environmental Protection Act
NERP	National Environmental Research Park
O&M	Operations & Maintenance
OU	operable unit
pCi/g	picocurie per gram
pCi/L	picocurie per liter
PAGW	P-Area Groundwater
PAOU	P-Area Operable Unit
PCB	polychlorinated biphenyl
PP	Proposed Plan
PRG	preliminary remedial goals
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
RfD	reference dose
RFI	RCRA Facility Investigation
RI	Remedial Investigation
ROD	Record of Decision
RSL	regional screening levels
RWS	River Water System
SARA	Superfund Amendments Reauthorization Act
SCDHEC	South Carolina Department of Health and Environmental Control

LIST OF ABBREVIATIONS AND ACRONYMS *(Continued/End)*

SEMS	Superfund Enterprise Management System
SREL	Savannah River Ecology Laboratory
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions, LLC
SRS	Savannah River Site
SVOC	semi-volatile organic compound
TAL	target analyte list
TBC	To-Be-Considered
TCL	target compound list
TCR	total cumulative risk
TRV	toxicity reference value
UCL	upper confidence limit
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WSRC	Westinghouse Savannah River Company, LLC prior to 2006 Washington Savannah River Company, LLC 2006 to 2009

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

Unit Name, Location, and Brief Description

Lower Three Runs (LTR) Integrator Operable Unit (IOU) (No Building Number [NBN])
Superfund Enterprise Management System (SEMS) Identification Number: OU-SEMS 35
Savannah River Site (SRS)
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Identification Number: SC1 890 008 989
Aiken, South Carolina
United States Department of Energy (USDOE)

(SRS occupies approximately (~) 802.9 square kilometers (km^2) (310 square miles [mi^2]) of land adjacent to the Savannah River, principally in Aiken and Barnwell counties of South Carolina. SRS is located ~40.2-kilomenter (km [2-mile {mi}]) southeast of Augusta, Georgia, and 32.1-km (20-mi) south of Aiken, South Carolina (Figure 1).

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

The Federal Facility Agreement (FFA) (FFA 1993) for SRS lists the LTR IOU (NBN) as a CERCLA unit requiring further evaluation.

The LTR IOU was evaluated through an investigation process to determine the actual or potential impact to human health and the environment of releases of hazardous substances to the environment.

II. SITE AND OPERABLE UNIT COMPLIANCE HISTORY

SRS Operational and Compliance History

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

Hazardous waste materials handled at SRS are managed under the Resource Conservation and Recovery Act (RCRA), a comprehensive law requiring responsible management of hazardous waste. Certain SRS activities require South Carolina Department of Health and Environmental Control (SCDHEC) operating or post-closure permits under RCRA. SRS received a RCRA hazardous waste permit from the SCDHEC, which was most recently renewed on February 11, 2014. Module VIII of the Hazardous and Solid Waste Amendments (HSWA) portion of the RCRA permit mandates corrective action requirements for non-regulated solid waste management units subject to RCRA 3004(u). Because the LTR IOU is not a RCRA 3004(u) solid waste management unit, a RCRA permit modification is not required.

On December 21, 1989, SRS was included on the National Priorities List. The inclusion created a need to integrate the established RCRA facility investigation (RFI) program with CERCLA requirements to provide for a focused environmental program. In accordance with Section 120 of CERCLA 42 United States Code Section 9620, USDOE has negotiated a FFA (FFA 1993) with United States Environmental Protection Agency (USEPA) and SCDHEC to coordinate remedial activities at SRS into one comprehensive strategy 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.

Operable Unit Operational and Compliance History

The LTR IOU is one of six IOUs that correspond to the respective watersheds associated with the stream systems located on the SRS (Upper Three Runs, Fourmile Branch, Pen Branch, Steel Creek, LTR), and the Savannah River, the receiving body for the onsite stream systems, that establishes the northwestern boundary of the SRS. The SRS IOUs are defined as surface water bodies (e.g., stream, lakes, and ponds) and associated wetlands/floodplains, including surface water, sediment/soil (stream channel/floodplain sediment and floodplain/wetland soil), and related biota. The LTR IOU is listed as a CERCLA unit in Appendix C, RCRA/CERCLA Units, of the SRS FFA (FFA 1993).

The LTR watershed is located in the southeastern portion of SRS (Figure 2). LTR is a large, blackwater stream that originates in the northeast portion of SRS and follows a southerly direction for ~40-km (24.5-mi), discharging into the Savannah River. The LTR watershed drains about 460 km^2 (180 mi^2). LTR is classified as Waters of the State for South Carolina.

For administrative purposes, the LTR IOU is delineated into Upper, Middle, and Lower subunits (Figure 3). The Upper subunit is located upgradient of the PAR Pond Dam, while the Middle and Lower subunits are located below the PAR Pond Dam that includes an area with a narrow land buffer referred to as the "tail" section of the LTR IOU.

The LTR IOU includes two main industrial SRS operable units (OUs): P-Area Operable Unit (PAOU) including P-Reactor, and R-Area Operable Unit (RAOU) including R-Reactor. In 1953, R-Reactor began operations, followed by P-Reactor in 1954. Both P- and R-Reactors received cooling water from the Savannah River via the river water distribution system. Prior to construction of the PAR Pond canal system, thermal reactor effluent from R-Reactor was discharged directly into Joyce Branch (R-Area Old Discharge Canal), a tributary of LTR. P-Reactor initially discharged to Steel Creek. In 1958, PAR Pond was created by constructing an earthen dam across the widened LTR stream corridor and the pre-cooler ponds/canal system was constructed. In 1963, P-Reactor began discharging into the LTR system via PAR Pond that was built to augment the cooling water available to both P- and R-Reactors. Effluent from R-Reactor was routed through the

R-Area Discharge Canal to pre-cooler Pond A and Pond B, ultimately discharging into the North Arm of PAR Pond (Figure 4). This effluent pathway was used for R-Reactor from 1961 until the reactor was shut down in 1964. P-Reactor discharges flowed to Pond 2, Ponds 4 and 5, and into PAR Pond via Pond C. Effluent discharges from P-Reactor ceased in 1987.

Liquid releases to the PAR Pond canal system included process leaks, reactor disassembly basin purges, thermal discharges, and makeup cooling water that contained low levels of metals and radionuclides, primarily cesium-137 (Cs-137), but also cobalt-60 (Co-60) in smaller quantities.

In March 1991, during an inspection of the PAR Pond Dam, a small surface depression was noted on the downstream face which necessitated a detailed structural investigation and initiated a precautionary drawdown of the reservoir. From June through September 1991, the level of PAR Pond was lowered from 60-meters (m) to 54-m (200-feet [ft] to 181-ft) mean sea level (msl) to reduce the risk and consequences of an unlikely event of dam failure. A CERCLA Interim Record of Decision (IROD) for PAR Pond was issued in 1995 to address potential exposure to the Cs-137-contaminated sediment/soil that was exposed following water level drawdown of the PAR Pond reservoir during repair of the dam (WSRC 1995). The objective of the interim remedy was to prevent exposure of contaminated shoreline sediments until a National Environmental Policy Act (NEPA) evaluation could be conducted. The IROD recognized that subsequent remedial actions would likely need to be performed for other components of the watershed and stream, including the series of pre-cooler ponds and canals. The resulting NEPA Record of Decision (ROD) from that evaluation noted that natural fluctuation of PAR Pond water elevations would remain between 195-ft and 200-ft msl without operation of the River Water System (RWS), although it noted the RWS availability in critical drought conditions. A 2009 revised Finding of No Significant Impact reduced the base flow requirements below PAR Pond dam to 5 cubic feet/second which supports a balanced biological community in the downstream reaches of LTR. The effectiveness of the 1995 IROD remedy has most recently been evaluated in the Sixth Five-Year Remedy Review Report

(SRNS 2019). The next Five-Year Remedy Review for the PAR Pond IROD is scheduled for 2025.

In 2004, an Early Action Fact Sheet was used to document an early action affecting the area from Patterson Mill Road to the Savannah River of LTR IOU (WSRC 2004). The Early Action Fact Sheet detailed the installation of warning signs and fences to mitigate the potential health risk by discouraging access to, and contact with, the Cs-137 contamination in the stream system. In 2007, the SCDHEC issued a Government Performance and Results Act Human Exposure Environmental Indicator letter indicating that additional actions were needed along the lower subunit of the LTR from Patterson Mill Road to the Savannah River. In response, USDOE conducted an early action plan (SCDHEC 2007) that included posting additional signs and documenting inspections. A letter was sent by the USDOE to all property owners adjacent to this portion of the LTR IOU Lower Subunit reinforcing that trespassing on USDOE property is illegal and the frequency of SRS security patrols in the area would be increased.

In 2009/2010, extensive sampling of the LTR IOU was conducted. Sampling associated with the Upper subunit was undertaken to augment previously collected data to support the risk evaluation. The sampling was performed as outlined in the approved Sampling and Analysis Plans (SRNS 2010, SRNS 2016) and included sampling of sediment/soil, surface water, and fish. The sampling included the canals, pre-cooler ponds, PAR Pond, and the LTR stream system below PAR Pond dam.

For the Middle and Lower subunits (tail portion), the 2009/2010 characterization identified areas that resulted in an unacceptable cancer risk (1E-04 or greater) to the adolescent trespasser who was identified as the most likely human receptor for the tail portion. Following a Non-time Critical Removal Action in 2012 involving excavation of Cs-137 contaminated sediment/soil in the Middle and Lower subunits, land use controls (LUCs) to install additional fencing and signage near the major road crossing and utility easements along the tail portion as well as additional signage on both sides of the entire length of the tail was selected as the remedial action for the Middle and Lower subunits. Completion of the remedial action for the Middle and Lower subunits is documented in the *Explanation*

*of Significant Differences (ESD) for the Revision 0 Interim Action Record of Decision Remedial Alternative Selection: PAR Pond Unit (U); Lower Three Runs Integrator Operable Unit Tail Portion Middle and Lower Subunit*s (SRNS 2012a).

For the Upper subunit of the LTR IOU, the Remedial Investigation/Baseline Risk Assessment (RI/BRA) summarizes the data associated with the unit, describes the nature and extent of the contamination in affected media, and evaluates the potential risk to human and ecological receptors (SRNS 2017). The Feasibility Study (FS) outlines potential remedial alternatives and screens remedial technologies (SRNS 2020a). The FS also includes a detailed remedial alternative analysis that was used to support the selection of the final remedy for the Upper subunit described in this ROD.

The remedial action implemented for the Middle and Lower subunits is protective of human health and the environment and is documented in this ROD as the final remedial action for the Middle and Lower LTR IOU subunits.

The USEPA, SCDHEC and USDOE have agreed on the preferred remedy identified in the *Proposed Plan for the Lower Three Runs Integrator Operable Unit (U)* (SRNS 2020b). The final remedy selected in this ROD does not contain any significant changes from the preferred remedy presented in the Proposed Plan (PP).

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

CERCLA requires the public to be given an opportunity to review and comment on the draft permit modification and proposed remedial alternatives. Public participation requirements are listed in Sections 113 and 117 of CERCLA (42 United States Code Sections 9613 and 9617). These requirements include establishment of an Administrative Record File (ARF) that documents the investigation and selection of the remedial alternatives for addressing the LTR IOU sediment/soils and fish. The ARF must be established at or near the facility at issue.

The SRS FFA Community Involvement Plan (SRNS 2011) is designed to facilitate public involvement in the decision-making process for permitting, closure, and the selection of

remedial alternatives. The plan addresses the requirements of RCRA, CERCLA, and the NEPA. Section 117(a) of CERCLA, as amended, requires the advertisement of the draft permit modification and notice of any proposed remedial action and provides the public an opportunity to participate in the selection of the remedial action. The PP for the LTR IOU, a part of the ARF, highlights key aspects of the investigation and identifies the preferred action for addressing the LTR IOU.

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

US Department of Energy
Public Reading Room
Gregg-Graniteville Library
University of South Carolina – Aiken Campus
471 University Parkway
Aiken, South Carolina 29803
(803) 641-3504

Thomas Cooper Library
Government Information and Maps Department
University of South Carolina
1322 Green Street
Columbia, South Carolina 29208
(803) 777-4841

The public was notified of the public comment period through mailings of the *SRS Environmental Bulletin*, a newsletter sent to citizens in South Carolina and Georgia, and through notices in the *Aiken Standard*, *The Augusta Chronicle*, *The People-Sentinel*, and *The State* newspapers. The public comment period was also announced on local radio stations.

The PP 45-day public comment period began on January 27, 2021 and ended on March 12, 2021. A Responsiveness Summary, prepared to address any comments received during the public comment period, is provided in Appendix A of the ROD.

IV. SCOPE AND ROLE OF THE OPERABLE UNIT

Due to the complexity and size of multiple waste units in different areas, the SRS is divided into watersheds for the purpose of managing a comprehensive cleanup strategy. The SRS is segregated into six watersheds: Upper Three Runs, LTR, Fourmile Branch, Steel Creek, Pen Branch, and the Savannah River. In addition, the SRS also identifies six IOUs which

are the surface water bodies and associated wetlands that correspond to the six respective watersheds. Waste units within a watershed may be evaluated and remediated individually or grouped with other waste units and evaluated as part of a larger Area OU. Upon disposition of all the waste units within a watershed, a final comprehensive ROD for the corresponding IOU (i.e., surface water and associated wetlands) will be pursued with additional public involvement.

Potential sources of contamination to the LTR IOU have been evaluated and mitigated. Remedial actions for source units at RAOU and PAOU have been completed. Two units originally identified in the LTR IOU workplan as potential sources to the LTR IOU, Dunbarton Railroad Yard and P-Area Groundwater, have subsequently been re-evaluated and administratively transferred to the Steel Creek watershed. All potential sources to the LTR IOU, except portions of the LTR IOU itself, have been mitigated or determined to require No Further Action. Table 1 provides the list of historic sources of contamination to LTR IOU along with their status.

A remedial action is needed in the Upper subunit of the LTR IOU due to the presence of Cs-137 and Co-60 in sediment/soil, and the presence of mercury (Hg) and Cs-137 in fish tissue at levels that may pose a threat to human health and the environment. Multiple remedies are needed to address the nature and extent of contamination. *Land use controls (LUCs) with Monitored Natural Recovery (MNR)* will be used in combination with *Excavation, Treatment and Disposal of Principal Threat Source Material (PTSM) Sediment/Soil,* and *Maintain Water in Ponds* remedies that target PTSM locations or maintain water levels and mitigate sediment/soil migration. These remedies are effective in reducing exposure of contaminated media to human and ecological receptors for the entire Upper subunit.

The previous completion of the non-time critical removal action for the Middle and Lower subunits as a final action for protection of human receptors (assessing threats to the adolescent trespasser) is also addressed in this ROD. The removal action included: 1) excavation of soil in three transect locations along the LTR stream corridor where the Cs-137 concentrations exceeded the 23.7 picocurie per gram (pCi/g) (1E-04 risk level for

the adolescent trespasser) action level to a depth necessary to achieve the cleanup level of 12 pCi/g (5E-05 risk for the adolescent trespasser), 2) lanthanum bromide (LaBr) radiological surveys and confirmatory sediment/soil analysis within the excavated areas to demonstrate that residual Cs-137 concentration in sediment/soil is equal to or less than the established cleanup level of 12 pCi/g, and 3) installation of fencing and signs to control access at selected locations along USDOE's LTR IOU property boundary (SRNS 2013a).

Altogether, this ROD documents the remedies selected for the Upper subunit and the completed remedies for the Middle and Lower subunits that are effective in reducing exposure of contaminated media to human and ecological receptors for the entire LTR IOU.

V. OPERABLE UNIT CHARACTERISTICS

Characteristics of the LTR IOU are provided below.

Conceptual Site Model for the LTR IOU

The conceptual site model (CSM) is an objective framework for assessing data pertinent to the investigation. The CSM identifies and evaluates suspected sources of contamination, contaminant release mechanisms, potentially affected media (secondary sources of contamination), potential exposure pathways, and potential human and ecological receptors.

Exposure pathways describe the course a chemical or physical agent can take from the source to the exposed receptor. The following five (5) components constitute an exposure pathway:

1. Source (facility operations, spill, etc.)
2. Exposure medium (soil, sediment, surface water, etc.)
3. Exposure point (soil surface, sediment surface, etc.)
4. Exposure route (ingestion, dermal contact, inhalation, external radiation, etc.)
5. Receptor (resident, worker, wildlife, etc.)

If any of these elements is missing, the pathway is incomplete, and it not considered further in a quantitative risk assessment. A pathway is complete when all five components are present to permit potential exposure of a receptor to a source of contamination. Exposure analysis is conceptually important in terms of identifying all the potentially complete exposure routes, understanding the nature and extent (as well as fate and transport) of contamination, and developing preliminary remedial alternatives. In a complete pathway, exposure occurs at exposure points that may represent only a small portion of the entire exposure route. If there is no exposure point, then there is no exposure, and the pathway is considered incomplete.

Due to the variability of environmental conditions and large scale of the LTR IOU, the Upper subunit is segregated into the following nine individual exposure areas (EAs) (Figure 5).

- EA1 includes Pond A and the R-Area Discharge Canal. Pond A, is ~2.6 hectare (ha [6.4 acre {ac}]), and received water from the R-Area Discharge Canal that subsequently discharged to Pond B. The canal from R-Reactor to Pond A is ~645-m (2,116.1-ft) long. The canal from the R-Discharge Canal to Joyce Branch is 233-m (764.4-ft) long.

- EA2 consists of the section of the canal system between Pond A and Pond B and is ~2,837-m (9,307.7-ft) long. The canal flow area (i.e., where contaminants most likely have been deposited) is ~3.0-m (9.8-ft) across the base of the canal.

- EA3 includes Pond B and the overflow canal connecting Pond B to Pond C. Pond B is ~82.1 ha (202.8 ac) and received water from the R-Area which subsequently discharged to PAR Pond. Pond B generally maintains its water level from year to year. The over flow canal from Pond B is ~547-m (1,794.6-ft) long.

- EA4 consists of the section of the canal system between Pond B and the North Arm of PAR Pond and is ~2,305-m (7,562.3-ft) long. The canal flow area (i.e., where

contaminants most likely have been deposited) is ~3.0-m (9.8-ft) across the base of the canal.

- EA5 consists of Joyce Branch (also known as the Old R-Area Discharge Canal) which is ~2,533-m (8,310.3-ft) long. Flow from the R-Reactor cooling water system was directed along Joyce Branch to LTR from 1953 until the diversion structure was built in 1958. The diversion structure eliminated direct reactor discharges to Joyce Branch. The flow area (i.e., where contaminants most likely have been deposited) is ~3-m (9.8-ft) across the base of the stream channel.

- EA6 consists of PAR Pond. PAR Pond is ~1,068.3 ha (2,640 ac) and received water from the R-Area and P-Area discharges.

- EA7 includes Pond 2 and the Discharge Canal between P-Area and Ponds 4 and 5. Pond 2 is ~7.9 ha (19.6 ac) and received water from P-Area and subsequently discharged to Ponds 4 and 5. The canal from P-Area to Pond 2 is ~3,582-m (11,751.9-ft) long. The canal from Pond 2 to Ponds 4 and 5 is ~2,081-m (6,827.4-ft) long. The canal flow area (i.e., where contaminants most likely have been deposited) is ~3-m (9.8-ft) across the base of the canal.

- EA8 includes Ponds 4 and 5 and the Discharge Canal between Ponds 4 and 5 to Pond C. Pond 4 is ~14.3 ha (35.3 ac) and received water from P-Area and subsequently discharged to Pond 5. Pond 5 is ~4.0 ha (9.9 ac) and received water from Pond 4 and subsequently discharged to Pond C via an 1,887-m (6,190.9-ft) long canal. The canal flow area (i.e., where contaminants most likely have been deposited) is ~3-m (9.8-ft) across the base of the canal.

- EA9 consists of Pond C. Pond C is ~53.5 ha (132.4 ac) and received water from the R-Area discharged directly from Joyce Branch and P-Area through the canal system. Water from Pond C flows to PAR Pond through a reverse riser (commonly referred to as the “bubble-up”). As long as PAR Pond is above 59.5-m (195.25-ft) msl, Pond C and PAR Pond will maintain the same water level. If PAR Pond drops below 59.5-m

(195.25-ft) msl, Pond C will remain at 59.5-m (195.25-ft) msl unless the drain gate is opened to release water.

Media Assessment

The overall approach that was implemented during the various facets of the LTR IOU investigation is described in the RI/BRA for the LTR IOU (SRNS 2017). The RI was based on a review of historical data supplemented by two phases of characterization initiated in 2009 to augment previously collected data. The data included sediment/soil (combined data for sediment and floodplain/wetland soils termed "sediment/soil"), surface water, and biota (fish) data. Additional sampling of sediment/soil, surface water, and fish was conducted in PAR Pond in 2016 to address data gaps identified by the SCDHEC and USEPA. The data were compiled and evaluated in data packages that were developed for each EA and included an assessment of the historical and supplemental data for usability in the RI/BRA.

Groundwater is not a subunit of the LTR IOU and is addressed separately under R-Area Groundwater (RAGW) OU and the P-Area Groundwater (PAGW) OU.

Exposure Area Unit Investigation (Sediment/Soil, Surface Water and Biota Media)

Characterization of the LTR IOU was conducted in 2009/2010 as a final action investigation. Additional characterization of PAR Pond was conducted in 2016. Historic data supplemented the characterization data since the LTR IOU system has been studied long-term for various research/investigative purposes. Figure 6 shows the comprehensive sampling locations for the entire Upper subunit.

In general, the characterization conducted during 2009/2010 involved LaBr gamma spectrum surveying of sediment/soil to determine relative levels at the sampling areas and guide location of manually collected samples. Sediment/soil sample locations for transects included taking a sediment/soil sample at the location that recorded the highest total gamma measurement based on the LaBr survey. Manually collected sediment/soil samples were analyzed for radionuclide indicators (gross alpha and non-volatile beta) and gamma

spectroscopy. If gross alpha exceeded 20 pCi/g, the sample also was analyzed for alpha spectroscopy and radium-226. If non-volatile beta exceeded 50 pCi/g, the sample also was analyzed for carbon-14 (low-level), iodine-129, nickel-59, nickel-63 (low-level), promethium-147, radium-228, strontium-90, and technetium-99. Additionally, sediment/ soil samples were analyzed for Target Compound List (TCL), Volatile Organic Compounds (VOCs), TCL Semi-Volatile Compounds (SVOCs), TCL pesticides/ Polychlorinated Biphenyls (PCBs), and Target Analyte List (TAL) metals.

Surface water samples included unfiltered and filtered samples. The unfiltered surface water samples were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals, gamma spectroscopy and tritium. The filtered surface water samples were analyzed for all the unfiltered sample analyses except for TCL VOCs and tritium.

Biota samples (i.e., fish tissue) were collected in the EAs that can sustain populations of consumable fish (EA3, EA6, and EA9) as well as Ponds 4 and 5. Biota samples were analyzed for TAL inorganics, radionuclide indicators (gross alpha and non-volatile beta), tritium, and gamma spectroscopy for gamma emitters including Cs-137.

This approach to sampling was similarly employed at all the EAs as described in the RI/BRA (SRNS 2017). The following discussion details the sampling conducted for each EA.

Exposure Area 1 (Pond A Including R-Area Discharge Canal)

Sediment and surface water samples have been routinely collected in the discharge canal since 1997. The characterization conducted during 2009/2010 collected 23 sediment samples and six surface water samples from EA1. Each transect sample location included a LaBr gamma survey taken every 5-m (16.4-ft) from the stream edge. Each transect included a LaBr gamma spectrum and one sediment/soil sample collected from two depth intervals (0- to 0.3-m [0- to 1-ft] and 0.3- to 1.2-m [1- to 4-ft]).

Two surface water samples (both filtered and unfiltered) and one sediment/soil sample were collected from the stream at each transect.

No biota (i.e., fish tissue) samples were collected from EA1. Figure 7 shows the sample locations for EA1.

Exposure Area 2 (Canal From Pond A to Pond B)

A total of 44 sediment/soil samples were collected from EA2 during the 2009/2010 sampling event. The sample locations (transects) were spaced out to approximately every 250-m (820-ft) along the entire length of the discharge canal. Two sediment/soil samples (0- to 0.3-m [0- to 1-ft] below ground surface (bgs) and 0.3- to 1.2-m [1- to 4-ft] bgs) were taken on either side of the canal ~3-m (10-ft) outside the high-water mark on each bank of the discharge canal. A third sediment/soil sample was collected on the slope leading down to the stream channel. This location was sampled from 0- to 0.3-m [0- to 1-ft) bgs and was collected on alternate sides of the channel for every other transect. Also, one manually-collected sediment sample was obtained from 0- to 0.15-m (0- to 0.5-ft) bgs for each transect.

Twenty (20) surface water samples were also taken at EA2 during the 2009/2010 sampling event. In general, two surface water samples were collected at each transect location, with one water sample being filtered and the other unfiltered.

No biota (i.e., fish tissue) samples were collected from EA2. Figure 8 shows the sample locations for EA2.

Exposure Area 3 (Pond B Including Canal to Pond C)

The characterization conducted during 2009/2010 collected a total of 15 sediment/soil samples from EA3. The sample locations were determined by the transect lines that were established at Pond B. Two samples (0- to 0.3-m [0- to 1-ft] bgs and 0.3- to 1.2-m [1- to 4-ft] bgs) were taken at each end of the transect lines in dry soil ~0.91-m (3-ft) away from the water line. Also, one manually collected sediment sample was obtained from 0- to 0.15-m (0- to 0.5-ft) bgs for each transect line.

Two surface water samples were also taken at Pond B during the 2009/2010 sampling event. Both surface water samples were collected at the transect location where the sediment/soil sample required the full analytical suite, with one water sample being filtered and the other unfiltered.

Biota samples (i.e., fish tissue) were collected at Pond B during the 2009/2010 sampling. Figure 9 shows the sample locations for EA3.

Exposure Area 4 (Canal from Pond B to North Arm of PAR Pond)

A total of 36 sediment/soil samples were collected from EA4 during the 2009/2010 sampling event. The sample locations (transects) were spaced out to approximately every 250-m (820-ft) along the entire length of the canal. The sample locations (transects) were collected as detailed in EA2.

Eighteen (18) surface water samples were also collected at EA4 during the 2009/2010 sampling event. Two surface water samples were collected at each transect location, with one water sample being filtered and the other unfiltered.

No biota samples (i.e. fish tissue) were collected at EA4. Figure 10 shows the sample locations for EA 4.

Exposure Area 5 (Joyce Branch [Old Discharge Canal])

A total of five sediment samples and 10 sediment/soil samples were collected from EA5 during the 2009/2010 sampling event. Two sediment/soil samples (0- to 0.3-m [0- to 1-ft] bgs and 0.3- to 1.2-m [1- to 4-ft] bgs) were taken per transect at the part of the transect that recorded the highest total gamma measurements. Also, one manually collected sediment sample was obtained from 0- to 0.15-m (0- to 0.5-ft) bgs for each transect.

Ten (10) surface water samples were also taken at EA5 during the 2009/2010 sampling event. Two surface water samples were collected at each of the five transect locations. Each sample consisted of one filtered water sample and the one unfiltered water sample.

No biota samples (i.e., fish tissue) were collected at EA5. Figure 11 shows the sample locations for EA5.

Exposure Area 6 (PAR Pond)

A total of three sediment samples were collected from EA6 during the May – June 2016 sampling event.

Fourteen (14) surface water samples were also taken at EA6 during the May – June 2016 sampling event. Each sample consisted of one filtered water sample and one unfiltered water sample.

Biota samples (i.e., fish tissue) were collected at PAR Pond during the 2009/2010 sampling. Figure 12 shows the sample locations for EA6.

Exposure Area 7 (Canal from P-Area to Ponds 5 and 6 Including Pond 2)

Pond 2 sample locations were determined by the established transect lines. Two sediment/soil samples (0- to 0.3-m [0- to 1-ft] bgs and 0.3- to 1.2-m [1- to 4-ft] bgs) were taken at each end of the transect line in dry soil ~0.91-m (3-ft) away from the water line. Also, one manually collected sediment sample was obtained from 0- to 0.15-m (0- to 0.5-ft) bgs for each transect line. P-Area Discharge Canal sediment/soil samples were collected at transect locations that were spaced approximately every 250-m (820-ft) between P-Reactor and Pond 2, and every 500-m (1,640-ft) between Pond 2 and Ponds 4 and 5. Sediment/soil samples were taken as described in EA2 above.

Two surface water samples were taken at Pond 2 and 30 surface water samples were collected from the P-Area Discharge Canal between P-Area and Ponds 4 and 5 during the 2009/2010 sampling event. Both Pond 2 surface water samples were collected at the transect location where the sediment/soil sample required a full analytical suite with one water sample being filtered and the other unfiltered. Two surface water samples were collected at each transect location of the P-Area Discharge Canal, with one water sample being filtered and the other unfiltered.

No biota samples (i.e., fish tissue) were collected at EA7. Figure 13 shows the sample locations for EA7.

Exposure Area 8 (Ponds 4 and 5 Including Canal from Ponds 4 and 5 to Pond C)

Thirty-three (33) sediment/soil samples and nine sediment samples were collected from EA 8 during the 2009/2010 sampling event. Pond 4 and 5 sample locations were determined by established transect lines. Two samples (0- to 0.3-m [0- to 1-ft] bgs and 0.3- to 1.2-m [1- to 4-ft] bgs) were taken at each end of the transect line in dry soil ~0.91-m (3-ft) away from the water line. Also, one manually collected sediment sample was obtained from 0- to 0.15-m (0- to 0.5-ft) bgs for each transect line. P-Area Discharge Canal sediment/soil samples were collected at transect locations that were spaced approximately every 500-m (1,640-ft) between Ponds 4 and 5 and Pond C. Sediment/soil samples were taken as described in EA2 above.

Two surface water samples were taken at Pond 4, two surface water samples were taken at Pond 5, and six surface water samples were collected from the P-Area Discharge Canal between Ponds 4 and 5 and Pond C during the 2009/2010 sampling event. Pond 4 and 5 surface water samples were collected at the transect location where the sediment/soil sample required a full analytical suite, with one water sample being filtered and the other unfiltered. Two surface water samples were collected at each transect location of the P-Area Discharge Canal, with one water sample being filtered and the other unfiltered.

Biota samples (i.e., fish tissue) were collected at Ponds 4 and 5 during the 2009/2010 sampling event. Figure 14 shows the sample locations for EA 8.

Exposure Area 9 (Pond C)

Twelve (12) sediment/soil samples and three sediment samples were collected from EA9 during the 2009/2010 sampling event. Pond C sample locations were determined by the established transect lines. Two samples were taken at each end of the transect line in dry soil ~0.91-m (3-ft) away from the water line. One sample was collected from 0- to 0.3-m (0- to 1-ft) bgs, and the second was taken from 0.3- to 1.2-m (1- to 4-ft) bgs. Also, one

manually collected sediment sample was obtained from 0- to 0.15-m (0- to 0.5-ft) bgs for each transect line.

Two surface water samples were taken at Pond C during the 2009/2010 sampling event. Pond C surface water samples were collected at the transect location where the sediment/soil sample required a full analytical suite with one water sample being filtered and the other unfiltered.

Biota samples (i.e., fish tissue) were collected at Pond C during the 2009/2010 sampling event. Figure 15 shows the sample locations for EA9.

Media Assessment Results

The characterization data was used to perform a human health risk assessment (HHRA), an ecological risk assessment (ERA), and a PTSM evaluation (SRNS 2017). Sediment/soil media was compared to USEPA regional screening levels (RSLs) for non-radionuclides and USEPA preliminary remediation goals (PRGs) for radionuclides, while surface water was compared to USEPA maximum contaminant levels (MCLs), SCDHEC ambient water quality criteria, RSLs, or PRGs as appropriate. For the HHRA, an IOU onsite worker (wetland researcher) is selected as the most likely receptor scenario for the Upper LTR IOU. A recreational fisherman scenario is also considered for EAs that can sustain populations of consumable fish. Table 2 summarizes the results of these evaluations and identifies refined constituents of concern (RCOCs) for each EA. RCOCs are those constituents that were retained following a weight-of-evidence evaluation and require remedial action. The details of the risk assessments, including references to the tables that present the screening criteria, is provide in Section VII Summary of Site Risks.

Surface water sampling was conducted as part of the RI and metals and radionuclides were detected in surface water. Several metals including mercury exceeded the SCDHEC ambient water quality criteria, while the highest detected concentration of Cs-137 in surface water was below the surface water MCL. Based on the conceptual site model considerations of the high affinity of Cs-137 for sediment/soil and low solubility in water, it was determined that Cs-137 contamination is predominantly located in sediment/soil, as

is mercury; therefore, surface water was determined to not be a media of concern and is not being directly addressed with the final remedial action. Instead, actions are proposed to address the sediment/soil as the "source" of the contamination (excavation/dredging, LUCs to reduce the chance of direct contact for humans and terrestrial ecological organisms by keeping the sediment/soil covered by water, restricting access, posting signs, restricting fishing on USDOE property, and MNR).

In summary, all EAs (EA1 through EA9) present a problem warranting remedial action. Cs-137 (+D), and to a lesser extent, Co-60 present in sediment/soil in the canals and ponds may pose a threat to human health and the environment.

In addition, for EAs that can sustain populations of consumable fish (EA3, EA6, and EA9), where the recreational fisherman scenario was determined viable, Cs-137(+D) and Hg are present in fish tissue that presents a problem warranting action.

Surface water was determined to not be a media of concern and did not pose an unacceptable risk.

A brief description of the media assessment results for each EA is provided below.

Exposure Area 1 (Pond A Including R-Area Discharge Canal)

The characterization data revealed Cs-137(+D) and Co-60, to a lesser extent, were present in the sediment/soil and may potentially pose a threat to human health and the environment. No fish samples were collected in EA1. There were no problems warranting action identified for surface water for EA1.

Cs-137(+D) was detected in 44 out of 45 samples for the 0- to 0.3-m [0- to 1-ft] depth interval, with four results being estimated values ("J" qualified, estimated values). Concentrations ranged from non-detect (ND) to 686 pCi/g with the highest detected concentration collected at location R-1, downstream of R-Area on 4/11/2005 (Figure 7). Problems warranting action for EA1 included Cs-137(+D) for the sediment/soil medium for the onsite worker.

Co-60 was detected in 15 out of 45 samples, with two results being estimated values ("J" qualified). Concentrations ranged from ND to 0.648 pCi/g with the highest detected concentration collected at R-1, downstream of R-Area on 6/13/2001 (Figure 7). Problems warranting action for EA1 included Co-60 for the sediment/soil medium for the onsite worker.

Exposure Area 2 (Canal From Pond A to Pond B)

Constituents that potentially pose a threat to human health and the environment include Cs-137(+D) in sediment/soil within EA2. No fish samples were collected in EA2. There were no problems warranting action identified for surface water for EA2.

Cs-137(+D) was detected in 21 out of 44 samples, with one sample being an estimated value (i.e., "J" qualified). Concentrations ranged from ND to 180 pCi/g with the highest detected concentration at location RDC007-001 collected on 4/14/2010 (Figure 8). Problems warranting action for EA2 include Cs-137(+D) for the sediment/soil medium for the onsite worker.

Exposure Area 3 (Pond B Including Canal to Pond C)

Constituents that pose a potential threat to human health and the environment include Cs-137(+D) for the onsite worker and recreational fisherman, and Hg for the recreational fisherman for EA3. Cs-137(+D) is present in sediment/soil while both Cs-137(+D) and Hg are present in fish samples from EA3. Surface water samples collected at Pond B during the 2009/2010 sampling event did not identify any concentrations that exceeded screening levels. There were no problems warranting action identified for surface water for EA3.

Cs-137(+D) The majority of historic data for Cs-137(+D) from Pond B were obtained from incremental analyses of two-centimeter intervals from cores collected from discrete sampling locations. To obtain an activity for Cs-137 from a discrete sampling location, the activities were combined and averaged for the results from the 0- to 0.3-m (0- to 1-ft) interval and the 0.3- to 1.22-m (1- to 4-ft) interval. Cs-137(+D) was detected in 44 out of 44 sediment/soil samples, with none being an estimated value (i.e., "J" qualified).

Concentrations ranged from 0.093 pCi/g to 456.8 pCi/g with the highest concentration detected at location Main Body near Heron Island: SCB-34 on 9/14/1994. The maximum centimeter incremental activity in Pond B was 930 pCi/g from the Main Body near Mouth of Outlet Bay: SCB-29-0 location collected from the 14- to 15-centimeter (5.5- to 5.9-inches) depth interval on 9/20/1994 (Figure 9). Problems warranting action for EA3 include Cs-137(+D) for the sediment/soil medium for the onsite worker.

Cs-137(+D) was detected in all 54 fish samples collected from Pond B. Concentrations ranged from 9.35 pCi/g to 113 pCi/g. Sample Pond B 28054 had the highest concentration, which was collected on 3/4/1998 (Figure 9). Cs-137(+D) in fish tissue were identified as a problem warranting action for the recreational fisherman receptor.

Mercury in fish was detected in 77 out of 81 samples with one result being estimated (i.e., "J" qualified). Concentrations ranged from ND to 1.83 mg/kg with the highest detected concentration collected at location Pond B-32081 on 1/1/1998 (Figure 9). Mercury in fish tissue were identified as a problem warranting action for the recreational fisherman receptor.

Exposure Area 4 (Canal from Pond B to North Arm of PAR Pond)

Constituents that pose a potential threat to human health and the environment include Cs-137(+D) for the onsite worker for EA4. No fish samples were collected in EA4. There were no problems warranting action identified for surface water for EA4.

Cs-137(+D) was detected in 24 out of 36 samples in EA4 with five of these being an estimated value (i.e., "J" qualified). Concentrations ranged from ND to 50 pCi/g, with the highest detected concentration collected at location RDC015-001 on 4/20/2010 (Figure 10). Cs-137(+D) in sediment/soil were identified as a problem warranting action for the IOU onsite worker.

Exposure Area 5 (Joyce Branch [Old Discharge Canal])

Constituents that pose a potential threat to human health and the environment include Cs-137(+D) and Co-60 in sediment/soil for EA5. No fish samples were collected in EA5. There was no problem warranting action for surface water for EA5.

Cs-137(+D) was detected in 17 out of 17 sediment/soil samples with none of these results being an estimated value (i.e., "J" qualified). Concentrations ranged from 1.7 pCi/g to 405 pCi/g, with the highest detected concentration collected at location LTR Environmental Restoration Data Management System (ERDMS) IOULTR2 Sampling Event: LTROU-02 on 4/28/2004 (Figure 11). Cs-137(+D) in sediment/soil was identified as a problem warranting action for the IOU onsite worker.

Co-60 was detected in 6 out of 17 sediment/soil samples with no results being estimated values (i.e., "J" qualified). Concentrations ranged from ND to 1.83 pCi/g, with the highest detected concentration collected at location LTR ERDMS IOULTR2 Sampling Event: LTROU-02 on 4/28/2004 (Figure 11). Co-60 was identified as a problem warranting action in sediment/soil for the IOU onsite worker for EA5.

Exposure Area 6 (PAR Pond)

Constituents that pose a potential threat to human health and the environment include Cs-137(+D) and Co-60 in sediment/soil, and Cs-137(+D) and Hg for fish tissue for EA6. There were no problems warranting action identified for surface water for EA6.

Cs-137(+D) was detected in 510 out of 540 sediment/soil samples, with one of these results being an estimated value (i.e., "J" qualified). Concentrations ranged from ND to 124 pCi/g. Sample location PAR Pond Sediment Fish: PF3-5 had the highest detected concentration and was collected on 9/16/1995 (Figure 12). Cs-137(+D) was identified as a problem warranting action in sediment/soil for the IOU onsite worker for EA6.

Cs-137(+D) was detected in 160 out of 165 fish samples, with one result being estimated (i.e., "J" qualified). Concentrations ranged from ND to 18.4 pCi/g. Sample PAR Pond 28055 had the highest activity concentration and was collected on 9/2/1993 (Figure 12).

On average, Cs-137 levels in fish tissue were 11.09 pCi/g. Cs-137(+D) in fish tissue was identified as a problem warranting action for the recreational fisherman for EA6.

Co-60 was detected in 132 out of 259 sediment/soil samples, with no results being estimated values ("J" qualified). Concentrations ranged from ND to 1.13 pCi/g, with the highest detected concentration at location PAR Pond Sediment Fish: PF3-5 collected on 9/16/1995 (Figure 12). Co-60 was identified as a problem warranting action in sediment/soil for the IOU onsite worker for EA6.

Mercury was detected in 224 out of 227 fish samples in which 38 of these results are estimated (i.e., "J" qualified). Concentrations ranged from ND to 3.18 mg/kg. Sample PAR Pond Sediment Fish PF2-2 105808 had the maximum detected fish concentration collected on 9/26/1995 (Figure 12). Mercury in fish tissue was identified as a problem warranting action for the recreational fisherman for EA6.

Exposure Area 7 (Canal from P-Area to Ponds 5 and 6 Including Pond 2)

Constituents that pose a potential threat to human health and the environment include Cs-137(+D) and Co-60 in sediment/soil for EA7. No fish samples were collected within EA7. There was no problem warranting action for surface water for EA7.

Cs-137(+D) was detected in 97 out of 138 sediment/soil samples with four of these results being estimated (i.e., "J" qualified). Activity concentrations ranged from ND to 149 pCi/g, with the highest activity concentration at location Pond 2 P25-019-01 on 3/9/2000 (Figure 13). Cs-137(+D) was identified as a problem warranting action for sediment/soil for the onsite worker for EA7.

Co-60 was detected in 18 out of 109 sediment/soil samples with one result being estimated (i.e., "J" qualified). Activity concentrations ranged from ND to 15.5 pCi/g, with the highest activity concentration at Pond 2 P25-007-01 on 3/9/2000 (Figure 13). Co-60 was identified as a problem warranting action in sediment/soil for the IOU onsite worker for EA7.

Exposure Area 8 (Ponds 4 and 5 Including Canal from Ponds 4 and 5 to Pond C)

Constituents that pose a potential threat to human health and the environment include Cs-137(+D) and Co-60 in sediment/soil for EA8. Although fish samples were collected in Ponds 4 and 5, this pond system is not considered viable for fishable fish populations. There were no problems warranting action identified for surface water for EA8.

Cs-137(+D) was detected in 59 out of 71 sediment/soil samples with four of these results being estimated (i.e., "J" qualified). Activity concentrations ranged from ND to 125.6 pCi/g, with the highest activity concentration at location Pond 5 P25-042-01 on 3/27/2000 (Figure 14). Cs-137(+D) was identified as a problem warranting action for sediment/soil for the onsite worker for EA8.

Co-60 was detected in 5 out of 73 sediment/soil samples with one result being estimated (i.e., "J" qualified). Activity concentrations ranged from ND to 0.586 pCi/g with the highest activity concentration at Pond 4 (P25-022-01) on 3/2/2000 (Figure 14). Co-60 was identified as a problem warranting action in sediment/soil for the IOU onsite worker for EA8.

Exposure Area 9 (Pond C)

Constituents that pose a potential threat to human health and the environment include Cs-137(+D) and Co-60 in sediment/soil, and Cs-137 (+D) and Hg in fish for EA9. No problem warranting action was identified for EA9 based on surface water data.

Cs-137(+D) was detected in 51 out of 54 sediment/soil samples with four of these results being estimated (i.e., "J" qualified). Activity concentrations ranged from ND to 116.5 pCi/g, with the highest activity concentration at location Pond C Site No. 3 Elevation 59.5 m (195 ft) on 7/30/1991 (Figure 15). Cs-137(+D) was identified as a problem warranting action for sediment/soil for the onsite worker for EA9.

Cs-137(+D) was detected in 2 out of 2 fish samples with no result being estimated (i.e., "J" qualified). Concentrations ranged from 1.18 pCi/g to 42.5 pCi/g. Sample LTR-PC had the highest activity concentration and was collected on 4/14/2010 (Figure 15). Cs-137(+D) in

fish tissue was identified as a problem warranting action for the recreational fisherman for EA9.

Co-60 was detected in 4 out of 24 sediment/soil samples with none of these results being estimated (i.e., "J" qualified). Activity concentrations ranged from ND to 0.448 pCi/g (Figure 15). The maximum, 0.448 pCi/g was from location Pond C SED-12, Pond C SED-28. Co-60 was identified as a problem warranting action for sediment/soil for the onsite worker for EA9.

Mercury was detected in 2 out of 2 fish samples with one result being estimated (i.e., "J" qualified). Concentrations ranged from 0.0206 mg/kg to 0.244 mg/kg. Sample LTR-PC had the maximum detected fish concentration and was collected on 4/14/2010 (Figure 15). Mercury in fish tissue was identified as a problem warranting action for the recreational fisherman for EA9.

Site-Specific Factors

The entire SRS became the nation's first National Environmental Research Park (NERP) in 1972. The LTR IOU, wetlands and pond systems have been actively studied as part of the NERP for various investigative purposes. The primary onsite entities that conduct research within the LTR IOU are the Savannah River Ecology Laboratory (SREL [University of Georgia]) and the Savannah River National Laboratory (SRNL). The emphasis in recent years has primarily been on aspects of radioecology in the Pond A, Pond B, and PAR Pond systems. The LTR IOU also contains a USDOE Research Set-Aside Program reserve area that provides a reference site for investigating human impacts on the environment. The SREL administers the Set-Aside program and coordinates activities to maintain the natural state of the area. The Boiling Springs Natural Area is a set-aside located in the Lower subunit of the LTR IOU adjacent to the LTR stream corridor. It is the only known intact old-growth (over 200 years) beech-magnolia-pine association climax forest known to exist on the SRS. The Boiling Springs Natural Area was registered in 1957 with the Society of American Foresters national system of Natural Areas.

Contaminant Transport Analysis

The mobility of Cs-137, the primary contaminant, from sediment/soil within the Upper subunit is variable for each EA (pond/canal) but general aspects abide in all. In both aquatic and terrestrial environments, strong binding of Cs-137 to sediment/soil reduces both the mobility of Cs-137 and assimilation by humans and other biota. In general, mobility of sediment/soil in the system is restricted by the inlet and outlet structures such as those in the R-Area Discharge Canal, the diversion box for Joyce Branch, the inlet/outlet structures for the pre-cooler ponds, and Pond B, Pond C, and PAR Pond dam infrastructures. Also, since high reactor cooling-related discharges are no longer occurring, the canals serve as a sink with limited pooling and movement that is now facilitated only by precipitation events. As a gravity-fed system, overall movement within the canal system would be toward PAR Pond. In situations where dams and weirs are present, such as PAR Pond, the infrastructure serves as a sedimentation barrier for sediment/soil transport. These sedimentation barriers maintain the depositional environment within each EA.

VI. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

Land Uses

Current land use in the LTR IOU is mixed. Industrial areas, including PAOU and RAOU, cover less than 10% of the SRS portion of the LTR watershed. The remainder of the watershed consists of managed forests, wetlands/floodplain habitats, and surface water impoundments and is no longer used for industrial purposes. The LTR IOU Upper subunit (including ponds and canals) and the Middle subunit (below PAR Pond dam) are well within the SRS property boundary. The Lower subunit includes a strip of USDOE property on both sides of the stream (tail portion) and is bounded on both sides by private property, some of which includes residential parcels. The USDOE-owned tail is ~0.20- to 0.40 km (0.125- to 0.25-mi) wide. There are four public road crossings, two power line crossings, and a railroad crossing along the tail portion of LTR (Figure 16).

According to the SRS Future Use Project Report (USDOE 1996), residential uses of SRS land should be prohibited. The Land Use Control Assurance Plan (LUCAP) for the SRS (WSRC 1999) designates the industrial areas within the Upper subunit of the LTR IOU. The LTR IOU (stream system/associated wetlands) is no longer used for industrial purposes. No future development or use of the LTR IOU is planned. The future land use is reasonably anticipated to remain non-residential, and primarily used for environmental/ecological research by the SREL and SRNL with USDOE maintaining control of the land.

Groundwater Uses/Surface Water Uses

Groundwater is not a part of the LTR IOU. Groundwater associated with the LTR IOU is addressed through the RAGW OU and the PAGW OU.

The use of surface water as a potential drinking water source, for irrigation, or for recreational purposes, is not anticipated for the LTR IOU until the concentrations of hazardous substances are below levels that allow for unrestricted use. Based on decay projections of Cs-137 activities, levels of Cs-137 in sediment/soil will be above 1.0E-04 risk levels for another 50-100 years and will not be below the 1.0E-06 risk level in all EAs for ~290 years. (SRNS 2020a).

VII. SUMMARY OF OPERABLE UNIT RISKS

Baseline Risk Assessment

As a component of the RI process, a BRA was performed to evaluate risks associated with the LTR IOU (SRNS 2017). The BRA estimates what risks the site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. The BRA includes the HHRA, ERA, and a PTSM evaluation. This section of the ROD summarizes the results of the BRA for the LTR IOU (SRNS 2017).

Summary of Human Health Risk Assessment

The LTR IOU Upper subunit was assessed as nine separate EAs in the HHRA. A streamlined approach that considered both standardized and site-specific receptor scenarios/exposure assumptions was used for this evaluation. Details of the HHRA are provided in Appendix B of the RI/BRA (SRNS 2017).

The standard USEPA future resident exposure scenario evaluates long term risks to individuals expected to have unrestricted use of the unit. It assumes that residents (adults and children) hypothetically live on the unit and are exposed chronically, both indoors and outdoors, to unit contaminants. The exposure assumptions for this scenario are 26 years, 350 days per year, and 24 hours per day.

The future resident receptor scenario is also evaluated for the surface water media. This includes a comparison of constituents to surface water threshold levels based on regulatory-based limits (i.e., maximum contaminant levels) or risk-based threshold values, as appropriate.

The future industrial worker exposure scenario is also a standard USEPA scenario which addresses long-term risks to workers who are exposed to unit contaminants within an industrial setting. The exposure assumptions for this scenario are 25 years, 250 days per year, and 8 hours per day.

The site-specific IOU onsite worker receptor scenario involves a worker who is performing maintenance, collecting samples, or conducting research within the LTR IOU. The exposure assumptions for the onsite worker are 20 years, 150 days per year, and 8 hours per day. These site-specific parameters were based on input provided by the SREL for a typical wetlands researcher. The IOU onsite worker was selected as the most likely receptor for exposure to contaminated sediment/soil in the Upper subunit.

The recreational fisherman receptor scenario is site specific and describes a person who fishes in the LTR IOU infrequently. This exposure scenario is evaluated by comparing fish tissue concentrations to receptor-based threshold levels for fish based on ingestion of

fillets. The exposure assumptions for fish ingestion are 54 grams (1.7 ounces) of fish fillet ingested per day, 350 days/year, for 26 years. Risk estimated for sediment/soil media for this receptor is not presented in the BRA since the onsite worker exposure assumptions are more conservative (i.e., results in higher risk) and bounds the risk for exposure to this media.

The potential exposure pathways for evaluation of human receptors include:

- Exposure to surface sediment/soil media (0 to 0.3 m [0 to 1 ft]) via incidental ingestion, dermal contact, inhalation, and external exposure from radionuclides.
- Exposure to surface water media via ingestion, dermal contact, inhalation, and external exposure from radionuclides (drinking water standard comparison only).
- Exposure to fish tissue via ingestion (risk-based threshold comparison only).

The USEPA publishes regional screening levels (RSLs) for nonradiological constituents and preliminary remediation goals (PRGs) for radiological constituents that are risk-based concentrations (or activities) that can be used to evaluate potentially contaminated waste sites. RSLs and PRGs combine current USEPA toxicity values with standard exposure factors that represent reasonable maximum exposure conditions to estimate contaminant concentrations in soil that the agency considers protective of humans over a lifetime. The concentrations are based on direct exposure pathways for which generally accepted methods, models, and assumptions have been developed for specific land use conditions.

The *USEPA Regional Screening Levels* website (USEPA 2016) was the source of RSLs used in this assessment. The website was accessed in October 2016. The generic table published in May 2016 used all default parameters for both the residential and industrial worker scenarios. The RSLs for the onsite worker and recreational fisherman scenarios were obtained by using the website calculator function to derive site-specific RSLs.

The *USEPA Superfund Radionuclide Preliminary Remediation Goals for Superfund* website (USEPA 2014) was the source of the PRGs used in this assessment. The website was accessed in October 2016. The PRGs for a residential scenario were obtained by using

the website calculator function to derive site-specific PRGs. These site-specific PRG values were calculated by eliminating the fruit and vegetable consumption pathways as standard input assumptions and using all other default parameters (SRNS 2012b). The PRGs for an industrial worker scenario were obtained from the website using the calculator function and assuming all default parameters. The PRGs for the IOU onsite worker and recreational fisherman scenarios were obtained by using the website calculator function to derive site-specific PRGs.

The first step of the formal HHRA for sediment/soil media was a data screening exercise to identify human health constituents of potential concern (COPCs). The maximum detected soil concentration for each constituent was compared to a residential RSL or PRG value and SRS background concentration, if appropriate (i.e., for naturally-occurring constituents only). Constituents that exceeded the soil media screening criteria were identified as COPCs and were carried forward to the quantified risk evaluation.

The quantitative risk assessment for sediment/soil media was implemented by a streamlined approach which used the RSLs/PRGs to calculate the human health risk estimates for each exposure scenario. For carcinogens, the risk estimate was calculated using the following equation:

Cancer Risk = (exposure point concentration / RSL or PRG) x 1.0E-06

The exposure point concentration (EPC) is identified as the lesser of the maximum detected value or the 95% upper confidence limit (UCL) of the mean concentration. Carcinogenic constituents with an individual cancer risk greater than (>)1.0E-06 were identified as human health constituents of concern (COCs).

For noncarcinogens, the hazard estimate was calculated using the following equation:

Noncancer Hazard Quotient = EPC / RSL

If the total media hazard index (HI) was less than 1, then no COCs were identified. If the total media HI was greater than or equal to (≥) 1, then the constituents were segregated based on relevant target organs. Hazard Quotients (HQs) were summed according to target

organs. Specific constituents were identified as human health COCs if their total organ HQ was ≥0.1 and the total organ HI was ≥1.

For surface water, maximum contaminant levels (MCLs) are used to screen against maximum detected concentrations and activity concentrations in water. Where MCLs are not available, the lesser of tapwater RSLs or PRGs are used. Constituents that exceed the MCL (or RSL/PRG in the absence of a MCL) thresholds are further evaluated in the refinement of COCs step (i.e., uncertainty discussion).

For fish tissue, maximum detected concentrations of each constituent detected in fish samples are compared to RSLs and PRGs for the recreational fisherman scenario. Constituents that exceed RSL or PRG thresholds are further evaluated in the refinement of COC step.

A recommendation of whether or not a human health COC should be carried forward for further remedial evaluation was based on a thorough analysis of each constituent in an uncertainty discussion (i.e., refinement step). The major categories of uncertainty used in this evaluation (as well as the ERA and PTSM evaluation) include:

- unit-related uncertainty, which includes uncertainties related to the nature and extent of contamination, consistency with history of use, and presence in background;
- data quality uncertainty and risk assessment uncertainties, which includes uncertainties related to data quality and physical characteristics; and
- risk assessment uncertainty, which includes uncertainties related to toxicity data and changes in constituent concentrations due to radioactive decay.

An additional risk calculation is also presented in the refinement step that considers radioactive decay for short-lived isotopes Co-60 (half-life = 5.3 years) and Cs-137 (half-life = 30.2 years). The Co-60 and Cs-137 datasets were decay-corrected to January 1, 2017, as appropriate. COCs that were not eliminated in the refinement process based on a weight-of-evidence evaluation were classified as human health RCOCs.

Cesium-137 and Co-60 were identified as RCOCs in sediment/soil media as detailed below. The primary pathway of concern is external exposure to radionuclides in the contaminated sediment/soil. No RCOCs were identified for surface water media in any of the EAs. For fish tissue, Cs-137 and Hg were identified as RCOCs in the RI/BRA for all of the EAs. The pathway of concern is contaminated sediment/soil to benthic/aquatic organisms to fish and ultimately to the recreational fisherman via ingestion of fish tissue. However, this conclusion was modified in the FS to acknowledge that only EA3 (Pond B), EA6 (PAR Pond), and EA9 (Pond C) can support sustainable populations of edible fish (SRNS 2017).

The Risk Assessment Guidance for Superfund Part D tables are presented for the RCOCs identified in the BRA to support the human health risk discussion. Tables 3a through 3i lists the RCOCs and their EPCs, including decay-corrected concentrations for sediment/soil media, for each EA. Table 4 provides a summary of the cancer toxicity data, and Table 5 is a summary of the non-cancer toxicity data. Tables 6 through 8 provide the calculated risk levels for each of the receptor scenarios for sediment/soil media. A summary of the conclusions of the HHRA are provided below for each EA.

HHRA Conclusion for EA1

Sediment/Soil Media

- **Resident scenario:** Cs-137(+D) (risk = 2.4E-03) and Co-60 (risk = 4.4E-06) identified as RCOCs with a total cumulative risk (TCR) = 2.4E-03. Decay-adjusted Cs-137(+D) risk = 1.9E-03, decay-adjusted Co-60 risk = 9.7E-07, and decay adjusted TCR = 1.9E-03.
- **Industrial Worker scenario:** Cs-137(+D) (risk = 1.6E-03) and Co-60 (risk = 3.0E-06) identified as RCOCs with a TCR = 1.6E-03. Decay-adjusted Cs-137(+D) risk = 1.3E-03, decay-adjusted Co-60 risk = 6.7E-07, and decay adjusted TCR = 1.3E-03.
- **IOU Onsite Worker scenario:** Cs-137(+D) (risk = 8.2E-04) and Co-60 (risk = 1.7E-06) identified as RCOCs with a TCR = 8.2E-04. Decay-adjusted Cs-137(+D) risk = 6.4E-04, decay-adjusted Co-60 risk = 3.8E-07, and decay adjusted TCR = 6.4E-04.

HHRA Conclusion for EA2

Sediment/Soil Media

- **Resident scenario:** Cs-137(+D) (risk = 8.1E-04) is identified as a RCOC; decay-adjusted Cs-137(+D) risk = 6.9E-04.
- **Industrial Worker scenario:** Cs-137(+D) (risk = 5.4E-04) is identified as a RCOC; decay-adjusted Cs-137(+D) risk = 4.6E-04.
- **IOU Onsite Worker Scenario:** Cs-137(+D) (risk = 2.7E-04) is identified as a RCOC; decay-adjusted Cs-137(+D) risk = 2.3E-04.

HHRA Conclusion for EA3

Sediment/Soil Media

- **Resident scenario:** Cs-137(+D) (risk = 1.6E-03) is identified as a RCOC; decay-adjusted Cs-137(+D) risk = 9.8E-04.
- **Industrial worker scenario:** Cs-137(+D) (risk = 1.1E-03) is identified as a RCOC; decay-adjusted Cs-137(+D) risk = 6.5E-04.
- **IOU Onsite worker scenario:** Cs-137(+D) (risk = 5.5E-04) is identified as a RCOC; decay-adjusted Cs-137(+D) risk = 3.3E-04.

Fish Media

- **Recreational fisherman scenario:** Cs-137 and Hg are identified as RCOCs in fish tissue. Cs-137 (maximum concentration [max] = 113 pCi/g; PRG = 0.054 pCi/g) and Hg (max = 1.83 mg/kg; RSL = 0.154 mg/kg) in fish tissue exceeds risk-based screening levels for the recreational fisherman (ingestion of fish fillets).

HHRA Conclusion for EA4

Sediment/Soil Media

- **Resident scenario:** Cs-137(+D) (risk = 3.0E-04) is identified as RCOC; decay-adjusted Cs-137(+D) risk = 2.6E-04.

- **Industrial Worker scenario:** Cs-137(+D) (risk = 2.0E-04) is identified as a RCOC; decay-adjusted Cs-137(+D) risk = 1.7E-04.
- **IOU Onsite Worker scenario:** Cs-137(+D) (risk = 1.0E-04) is identified as a RCOC; decay-adjusted Cs-137(+D) risk = 8.8E-05.

HHRA Conclusion for EA5

Sediment/Soil Media

- **Resident scenario:** Cs-137(+D) (risk = 3.8E-03) and Co-60 (risk = 2.3E-05) are identified as RCOCs with a TCR = 3.8E-03. Decay-adjusted Cs-137(+D) risk = 2.8E-03 and decay-adjusted Co-60 risk = 4.3E-06 with a decay-adjusted TCR = 2.8E-03.
- **Industrial Worker scenario:** Cs-137(+D) (risk = 2.5E-03) and Co-60 (risk = 1.6E-05) are identified as RCOCs with a TCR = 2.5E-03. Decay-adjusted cesium-137(+D) risk = 1.8E-03 and decay-adjusted Co-60 risk = 3.0E-06, with a decay adjusted TCR = 1.9E-03.
- **IOU Onsite Worker scenario:** Cs-137(+D) (risk = 1.3E-03) and Co-60 (risk = 9.1E-06) are identified as RCOCs with a TCR = 1.3E-03. Decay-adjusted Cs-137(+D) risk = 9.4E-04 and decay-adjusted Co-60 risk = 1.7E-06, with a TCR = 9.4E-04.

HHRA Conclusion for EA6

Sediment/Soil Media

- **Resident scenario:** Cs-137(+D) (risk = 1.5E-04) and Co-60 (risk = 2.9E-06) are identified as RCOCs with a TCR = 1.5E-04. Decay-adjusted cesium-137(+D) risk = 8.6E-05 and decay-adjusted Co-60 risk = 1.8E-07 with a decay-adjusted TCR = 8.7E-05.
- **Industrial Worker scenario:** Cs-137(+D) (risk = 9.7E-05) and Co-60 (risk = 2.0E-06) are identified as RCOCs with a TCR = 9.9E-05. Decay-adjusted Cs-137(+D) risk =

5.8E-05 and decay-adjusted Co-60 risk = 1.3E-07, with a decay adjusted TCR = 5.8E-05.

- **IOU Onsite Worker scenario**: Cs-137(+D) (risk = 4.9E-05) and Co-60 (risk = 1.2E-06) are identified as RCOCs with a TCR = 5.0E-05. Decay-adjusted Cs-137(+D) risk = 2.9E-05 and decay-adjusted Co-60 risk = 7.2E-08, with a TCR = 2.9E-05.

Fish Media

- **Recreational fisherman scenario:** Cs-137 and Hg are identified as RCOCs in fish tissue. Cs-137 (max = 18.4 pCi/g; PRG = 0.054 pCi/g) and Hg (max = 3.18 mg/kg; RSL = 0.154 mg/kg) in fish tissue exceeds risk-based screening levels for the recreational fisherman (ingestion of fish fillets).

HHRA Conclusion for EA7

Sediment/Soil Media

- **Resident scenario:** Cs-137(+D) (risk = 2.3E-03) and Co-60 (risk = 2.4E-05) are identified as RCOCs with a TCR = 2.3E-03. Decay-adjusted Cs-137(+D) risk = 1.3E-03 and decay-adjusted Co-60 risk = 2.6E-06 with a decay-adjusted TCR = 1.3E-03.

- **Industrial Worker scenario:** Cs-137(+D) (risk = 1.5E-03) and Co-60 (risk = 1.7E-05) are identified as RCOCs with a TCR = 1.5E-03. Decay-adjusted Cs-137(+D) risk = 8.9E-04 and decay-adjusted Co-60 risk = 1.8E-06, with a decay adjusted TCR = 8.9E-04.

- **IOU Onsite Worker scenario:** Cs-137(+D) (risk = 7.7E-04) and Co-60 (risk = 9.6E-06) are identified as RCOCs with a TCR = 7.8E-04. Decay-adjusted Cs-137(+D) risk = 4.5E-04 and decay-adjusted Co-60 risk = 1.0E-06, with a decay adjusted TCR = 4.5E-04.

HHRA Conclusion for EA8

Sediment/Soil Media

- **Resident scenario:** Cs-137(+D) (risk = 8.3E-04) and Co-60 (risk = 1.7E-06) are identified as RCOCs with a TCR = 8.3E-04. Decay-adjusted Cs-137(+D) risk = 5.7E-04 and decay-adjusted risk for Co-60 = 2.1E-07 with a decay-adjusted TCR = 5.7E-04.
- **Industrial Worker scenario:** Cs-137(+D) (risk = 5.5E-04) and Co-60 (risk = 1.2E-06) are identified as RCOCs with a TCR = 5.5E-04. Decay-adjusted cesium-137(+D) risk = 3.8E-04 and decay-adjusted Co-60 risk = 1.5E-07 with a decay adjusted TCR = 3.8E-04.
- **IOU Onsite Worker scenario:** Cs-137(+D) (risk = 2.8E-04) is identified as a RCOC; decay-adjusted Cs-137(+D) risk = 1.9E-04.

HHRA Conclusion for EA9

Sediment/Soil Media

- **Resident scenario:** Cs-137(+D) (risk = 3.4E-04) and Co-60 (risk = 3.5E-06) are identified as RCOCs with a TCR = 3.5E-04. Decay-adjusted Cs-137(+D) risk = 2.0E-04 and decay-adjusted Co-60 risk = 2.4E-07 with a decay-adjusted TCR = 2.0E-04.
- **Industrial Worker scenario:** Cs-137(+D) (risk = 2.3E-04) and Co-60 (risk = 2.4E-06) are identified as RCOCs with a TCR = 2.3E-04. Decay-adjusted Cs-137(+D) risk = 1.3E-04 and decay-adjusted Co-60 risk = 1.7E-07 with a decay adjusted TCR = 1.3E-04.
- **IOU Onsite Worker scenario:** Cs-137(+D) (risk = 1.2E-04) and Co-60 (risk = 1.4E-06) are identified as RCOCs with a TCR = 1.2E-04. Decay-adjusted Cs-137(+D) risk = 6.7E-05 and decay adjusted Co-60 risk = 9.6E-08 with a decay adjusted TCR = 6.7E-05.

Fish Media

- **Recreational fisherman scenario**: Cs-137 and Hg are identified as RCOCs in fish tissue. Cs-137 (max = 42.5 pCi/g; PRG = 0.054 pCi/g) and Hg (max = 0.244 mg/kg; RSL = 0.154 mg/kg) in fish tissue exceeds risk-based screening levels for the recreational fisherman (ingestion of fish fillets).

Summary of Ecological Risk Assessment

Ecological risk is associated with the potential for harmful effects to ecological systems resulting from exposure to an environmental stressor. A stressor is any physical, chemical, or biological entity that can induce an adverse response. Stressors may adversely affect specific natural resources or entire ecosystems, including plants and animals, as well as the environment with which they interact.

The ERA considered multiple lines-of-evidence to make a determination whether sediment/soil, surface water or biota within the LTR IOU either has in the past or has the potential in the future to pose a significant risk to wildlife receptors. These lines-of-evidence included the following: chemical analysis of the potentially impacted environmental medium, literature-based risk calculations, bioaccumulation and field tissue surveys (flora and fauna), and trophic level modeling. The ERA is conducted and presented for each of the nine EAs. Details of the ERA are provided in Appendix C of the RI/BRA (SRNS 2017).

The habitats within the LTR IOU support both terrestrial and aquatic/semi-aquatic receptors. A conservative screening-level effects evaluation used literature-based ecological threshold levels to assess (i.e., screen) sediment/soil and surface water data from potentially contaminated EAs for these receptors. The thresholds were derived from four published sources and were used in a tiered approach to evaluate both the No Observed Adverse Effects Levels and Low Observed Adverse Effect Level. These sources include: 1) the USEPA Region 4 Ecological Risk Assessment Supplement Guidance Interim Draft (USEPA 2015); 2) the Los Alamos National Laboratory (LANL) ECORISK Database Tool

(LANL 2015); 3) the SCDHEC, R.61-68, Water Classifications and Standards (SCDHEC 2014); and 4) USEPA Region 5 Ecological Screening Levels (USEPA 2003).

The screening-level ecological effects evaluation concluded that more information was needed for some constituents to more thoroughly assess the risk potential to wildlife receptors. Trophic-level modeling used site-specific data to address the uncertainty associated with relying strictly on literature-based toxicity values and exposure assumptions. More specifically, aluminum, iron, cyanide, lead, manganese, Hg, dichlorodiphenyldichloroethane (DDD), dichlorodiphenyldichloroethylene (DDE) and dichlorodiphenyltrichloroethane (DDT) were identified as constituents of potential concern. Risks posed by these contaminants to mammalian and avian receptors (river otter, raccoon, belted kingfisher, and blue heron) that represent the ecological niches of concern were assessed using contaminant exposure models that estimated contaminant intake resulting from ingestion of food, water, and sediment/soil and compared these intakes with literature-based toxicity reference values (TRVs).

The trophic modeling effort identified low-effect TRV exceedances for the kingfisher and blue heron resulting in HQs ranging from 1.7 to 3.6 due to exposure to Hg. The principal route of Hg exposure in all EAs for these receptors is the consumption of fish. Mercury typically reaches higher levels in fish tissues than in sediment or water as a result of bioaccumulation.

Mercury is ubiquitous in the environment. Relatively high levels of Hg in fish have been observed in many water bodies on the SRS including reference areas not directly affected by SRS operations. Beyond contribution of Hg from industrial sources upgradient of the SRS, a contributing factor is the atmospheric deposition of Hg from non-SRS sources, which has resulted in relatively high levels of Hg in fish throughout the Savannah River basin, including LTR and its watershed. In addition, Savannah River water contaminated with substantial amounts of Hg from industries located upstream of the SRS was used as process cooling water in the reactors and was discharged into the LTR pre-cooler ponds. Those SRS water bodies that received reactor cooling water from the Savannah River typically have elevated levels of Hg in biota compared with those that were not used for

reactor cooling. Thus, elevated Hg levels in the LTR pre-cooler ponds are unrelated to ongoing SRS industrial processes and are associated with the former use of contaminated Savannah River water by the SRS and other non-SRS related sources. There is essentially no difference in concentrations of Hg in fish tissue samples that were collected from the Savannah River upstream of the SRS (i.e., background) and from samples that were collected from the LTR IOU EAs. Considering these lines of evidence, Hg was not identified as a problem warranting action for ecological receptors.

In conclusion, the results of the ERA showed that no ecological RCOCs were identified for any EA within the LTR IOU.

Discussion of Principal Threat Source Material (PTSM)

The concept of principal threat waste and low-level threat waste, as developed by the USEPA in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] 300.430(a)(1)(iii)), is to be applied on a site-specific basis when characterizing source material. Source materials are those materials that include or contain hazardous substances, pollutants, or contaminants that can act as a reservoir for migration to surface water, or air, or that can act as a source for direct exposure (USEPA 1991). The determination of whether or not the source materials present at a waste unit would be classified as PTSM is based principally on the USEPA guidance document (USEPA 1991).

Details of the PTSM evaluation are provided in Appendix D of the RI/BRA (SRNS 2017). In determining whether the source should be preliminarily considered PTSM, the evaluation considers the cumulative effects of both the potential risk from carcinogenic constituents and the adverse health effects from non-carcinogens to human receptors. The toxicity assessment of the source material is based on the potential exposure of the onsite worker (a wetlands researcher), which is the most likely receptor scenario at the LTR IOU. The USEPA RSL website (USEPA 2016) is the source of chemical constituent risk-based threshold values, and the USEPA PRGs for Superfund website (USEPA 2014) is the source of the radionuclide threshold values used in the PTSM evaluation.

The source material from all depth intervals is preliminarily considered to be PTSM if the cumulative risk exceeds one of the following toxicity threshold criteria:

- Carcinogens: >1.0E-03 IOU onsite worker risk, and
- Non-carcinogens: IOU onsite worker HI ≥10.

If the threshold criteria for PTSM is not exceeded based on a maximum concentration, then PTSM is not present and it is not necessary to carry the assessment into an uncertainty evaluation. An uncertainty evaluation is performed on potential PTSM constituents using similar criteria as that done for the identification of human health RCOCs. This includes, but is not limited to, frequency of detection and comparing to maximum detected activity concentrations or EPCs for specific radionuclides that are decay-corrected based on the half-life, as applicable. Cesium-137 is the only constituent that exceeded the preliminary screening criteria. In the refinement step, the Cs-137 95% UCL was decay corrected to January 1, 2017 (half-life = 30.2 years).

No PTSM RCOCs are formally identified for any EA within the LTR IOU. This determination is based on an evaluation of each EA as a whole using the decay-corrected 95% UCL as the EPC and the associated risks that are <1.0E-03, not individual sample results. However, EA1, EA3, and EA5 had specific locations where Cs-137 levels were above the PTSM threshold (180 pCi/g) (Figure 17). At EA1, one submerged location (R-Area Downstream of R-1) had five separate sample results above the PTSM threshold; at EA3, two submerged locations had sample results above the threshold; and at EA5, two periodically submerged locations had sample results above the threshold. These locations with higher Cs-137 activity concentrations (i.e., hotspots) were re-evaluated in the FS phase of the project to ensure that a full range of alternatives is considered in the remedy selection process.

Conclusions

In summary, analysis of all data and weight-of-evidence indicates that problems warranting action only exist for human health receptors from exposure to the sediment/soil media and

ingestion of fish tissue. No problems warranting action were identified for ecological receptors. As previously discussed, the HHRA evaluated multiple receptors for risk management purposes; however, problems warranting action are based on the IOU onsite worker receptor scenario which was selected as the most appropriate receptor for the LTR IOU.

Surface water was determined to not be a media of concern and did not pose an unacceptable risk to human or ecological receptors. Surface water sampling was conducted as part of the RI and metals and radionuclides were detected in surface water. Several metals including mercury exceeded the SCDHEC ambient water quality criteria, while the highest detected concentration of Cs-137 in surface water was below the surface water MCL. Based on the conceptual site model considerations of the high affinity of Cs-137 for sediment/soil and low solubility in water, it was determined that Cs-137 contamination is predominantly located in sediment/soil, as is mercury; therefore, surface water was determined to not be a media of concern and is not being directly addressed with the final remedial action.

In December 2016, the USEPA PRG website announced a revision to the approach for calculating PRG thresholds. The primary change was that the plus daughters (+D) option had been removed from the selection list and secular equilibrium PRGs became the preferred (default) option. The revised Cs-137 secular equilibrium PRG is 0.144 pCi/g for the IOU onsite worker. This activity corresponds to a 1.0E-06 risk; 144 pCi/g corresponds to a 1.0E-03 risk and PTSM threshold. Risks presented in the BRA were not recalculated using the secular equilibrium PRGs. However, the PTSM threshold for Cs-137 evaluated in the FS phase of the project was based on the secular equilibrium PRG, and the risk-based range of PRG concentrations were established using the updated secular equilibrium PRGs.

VIII. REMEDIAL ACTION OBJECTIVES AND CLEANUP LEVELS

This section discusses the remedial action objectives (RAOs) and cleanup levels for the Upper subunit of the LTR IOU. The goals of the remedial actions are to project human health and the environment and mitigate the effects of contamination.

Remedial Action Objectives

RAOs are media- or IOU-specific objectives for protecting human health and the environment. RAOs usually specify potential receptors and exposure pathways and are identified during project scoping once the CSM is understood. RAOs describe what the remediation must accomplish and are used as a framework for developing remedial alternatives. The RAOs are based on the nature and extent of contamination, threatened resources, and the potential for human and environmental exposure. The following RAOs are identified for the Upper subunit of the LTR IOU and are protective of the onsite worker:

- Protect IOU onsite workers from exposure to Cs-137 and Co-60 in sediment/soil that exceed 1.0E-06 risk threshold or background levels. The primary exposure route of concern is the external radiation pathway.
- Protect the recreational fisherman from exposure to Cs-137 and Hg in fish tissue that exceed risks of 1E-06 and HQ of 1, respectively. The primary route of exposure is the ingestion of fish pathway.

Cleanup Levels

PRGs (previously referred to as remedial goal options in earlier documentation) serve to provide a range of cleanup levels for each RCOC and are typically identified along with the RAOs. Following public comment and approval of the PP, the final cleanup levels for the selected remedy are chosen from the PRGs and documented in the ROD. Cleanup levels were previously referred to as remedial goals in earlier documentation.

Cleanup levels can be qualitative statements or numerical values often expressed as concentrations in soil and groundwater, or actions (installation of engineered barriers, placement of caps and covers, etc.) that achieve the RAO. These cleanup levels are either concentration levels that correspond to a specific risk or hazard or are based on Applicable, or Relevant and Appropriate Requirements (ARARs). Final cleanup levels will be monitored to determine when the remedial action is complete.

Cleanup levels were calculated for the IOU onsite worker and recreational fisherman receptor to correspond to a target cancer risk of 1.0E-06 or target HQ of 1 and are presented in Table 9.

Figure 18 is a map of the human health RCOC locations that exceed the cleanup levels for the IOU onsite worker scenario. Figure 19 is a map of the human health RCOC locations that exceed the cleanup levels for the hypothetical recreational fisherman scenario.

Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA, as amended by the Superfund Amendments Reauthorization Act (SARA), requires that remedial actions for cleanup of hazardous substances must comply with requirements and standards set forth under Federal and State environmental laws and regulations that are applicable or relevant and appropriate (i.e., ARARs). ARARs include only Federal or State environmental or facility laws and regulations and do not include occupational safety or worker protection requirements. SARA requires that the remedial action for a site meet all ARARs unless a waiver is invoked.

ARARs consist of two sets of requirements: those that are applicable, and those that are relevant and appropriate. Applicable requirements are those substantive standards that specifically address the situation at a CERCLA site and are promulgated under Federal or State environmental laws. If a requirement is not applicable, it may still be relevant and appropriate. "Applicability" is a legal and jurisdictional determination, while the determination of "relevant and appropriate" relies on professional judgment, considering environmental and technical factors at the Site. A requirement may be "relevant", in that it covers situations similar to that at the Site but may not be "appropriate" to apply for various reasons and, therefore, not well suited to the site. In some situations, only portions of a requirement or regulation may be judged relevant and appropriate; if a requirement is applicable, however, all substantive parts must be followed. In addition, to ARARs, many Federal and State environmental and public health programs include criteria, guidance, and proposed standards that are not legally binding but provide useful approaches or

recommendations. Such information is required to-be-considered when cleanup levels are developed.

Key ARARs associated with each alternative are discussed in more detail in the Description of Alternatives section.

IX. DESCRIPTION OF ALTERNATIVES

This section presents and summarizes the remedial alternatives for the final remedy for the LTR IOU. The LTR IOU FS included the identification and screening of technologies, development and screening of alternatives, and a detailed analysis of remedial alternatives (SRNS 2020a).

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

The range of alternatives includes options that 1) reduce the contaminant volume and need for long-term management; or 2) limit future exposure to contaminated media. As required by the NCP, the No Action alternative is provided as a baseline for comparison.

Seven alternatives (Alternatives A-1 through A-7) were evaluated in the FS for the LTR IOU (SRNS 2020a). Alternative A-4 *Broadcast of Amendments to Limit Bioavailability* and Alternative A-7 *Excavation and Disposal of All Contaminated Sediment/Soil* were not retained for the detailed analysis in the FS.

Five alternatives were retained for the comparative analysis in the FS (SRNS 2020a) and are summarized below.

Alternative A-1 – No Action

Alternative A-1 is required by the NCP to serve as a baseline for comparison with other remedial alternatives. The No Action alternative is considered for the entire Upper subunit of the LTR IOU. Under this alternative, no effort would be made to control access, limit exposure, or reduce toxicity, mobility, or volume of RCOC at the LTR IOU. This

alternative would leave the Upper subunit in its current condition with no additional controls. The RAOs would not be achieved through the implementation of this alternative. No costs are associated with this alternative. This alternative does not include a five-year remedy review.

Alternative A-2 – Land Use Controls with Monitored Natural Recovery

Alternative A-2 involves the use of LUCs to limit access to the entire Upper subunit of the LTR IOU and MNR for all EAs. The MNR component includes monitoring the decay of Cs-137 and Co-60 in sediment/soil as well as the consideration of Cs-137 and Hg in fish for fishable EAs (EA3 [Pond B]; EA6 [PAR Pond]; and EA9 [Pond C]).

LUCs include engineering controls (i.e., signs, gates) and institutional controls (i.e., deed restrictions, worker protective programs) to limit inadvertent human exposure by restricting and controlling access to contaminated areas. LUCs would be implemented at each EA by posting warning and "No Trespassing" signs at access points. "No Unauthorized Fishing" signs will be posted at access points that approach viable surface water bodies (EA3 [Pond B]; EA6 [PAR Pond]; and EA9 [Pond C]) that maintain fishable fish populations. Compliance with the Site Use Program and other associated procedures would be ensured, and deed restrictions would be in place in the event the property is ever transferred from Federal ownership.

MNR was identified to address the long-term monitoring component of LUCs for the Upper subunit. MNR is a remedy that uses ongoing, naturally-occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment/soil (USEPA 2005). The Upper subunit of the LTR IOU is conducive to the MNR remedy because natural recovery processes of radiological decay and continued sediment/soil deposition would reduce bioavailability. In addition, the anticipated land use for the LTR IOU is compatible with natural recovery

Long-term (290 years) monitoring, a component of the MNR remedy, includes consideration of sampling methods such as remote sensing (e.g., remote gamma surveys) and ground truthing (e.g., sediment/soil sampling or collection of field measurements) to

measure and document the decay of Cs-137 and Co-60 in the Upper subunit of the LTR IOU. MNR also includes consideration of biological sampling and passive sampling techniques to assess bioavailability of Cs-137 and Hg. As technology advances, new innovative sampling techniques will be employed. The MNR remedy would include a single comprehensive monitoring plan for all nine EAs that would be subject to USEPA and SCDHEC review and approval. Monitoring data would be presented in the five-year remedy reviews and would be used to document the effectiveness of a remedial action or evaluate the need for further actions. The need for continued monitoring would be re-evaluated after Cs-137 concentrations in the Upper subunit decay below the PTSM threshold.

Alternative A-2, LUCs with MNR is an appropriate remedy to be considered for the entire Upper subunit of the LTR IOU (EA1 through EA9). Alternative A-2, LUCs with MNR would be implemented in combination with other alternatives that target PTSM or maintain water levels to reduce exposure and mitigate sediment/soil migration as discussed in Alternatives A-3 through A-6. Alternative A-2, LUCs and MNR would be effective in achieving RAOs for the Upper subunit of the LTR IOU. This alternative includes five-year remedy reviews. The Operations & Maintenance (O&M) costs associated with the five-year remedy review are only included in Alternative A-2.

Summary of Costs

Entire Upper Subunit (EA1 through EA9)	
Capital Cost	$696,168
O&M Cost	$16,624,973
Total Present-Worth Cost	$17,321,141

Alternative A-3 – In Situ Capping on PTSM Sediment/Soil (Including Consideration of a Hybrid Cap)

Alternative A-3 consists of placing a defined barrier (cap) over the identified subaqueous (or floodplain sediment/soil) PTSM sediment/soil identified at EA1, EA3 and EA5. Caps are generally constructed of sand and/or gravel; however, a more complex cap design could include the addition of an amendment. The cap would be designed to reduce risk through the following primary functions:

- Physical isolation of the Cs-137 contaminated sediment/soil, sufficient to reduce exposure due to direct contact and to reduce the ability of burrowing organisms to move contaminants to the surface;
- Stabilization of contaminated sediment/soil and erosion protection of sediment/soil and cap, sufficient to reduce resuspension and transport; and/or
- Sequestration of Cs-137 through the use of an amendment added to the cap material to reduce bioavailability.

In-situ capping can quickly reduce exposure to contaminants and requires minimal worker exposure to contaminated sediment/soil during placement. A cap often provides a clean substrate for recolonization by bottom-dwelling or riparian organisms. Resuspension of contaminated sediment/soil is minimal during cap placement. Erosion protection for in-situ caps in shallow water bodies or floodplain/wetland environments may require the use of a stone armor, essentially a layer of rubble used to provide a barrier of protection.

Cap placement in shallow water would be placed from the shore using conventional equipment such as a clamshell or front-end loader. During placement, best management practices (BMPs) (e.g., silt curtains) would be implemented to reduce sediment/soil migration. Placement of an in-situ cap in deeper water would require a bathymetric survey prior to installation to determine slope and cap material dispersion during placement. A barge with a surface release mechanism such as a tremie or bottom placement using conventional equipment such as clamshells would be required to place the in-situ cap in deeper water.

The performance objective of the in-situ cap is to provide sufficient physical isolation and stabilization of the Cs-137 contaminated sediment/soil until concentrations are reduced below the PTSM thresholds, which would require long-term monitoring. Inspections and maintenance activities would be implemented to ensure that there is no erosion or other physical disturbance of the cap. Prior to implementation, this alternative would require sampling to define the extent of PTSM in the identified EAs and a cap design that considers the unique site characteristics at each location. The cap design would consider the use of

an amendment to reduce bioavailability. Amended caps have the potential to reduce the thickness of traditional caps and improve the resistance to erosional events and advective transport of Cs-137. Implementation of this alternative would involve significant mobilization and demobilization of heavy equipment and materials, clearing of vegetation, radiological controls, and a post-installation verification to ensure the placement and thickness of the cap. This alternative would be combined with Alternative A-2 LUCs with MNR to achieve the RAOs. This alternative includes five-year remedy reviews. The O&M costs associated with the five-year remedy reviews are included in Alternative A-2.

Summary of Costs

EA1	
Capital	$325,311
O&M Cost	$91,256
Total Present-Worth Cost	$416,566

EA5	
Capital	$662,690
O&M Cost	$142,500
Total Present-Worth Cost	$805,190

EA3	
Capital	$2,536,207
O&M Cost	$92,500
Total Present-Worth Cost	$2,678,707

Alternative A-5 – Excavation, Treatment and Disposal of PTSM Sediment/Soil

Alternative A-5 involves the excavation, treatment and disposal of known PTSM sediment/soil to reduce exposure, mobility, and toxicity of the most highly contaminated media, and lower the overall risk within the associated EAs. This alternative is only applicable to EA1, EA3, and EA5 that contain localized areas of sediment/soil above the PTSM threshold. Implementation of this alternative would involve the excavation of PTSM in shallow water bodies/floodplain sediment/soil and dredging of PTSM sediment/soil from deeper ponds (EA3). Migration of suspended contaminated sediment/soil that would result from subaqueous excavation/dredging would be controlled by implementing BMPs (e.g., silt curtains) as appropriate. Excavation of shallow PTSM sediment/soil would require the use of standard commercial equipment (i.e., mini-excavator, skidsteer, dump truck) which would require special access control provisions for the remote floodplain conditions. PTSM sediment/soil located in deep water would require the use of a barge and dredging equipment. Significant mobilization would be

required to transport and launch the barge as there is currently no significant infrastructure to support large vessels. Sediment/soil would be placed into large disposal bags or containers, dewatered and treated with a drying agent before being transported to an approved waste disposal facility (e.g., Low Level Waste Facility [LLWF]). The E-Area LLWF is operated by the USDOE under the authority of the Atomic Energy Act and in accordance with USDOE Order 435.1, *Radioactive Waste Management*. The E-Area LLWF has CERCLA Off-Site Rule Acceptability issued by the USEPA Region 4 RCRA Division. A post-excavation sampling survey to ensure the effectiveness of the remedy would be required.

This action includes sampling to define the extent of PTSM in the unit, mobilization and demobilization of heavy equipment and materials, the scanning and clearing of vegetation, dewatering, installation of sediment/soil control features, sediment/soil excavation, treatment and disposal, and a post excavation sampling survey. This alternative would be combined with Alternative A-2 LUCs with MNR to achieve the RAOs. This remedy requires five-year remedy reviews. The O&M costs associated with the five-year remedy reviews are included in Alternative A-2.

Summary of Costs

EA1	
Capital	$482,986
O&M Cost	$0
Total Present-Worth Cost	$485,986

EA3	
Capital	$1,990,626
O&M Cost	$0
Total Present-Worth Cost	$1,990,626

EA5	
Capital	$795,537
O&M Cost	$0
Total Present-Worth Cost	$795,537

Alternative A-6 – Maintain Water in Ponds

Alternative A-6 consists of maintaining dam structures to sustain water levels. This alternative minimizes access and breaks a direct contact pathway that limits exposure to submerged, contaminated sediment/soil within the pond. This alternative addresses contamination in sediment and is not intended to address surface water as it is not identified

in the RI/FS as a media of concern. This action is only applicable to EA3, EA6, and EA9 that contain infrastructure to retain water and have historically maintained consistent water levels. The dams will retain water to act as a shield to submerged contamination and prevent exposure to receptors. These physical structures also act as sedimentation barriers to prevent contaminant mobilization and harm to receptors and the public. Inspections and maintenance of the water retaining structures would be required.

The dam structure for Pond B (EA3) was constructed in 1960 as a simple earthen dam with a sand toe drain system, with no spillway discharge system or monitoring devices. O&M of the dam currently includes routine inspections and repairs as needed.

The dam structure for PAR Pond (EA6) was constructed in 1958. O&M maintenance of the dam currently includes routine inspections and repairs as needed.

The dam and reverse riser (bubble-up) structure for Pond C (EA9) were completed in the early 1960's. The reverse riser structure allows water to flow from Pond C into PAR Pond. The riser uses hydraulic pressure to stabilize water elevation between the two ponds. O&M of the dam currently includes routine inspections and repairs as needed.

Alternative A-6 includes the monitoring of dam structures and water levels, annual inspections, and periodic maintenance of physical attributes that make water retention viable. Should future conditions warrant, the capability to provide additional water to PAR Pond currently exists through other site services and is expected to continue. Inspection and maintenance activities would be re-evaluated after Cs-137 concentrations in Pond B drop below PTSM levels. Also, if an inspection or maintenance activity identifies structural inadequacies with the dams, the appropriate regulatory path would be pursued. Alternative A-6 provides additional protection of human health and the environment through shielding and would be combined with Alternative A-2 LUCs with MNR to achieve the RAOs. This remedy requires five-year remedy reviews. The O&M costs associated with the five-year remedy reviews are included in Alternative A-2.

Summary of Costs

EA3	
Capital	$18,500
O&M Cost	$2,064,116
Total Present-Worth Cost	$2,064,116

EA9	
Capital	$18,500
O&M Cost	$572,676
Total Present-Worth Cost	$591,176

EA6	
Capital	$18,500
O&M Cost	$2,064,116
Total Present-Worth Cost	$2,064,116

X. COMPARATIVE ANALYSIS OF ALTERNATIVES

The NCP (40 Code of CFR 300.430(e)(9)) requires that potential remedial alternatives undergo detailed analysis using relevant evaluation criteria that will be used to select a final remedy. USEPA has established nine evaluation criteria to address the statutory requirements under CERCLA. The criteria fall into categories of threshold criteria, primary balancing criteria and modifying criteria. The nine evaluation criteria are detailed in Table 10.

The potential remedial alternatives have been evaluated against the threshold and primary balancing criterial. Provided below is a summary of the comparison of the alternatives against the CERCLA evaluation criteria. Key advantages and disadvantages for each alternative relative to one another and in relation to the two threshold criteria and five primary balancing criteria are discussed below and summarized in Table 11.

Overall Protection of Human Health and the Environment

Alternative A-1 would not be protective of human health or the environment. All other alternatives (A-2, A-3, A-5, and A-6) are protective of human health and the environment. Alternative A-2, will prevent human exposure to all contaminated sediment/soil. Contaminated sediment/soil would be left in place, but exposure pathways would be broken, and LUCs would ensure that the human receptors will not be exposed to contaminated sediment/soil. MNR would ensure that any unexpected changes to the system that would allow for human exposure to contaminated sediment/soil would be identified and mitigated.

Alternatives A-3, A-5, and A-6 each include LUCs with MNR as part of the remedy. These alternatives include additional actions. Alternative A-3 would install an integrated soil amendment/physical capping system over PTSM level contaminated sediment/soil. This would reduce the bioavailability of Cs-137 for fish. However, Alternative A-3 offers no further level of protection to human exposure as opposed to LUCs with MNR because LUCs would effectively protect human receptors from eating any contaminated fish. Alternative A-5 prescribes excavation of sediment/soil that exceed PTSM levels. This would remove the most highly contaminated sediment/soil from the unit thereby reducing the bioavailability of Cs-137 for fish. Alternative A-5 would not provide a further level of protection to human exposure as opposed to LUCs with MNR because LUCs would effectively protect human receptors from eating any contaminated fish. Alternative A-6 calls for maintaining the water levels in the ponds to preserve the existing barrier to human exposure posed by the depth of water over all contaminated sediment/soil. This would likely be achieved through continued maintenance of the existing dams. Alternative A-6 would not provide a further level of protection to human exposure as opposed to LUCs with MNR because LUCs would effectively protect human receptors from exposure to contaminated sediment/soil. Based on this logic, the overall protectiveness of each of the remedial alternatives A-2, A-3, A-5, and A-6 have been rated the same in Table 11.

Compliance with ARARs

The list of ARARs and To-Be-Considered (TBC) Criteria for the Upper Subunit of the LTR IOU are presented in Table 12. There are no ARARs associated with Alternative A-1. Alternatives A-2, A-3, A-5, and A-6 are expected to comply with the identified ARARs as shown in the comparative analysis evaluation in Table 11.

Long-term Effectiveness and Permanence

Alternative A-1 does not provide long-term effectiveness. Alternative A-2 provides excellent long-term effectiveness. LUCs with MNR would remain in place until the contaminated sediment/soil reaches cleanup levels. LUCs would ensure that the exposure pathways remain broken. MNR will identify any unexpected long-term changes to allow

for an evaluation of change in protection of human exposure to contaminated sediment/soil. Alternatives A-3, A-5 and A-6 each include LUCs with MNR as part of the remedy. Alternatives A-3 and A-6 provide additional barriers to exposure but do not shorten the time-frame for reaching RGs. Alternative A-5 would remove sediment/soil with the highest concentrations of contamination and thereby effectively shorten the timeframe for the radioactive decay mechanism to reach cleanup levels. However, the reduction in time to meet cleanup levels is relatively small. Based on this logic, the long-term effectiveness of each of the remedial alternatives A-2, A-3, A-5, and A-6 have been rated the same in Table 11.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Two of the alternatives (A-3 and A-5) apply a treatment technology. A reduction of mobility is accomplished via the use of an amendment within the hybrid cap (Alternative A-3), and with the use of a drying agent for the excavated sediment/soil (Alternative A-5) to allow safe transport and disposal. No other alternatives evaluated for the Upper subunit of the LTR IOU provide a reduction of toxicity, mobility, or volume through treatment. Based on this logic, the Reduction of Toxicity, Mobility, or Volume Through Treatment of each of the remedial alternatives A-1, A-2, and A-6 have been identified as 'none' in Table 11.

Short-term Effectiveness

Short-term effectiveness considers whether an alternative will disturb, mitigate, increase or cause injury to a natural resource. Alternative A-1 will not implement an action. Therefore, no disturbance to a natural resource will occur. Alternative A-2 would consist of administrative controls, signs, and long-term monitoring. These activities are minimally invasive and would result in no injury to a natural resource. Alternative A-3 consists of applying a cap of sand and soil amendments and is expected to create minimal disturbance. Alternative A-6 consists of maintaining the existing dams and is also likely to impose minimal disturbance. Alternative A-5 would be the most disruptive of the alternatives.

Based on this logic, the alternatives are ranked as either high or medium for short term effectiveness on the individual EAs in Table 11.

Implementability

The implementability of alternatives is determined by factors such as the ease of access to the unit, availability of materials and equipment, ability to construct and operate, technology, and ability to obtain the proper permits and approvals. All of the alternatives evaluated are implementable, the relative level of difficulty for each is identified in Table 11.

Alternative A-1 does not require implementation. Alternative A-2 would consist of administrative controls, signs, and long-term monitoring. Alternative A-6 consists of maintaining the existing dams. Most activities associated with these remedies are currently ongoing. Therefore, Alternatives A-2 and A-6 are rated as is highly implementable on Table 11.

Alternative A-3 would require mobilization of heavy equipment and installation of a sand/soil amendment type cap system over contaminated sediment/soil. Alternative A-5 would require mobilization of heavy equipment, excavation of sediment/soil, drying of sediment/soil, transport, and disposal of contaminated sediment/soil. The relative difficulty of implementation of these alternatives varies depending on the site-specific conditions. Alternatives A-3 and A-5 are identified as either difficult or of medium difficulty for individual EAs in Table 11.

Cost

A total present worth cost for each alternative was calculated for each applicable EA and is presented in Table 11. The cost estimates include capital and annual O&M costs. Capital costs include direct costs, such as construction, equipment, materials, labor, mobilization, pilot studies, disposal fees, etc., as well as indirect costs such as engineering, health and safety, project management, overhead, contingency, etc. Capital costs were derived from SRS experience, review of cost studies performed for similar technologies at other sites,

consultation from vendors, volume estimates based on RI data, etc. O&M direct costs primarily consist of labor for inspections, labor and material for maintenance, and costs of periodic (every 5 years) reviews. Indirect O&M costs also include project management, health and safety, overhead and contingency. O&M costs were primarily derived from experience at SRS and recent maintenance costs from the SRS site infrastructure organization. A present worth analysis is performed for both Capital and O&M costs. The level of detail is representative of an order of magnitude estimate with an assumed accuracy of +50%/-30%.

Cost associated with Alternative A-2 is identified for the Upper subunit of the LTR IOU in its entirety. The total estimated cost of A-2 for the Upper subunit which includes all nine EAs (EA1 through EA9) is ~$17M. The cost of this alternative is in addition to any additional remedy selected for an individual EA.

In general, costs associated with Alternatives A-3, A-5, and A-6 are in the same range at a specific EA, but they vary widely across EAs. Estimated costs of these alternatives range from ~$500K to $2.5M depending on the EA. Costs are presented for each alternative at each EA in Table 11.

XI. THE SELECTED REMEDY

Detailed Description of the Selected Remedy

The remedial action for the Middle and Lower subunits was previously documented in the *Explanation of Significant Differences (ESD) for the Revision 0 Interim Action Record of Decision Remedial Alternative Selection: PAR Pond Unit (U); Lower Three Runs Integrator Operable Unit Tail Portion Middle and Lower Subunit*s (SRNS 2012a). The remedial action implemented for the Middle and Lower subunits is protective of human health and the environment and is documented in this ROD as the final remedial action for the Middle and Lower LTR IOU subunits. No further action is needed for the Middle and Lower Subunits.

Due to the complexity of the Upper subunit, multiple remedies are needed to address the nature and extent of contamination within the LTR IOU system. The selected alternatives vary between the Upper subunit EAs. A generic CSM illustrating how the various exposure pathways are broken following implementation of the selected remedy is shown in Figure 20. The selected alternatives for the Upper Subunit of the LTR IOU are as follows:

Surface water sampling did detect metals and radionuclides in surface water. Several metals including Hg exceeded the SCDHEC ambient water quality criteria, while the highest detected concentration of Cs-137 in surface water was below the MCL. Based on the CSM considerations including the high affinity of Cs-137 for sediment/soil and low solubility in water, it was determined that Cs-137 contamination is predominantly located in sediment/soil, as is Hg; therefore, surface water was determined to not be a media of concern and is not being directly addressed with the selected remedial actions. Instead, remedial actions selected in this ROD will address the sediment/soil as the source of the contamination.

Alternative A-2 *LUCs with MNR* is the selected alternative for all nine EAs (EA1 through EA9).

Alternative A-5 *Excavation, Treatment and Disposal of PTSM Sediment/Soil* is the selected alternative for the PTSM location in EA1 (Pond A – Including R Discharge Canal) to reduce exposure and mitigate sediment/soil migration;

Alternative A-6 *Maintain Water in Ponds* is the selected alternative for EA3 (Pond B) and EA6 (PAR Pond) to maintain water levels in Pond B, PAR Pond, and Pond C to reduce exposure and mitigate sediment/soil migration; and

A comparative alternative review is provided in Table 11. The selected remedial actions for EA1 through EA9 are discussed below.

Alternative A-2 – LUCs with MNR

Alternative A-2 is the selected alternative for the entire Upper subunit (all nine EAs) and was selected because the remedy is effective in reducing exposure of contaminated media to human receptors for the entire Upper subunit and will achieve the RAOs.

The following LUC objectives are necessary to ensure protectiveness of Alternative A-2:

- Prevent contact, removal, or excavation of sediment/soil within the LTR IOU.
- Prohibit the development and use of property for residential housing, elementary and secondary schools, child care facilities and playgrounds.
- Prevent fishing within the LTR IOU.

LUCs for the LTR IOU Upper subunit selected to meet the LUC objectives are presented in Table 13 and include the following:

- Administrative/Worker Access Controls including Institutional Controls (i.e., administrative measures) and use restrictions for onsite workers as implemented under the Site Use/Site Clearance Program. Other administrative controls to ensure worker safety include work controls/work packages that include worker training, pre-work briefings, and health and safety requirements.

- SRS access controls to prevent exposure to trespassers, as described in the 2013 RCRA Permit Renewal Application, Volume I, Section F.1, which describes the security procedures and equipment, 24-hour surveillance system, artificial or natural barriers, control entry systems, and warning signs in place at the SRS boundary.

- Signage posted at each LTR IOU Upper Subunit access point as shown in Figure 21 and detailed in Figures 22 through 25. Signage includes Warning signs, Soil Contamination Area signs, and LUC sign notifications. No Unauthorized Fishing signs will be posted at access points that approach viable surface water bodies (Ponds B, C, and PAR) that maintain consumable fish populations. The date for installation of the

signs will be stated in the unit-specific Land Use Control Implementation Plan (LUCIP) referenced in this ROD.

For Joyce Branch (EA5), PTSM is present in two locations (Figure 17). EA5 is located interior to the site ~7.2 km (4.5 mi) from the SRS boundary, remotely located from site operations, and is not accessible to the public (i.e., trespassers). Therefore, a remedial action to excavate or cover the two remote PTSM locations in addition to LUCs with MNR is not warranted. Instead, more robust LUCs will be applied at EA5 in the form of additional signage at access roads and utility corridors in addition to the installation of barrier gates across roads leading to the two PTSM locations. Additional signage would also be installed along the bank near the PTSM locations.

Alternative A-5 – Excavation, Treatment and Disposal of PTSM Sediment/Soil

For EA1 (Pond A Including R Discharge Canal), the selected alternative is Alternative A-5 Excavation, Treatment and Disposal of PTSM Sediment/Soil in addition to Alternative A-2 LUCs with MNR. Alternative A-5 will remove sediment/soil from one location within EA1 that exceeds the PTSM threshold for Cs-137 and thereby will effectively shorten the timeframe for radioactive decay to reach cleanup levels from 290 years to 225 years in EA1. The location of the samples exceeding PTSM threshold for Cs-137 is presented in Figure 17.

Alternative A-5 applies a treatment technology with the use of a drying agent for the excavated sediment/soil to reduce contaminant mobility and allow for safe transport and disposal. Therefore, Alternative A-5 provides a reduction of toxicity, mobility, or volume through treatment.

Alternative A-6 – Maintain Water in Ponds

Alternative A-6 *Maintain Water in Ponds* is the selected alternative for EA3 (Pond B) and EA6 (PAR Pond). This alternative was evaluated through the timeframe that allows Cs-137 concentrations to decay below the PTSM threshold (~50 years). The PTSM decay threshold is based on two discrete sediment/soil sample locations within EA3 only

(Figures 6 and 9). This remedy is protective of human health and the environment to minimize access and to break a direct contact pathway to submerged, contaminated sediment within the ponds. This remedy includes maintenance of the dam structures so that water retention is viable and allows for natural fluctuations of water levels. In addition, the presence of the PAR Pond Dam and maintenance of the dam structures controls sediment movement downstream of the Upper subunit. Pond C (EA9) is hydrologically connected to PAR Pond (EA6) and maintains an equivalent level with PAR Pond. Therefore, the water level in Pond C (EA9) will be maintained through implementation of Alternative A-6 at PAR Pond (EA6). This alternative includes annual inspections and periodic maintenance of the physical attributes (i.e., dams, weirs, control gates, etc.) that make water retention viable. Alternative A-6 provides shielding to human receptors by allowing water to remain over the contaminated sediments but does not reduce the time to reach RGs.

In the long term, if the property, or any portion thereof, is ever transferred from USDOE, the U.S. Government and/or USDOE will take those actions necessary pursuant to Section 120(h)(1) of CERCLA. Those actions will include in any contract, deed, or other transfer document, notice of the type and quantity of any hazardous substances that were known to have been stored (for more than one year), released, or disposed of on the property. The notice will also include the time at which the storage, release, or disposal took place to the extent such information is available.

In addition, if the property, or any portion thereof, is ever transferred by deed, the U.S. Government will also satisfy the requirements of CERCLA 120(h)(3). The requirements include: a description of the remedial action taken, a covenant, and an access clause.

The LUCs will be implemented through the following:

- The contract, deed, or other transfer document shall also include restrictions precluding residential use of the property. However, the need for these restrictions may be reevaluated at the time of transfer in the event that exposure assumptions differ and/or the residual contamination no longer poses an unacceptable risk under residential use.

Any reevaluation of the LUCs will be done through an amended ROD with USEPA and SCDHEC review and approval.

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

In the event of a property lease or interagency agreement, the equivalent restrictions will be implemented as required by CERCLA Section 120(h).

The selected remedy for the LTR IOU leaves hazardous substances in place that pose a potential future risk and will require land use restrictions for as long as necessary to keep the selected remedy fully protective of human health and the environment. As agreed on March 30, 2000, among the USDOE, USEPA, and SCDHEC, SRS is implementing a LUCAP (WSRC 1999) to ensure that the LUCs required by numerous remedial decisions at SRS are properly maintained and periodically verified. The unit-specific LUCIP referenced in this ROD will provide details and specific measures required to implement and maintain the LUCs selected as part of this remedy. The USDOE is responsible for implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs selected under this ROD. The LUCIP, developed as part of this action, will be submitted concurrently with the Remedial Action Implementation Plan, as required in the FFA for review and approval by USEPA and SCDHEC. Upon final approval, the LUCIP will be appended to the LUCAP and is considered incorporated by reference into the ROD, establishing LUC implementation and maintenance requirements enforceable under CERCLA and the SRS FFA. The approved LUCIP will establish implementation, monitoring, maintenance, reporting, and enforcement requirements for the unit. The LUCIP will remain in effect unless and until modifications are approved as needed to be protective of human health and the environment. The LUCs shall be maintained until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use. Approval by USEPA and SCDHEC is required for any modification or termination of the OU-specific LUCs.

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

MNR includes sampling methods such as remote sensing (e.g., remote aerial gamma surveys) and ground truthing (e.g., sediment/soil sampling or collection of field measurements) to measure and document the decay of Cs-137 and Co-60 in the Upper subunit of the LTR IOU. MNR allows for technological advancements that could help in the collection and evaluation of data in future sampling events. MNR also includes consideration of biological sampling and passive sampling techniques to assess bioavailability of Cs-137 and Hg. The MNR remedy includes a single comprehensive monitoring plan to be developed for all nine EAs. Monitoring data will be presented in the five-year remedy reviews and will be used to document the protectiveness of the action or evaluate the need for further actions. The need for continued monitoring will be re-evaluated after Cs-137 concentrations in the Upper subunit decay below the PTSM threshold (~50 years).

The selected remedies may change as a result of the remedial design or construction processes. Changes to the remedy described in the ROD will be documented in the Administrative Record utilizing a memo, an ESD, or a ROD Amendment.

Cost Estimate for the Selected Remedy

The estimated costs to implement Alternative A-2 *LUCs with MNR* for all nine EAs (EA1 through EA9); Alternative A-5 *Excavation, Treatment and Disposal of PTSM Sediment/Soil* for the PTSM location in EA1 (Pond A – Including R Discharge Canal); and Alternative A-6 *Maintain Water in Ponds* for EA3 (Pond B) and EA6 (PAR Pond) is $22,725,665.

Remedy	Total Estimated Cost
A-2 LUCs and MNR	$17,321,141
A-5 Excavation, Treatment and Disposal of PTSM Sediment/Soil	$485,986
A-6 Maintain Water in Ponds – Pond B	$2,082,616
A-6 Maintain Water in Ponds – PAR	$2,835,922
A-6 Maintain Water in Ponds – Pond C	$591,176
	$23,316,841

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

Estimated Outcomes of Selected Remedy

Based on the information currently available, the lead agency believes that Alternative A-2 *LUCs with MNR* for the entire Upper subunit (EA1 through EA9), in addition to Alternative A-5 *Excavation, Treatment and Disposal of PTSM Sediment/Soil* for EA1, and Alternative A-6 *Maintain Water in Ponds* for both EA3 and EA6 provide the best balance of tradeoffs among the alternatives with respect to the evaluation criteria (Table 10). The USDOE expects the Selected Alternatives to satisfy the statutory requirements in CERCLA Section 121(b) to: 1) be protective of human health and the environment, 2) comply with ARARs, 3) be cost-effective, 4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable, and 5) satisfy the preference for treatment as a principal element.

Alternative A-2 is effective in reducing exposure of contaminated media to human receptors for the entire Upper subunit and will achieve the RAOs. The LUC activities are minimally invasive and will result in minimal exposure to workers during installation and monitoring, and no injury to a natural resource. The MNR component will ensure that any unexpected changes to the system that would allow for human exposure to contaminated sediment/soil or fish will be identified and mitigated.

Alternative A-6 maintains dam structures to sustain water levels and minimizes access and limits exposure to submerged, contaminated sediment/soil. This alternative also prevents the transport of contaminated sediment downstream due to the presence of the dam structures. This allows for natural fluctuations of water levels. In addition, since Pond C (EA9) is hydrologically connected to PAR Pond (EA6) and maintains an equivalent water level with PAR Pond, the water in Pond C will be maintained through implementation of Alternative A-6 at PAR Pond (EA6).

Alternative A-5 has the highest potential for worker exposure during dewatering, staging, and transportation of excavated sediment/soil, however, this alternative will permanently remove the most highly contaminated sediment/soil (i.e., ≥1E-03 risk) in a relatively accessible area (EA1). Alternative A-5 effectively shortens the time frame for the radioactive decay mechanism to reach cleanup levels. For Alternative A-5, the excavated sediment/soil will be treated with a drying agent to reduce contaminant mobility during transportation and disposal.

Alternative A-2 will consist of administrative controls, signage, and long-term monitoring while Alternative A-6 consists of maintaining the existing dams which is currently ongoing. Therefore, Alternatives A-2 and A-6 are highly implementable.

Waste Disposal and Transport

- Dewatering, staging, and removal of excavated sediment/soil associated with removal of contaminated sediment/soil, and any debris encountered, will be managed through a site-specific Waste Management Plan as CERCLA waste and disposed of at an approved waste disposal facility.
- In addition to the removed sediment/soil, the waste anticipated to be generated includes job control waste, personal protective equipment, and miscellaneous items. Prior to the transfer of these wastes to their final disposal facility, SRS will obtain an acceptability determination from the appropriate Regional Off-Site Rule Coordinator for disposal of CERCLA waste. Trees/vegetation cleared to gain access to the excavation site will be pushed aside and left near the site.

- Decontamination solutions and rinsates from cleaning items intended for reuse or recycle (e.g., field sampling tools, equipment, or personal protective equipment) may be discharged to the ground surface at an area which will not runoff or cause erosion. This method for handling decontamination solutions does not require an engineering evaluation to determine a waste disposal strategy. Decontamination wash and rinse solutions typically include laboratory grade soap and deionized water, and laboratory grade isopropyl alcohol for residual organic compound stripping and tool drying. Any residual isopropyl alcohol must be containerized and combined with the soapy wash water before the solution is discharged to the ground surface, to avoid discharging an ignitable hazardous solution.
- All unused environmental samples may be returned to the LTR IOU within the Area of Contamination. This only includes samples that have had no preservatives added.

XII. STATUTORY DETERMINATIONS

Based on the unit RFI/RI/BRA report, the LTR IOU poses a threat to human health and the environment. Therefore, Alternative A-2 *LUCs with MNR* for the entire Upper subunit (EA1 through EA9), Alternative A-5 *Excavation, Treatment and Disposal of PTSM Sediment/Soil* for EA1, and Alternative A-6 *Maintain Water in Ponds* for both EA3 and EA6 has been selected as the final remedies for the LTR IOU.

Since hazardous substances will be left in place that pose a potential future risk, land use restrictions will be required. As negotiated with USEPA, and in accordance with USEPA - Region 4 Policy (*Assuring Land Use Controls at Federal Facilities*, April 21, 1998), SRS has developed a LUCAP (WSRC 1999) to ensure that land use restrictions are maintained and periodically verified. The LTR IOU will require a specific LUCIP for the Upper subunit of the LTR IOU that will provide the details and specific measures required for the LUCs selected as part of this remedy. The approved LUCIP will establish implementation, monitoring, maintenance, reporting, and enforcement requirements for the unit. LUCIP modification will only occur through appropriate CERCLA documentation and require approval by USEPA and SCDHEC for any modification or termination of the LUCs.

The previous remedial decision selected for the Middle and Lower LTR IOU subunits was documented in an ESD issued in 2012 (SRNS 2012a). The 2012 ESD documented the selection of LUCs as the selected remedy for the Middle and Lower subunits following completion of a non-time critical removal action for contaminated sediment/soil. The non-time critical removal actions are detailed in the *Removal Action Report for the Lower Three Runs (LTR) Integrator Operable Unit (IOU) Tail Portion (Middle and Lower Subunits)* (SRNS 2013a) and the *Action Memorandum for the Non-Time Critical Removal Action for the LTR IOU Tail Portion (Middle and Lower Subunits)* (USDOE 2012). The remedial action implemented for the Middle and Lower subunits is protective of human health and the environment, and is documented in this ROD as the final remedial action for the Middle and Lower LTR IOU subunits. The Early Action Land Use Control Implementation Plan (EALUCIP) is in place for the Middle and Lower subunits describing the LUCs selected in the ESD and how the controls are implemented and maintained (SRNS 2013b). The LUC boundary established for the Middle and Lower subunits is shown in Figure 26.

Because hazardous substances will remain at the site above levels that allow for unlimited exposure and unrestricted use, the USDOE will review the remedial action for the LTR IOU Upper, Middle, and Lower subunits no less than every five years per CERCLA Section 121(c) and the NCP at 40 CFR 300.430(f)(4)(ii) until the levels of RCOCs allow for unrestricted use and unlimited exposure of soil/sediment. If results of the five-year reviews reveal that remedy integrity is compromised and protection of human health and the environment is insufficient, then additional remedial actions will be evaluated by the USDOE, USEPA, and SCDHEC.

XIII. EXPLANATION OF SIGNIFICANT CHANGES

The remedy/remedies selected in this ROD do not contain any significant changes from the preferred alternative(s) presented in the PP (SRNS 2020b). No comments were received during the public comment period.

XIV. RESPONSIVENESS SUMMARY

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

XV. POST-ROD DOCUMENT SCHEDULE AND DESCRIPTION

A summary of the key deliverables and submittal dates for the LTR IOU is shown in Figure 27 and is summarized below.

Submit Rev. 0 Record of Decision	May 6, 2021
Issuance of the Record of Decision	January 24, 2022
Submit Rev. 0 Remedial Action Implementation Plan	April 1, 2022
Submit Rev. 0 Land Use Control Implementation Plan	April 1, 2022
Remedial Action Start	April 24, 2023
Submit Rev. 0 Post Construction Report/Remedial Action Completion Report	January 21, 2025

XVI. REFERENCES

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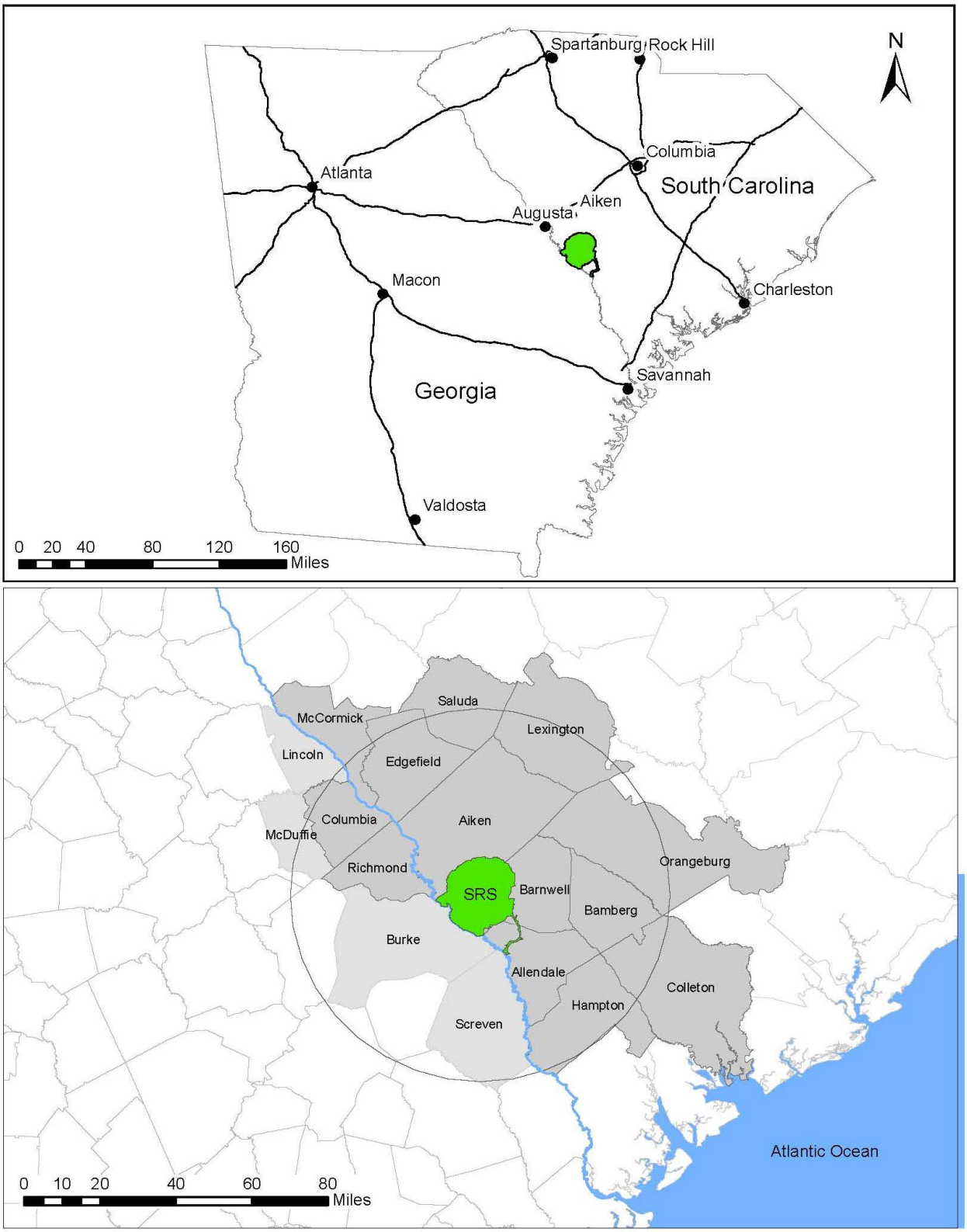

Figure 1. Location of the SRS

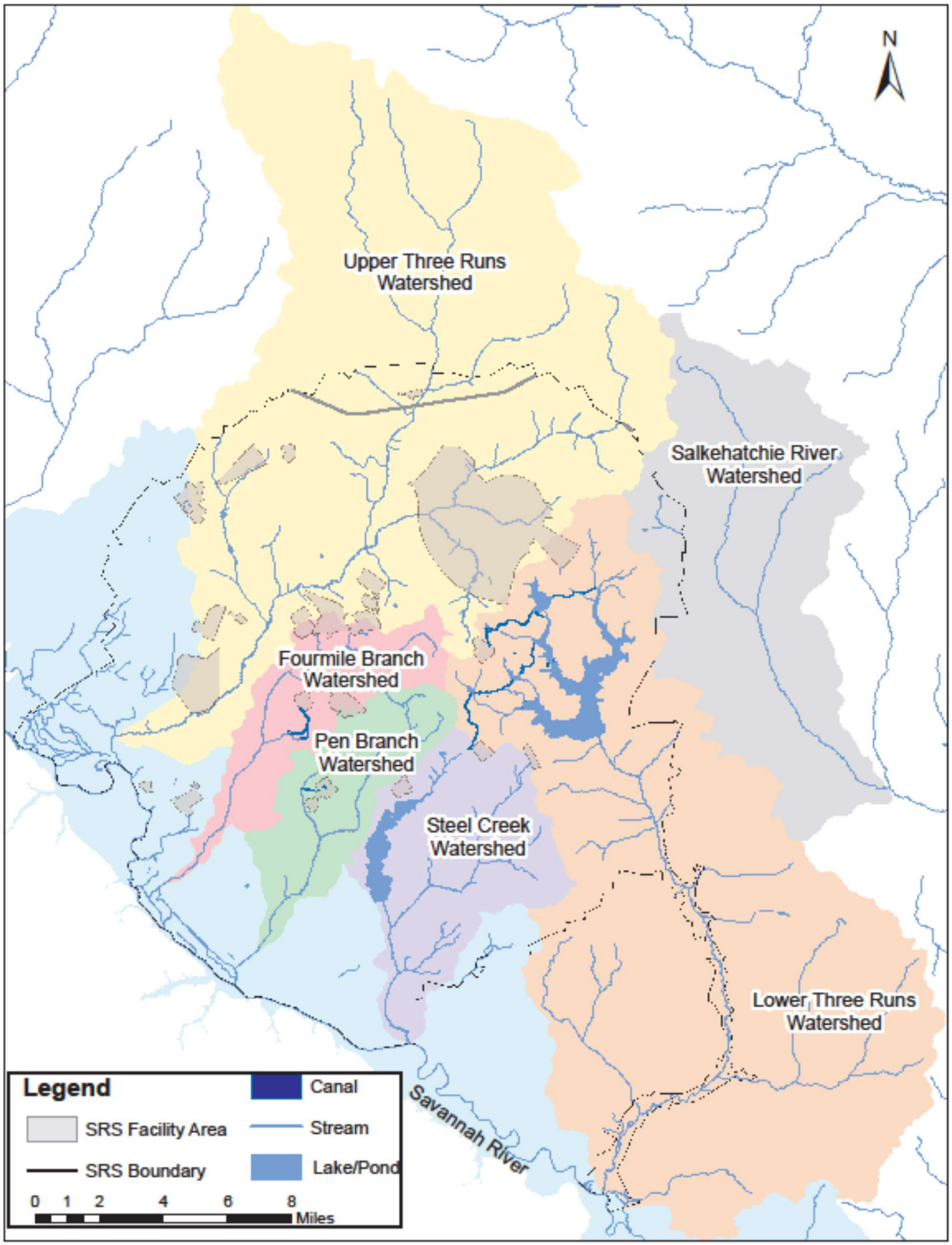

Figure 2. Location of LTR Watershed

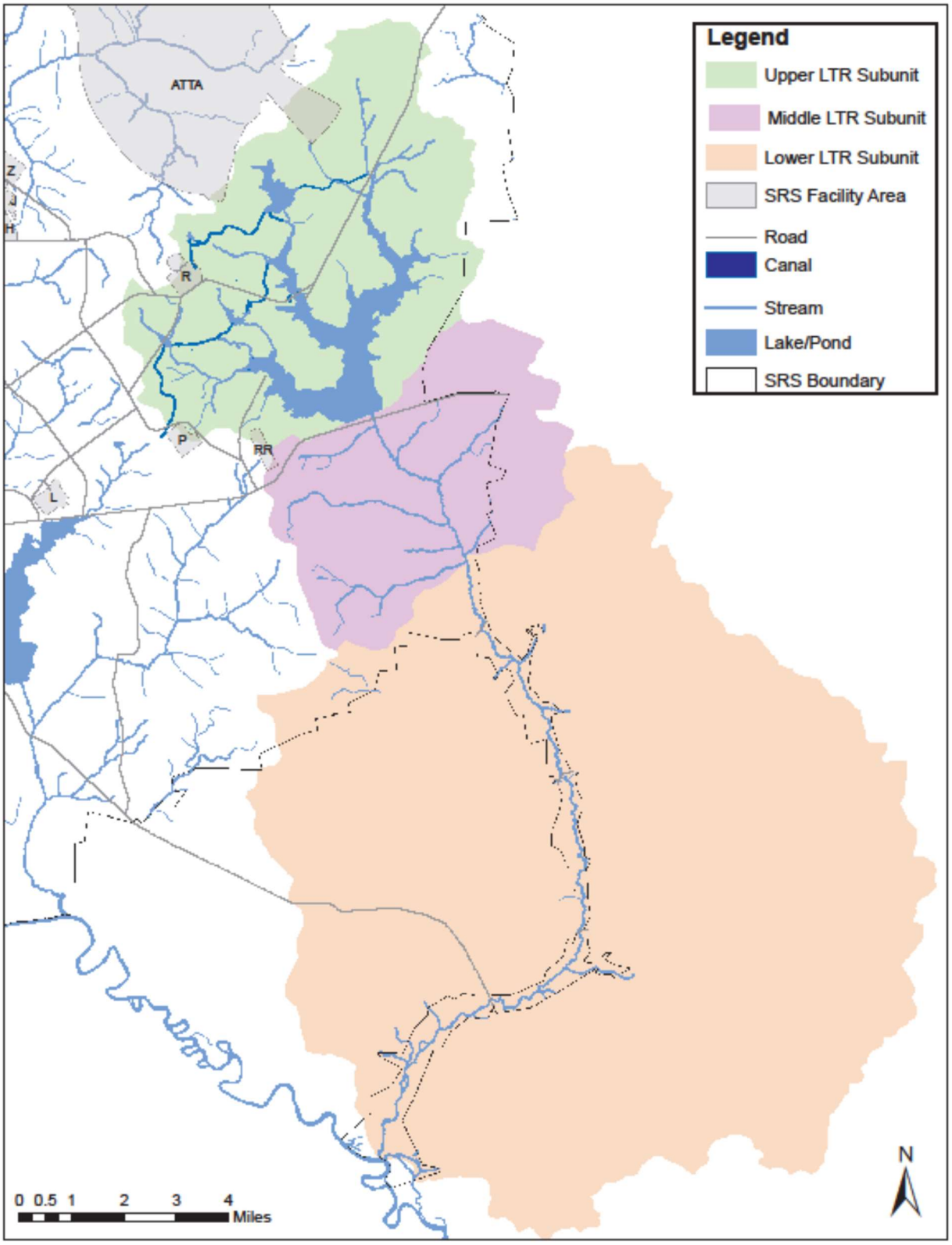

Figure 3. LTR Subunits

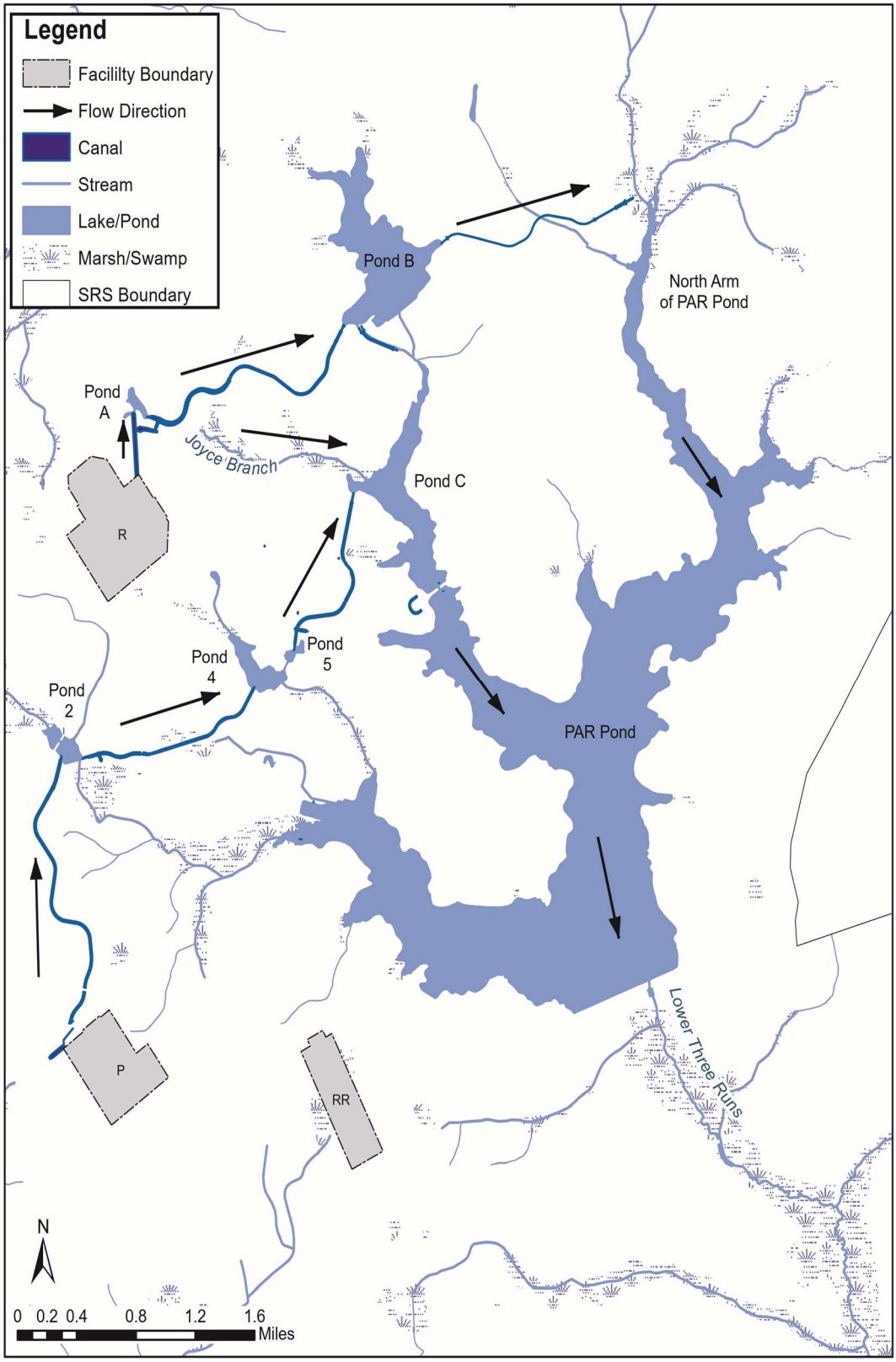

Figure 4. Flow Direction for the Upper Subunit Canal and Pond System

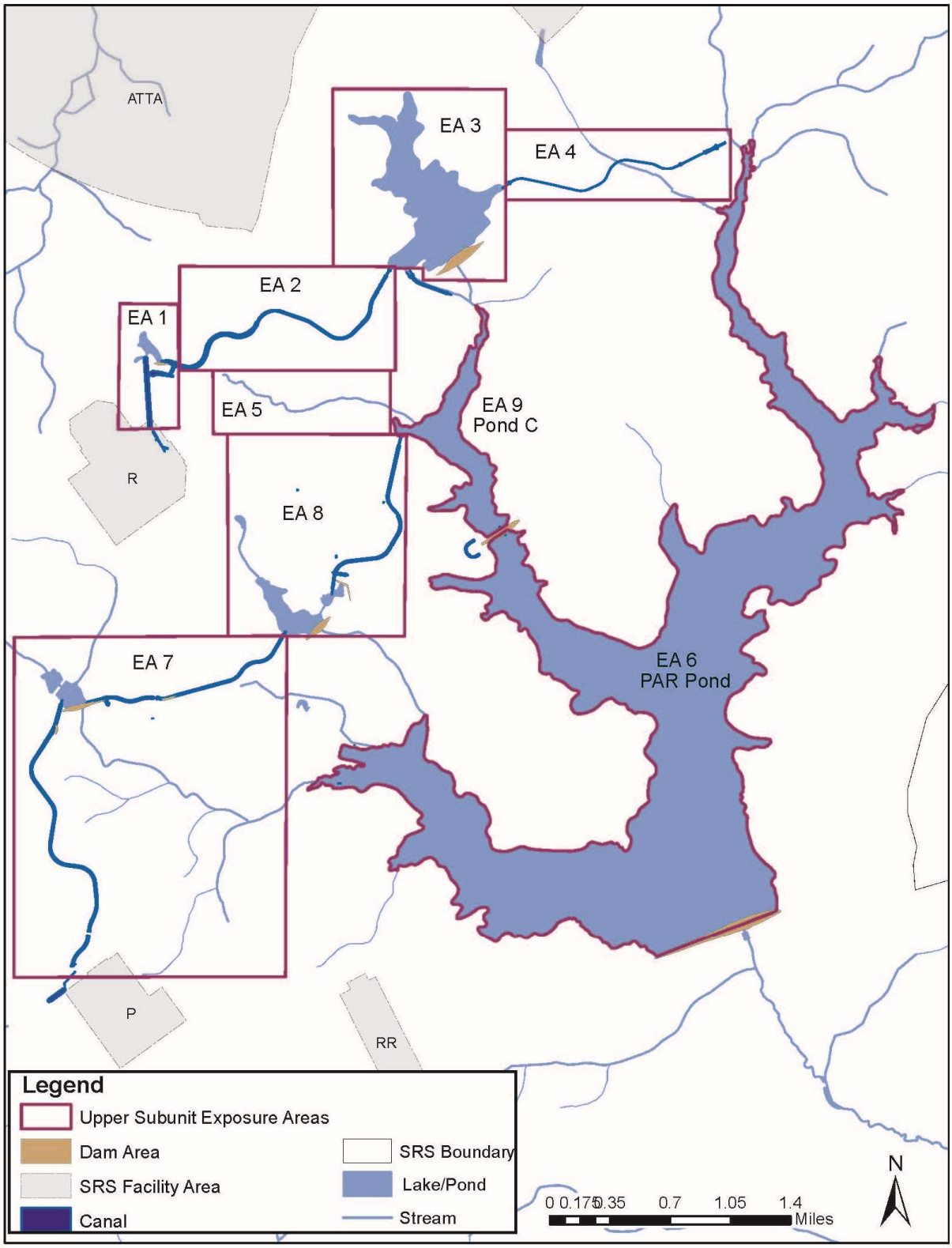

Figure 5. Exposure Areas of the Upper Subunit of the LTR IOU

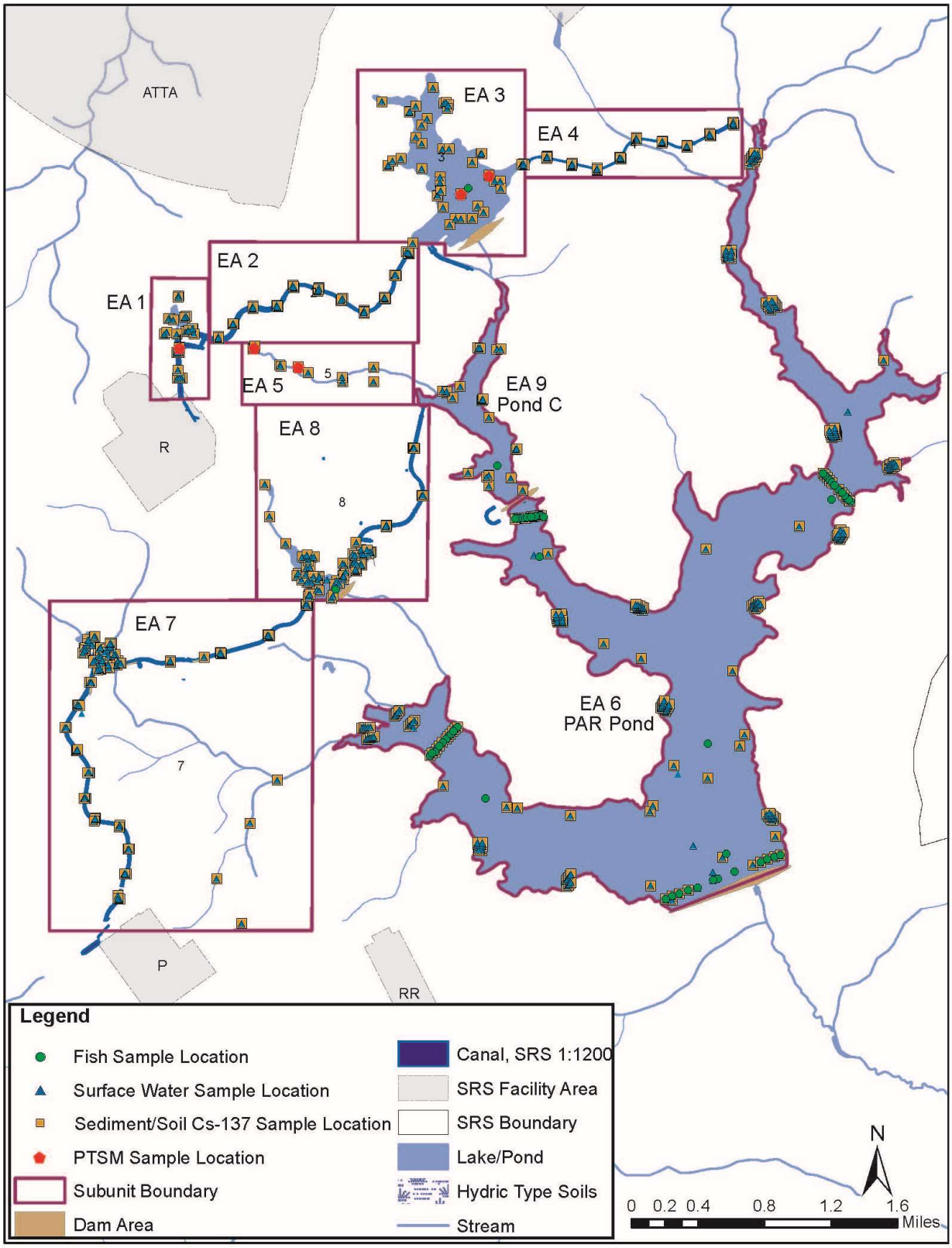

Figure 6. Sample Locations for the Upper Subunit of the LTR IOU

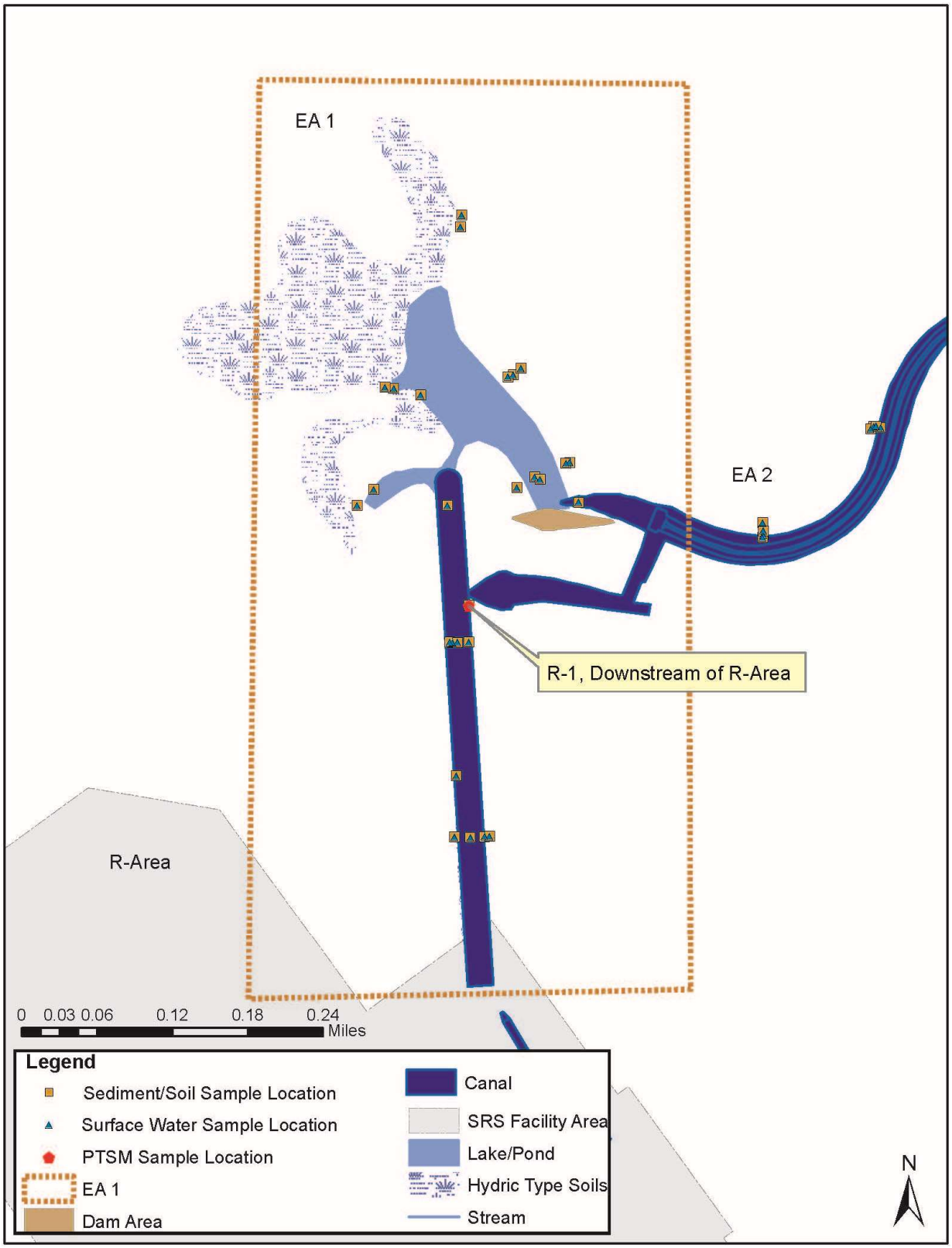

Figure 7. Sample Locations for EA1 in the Upper Subunit of the LTR IOU

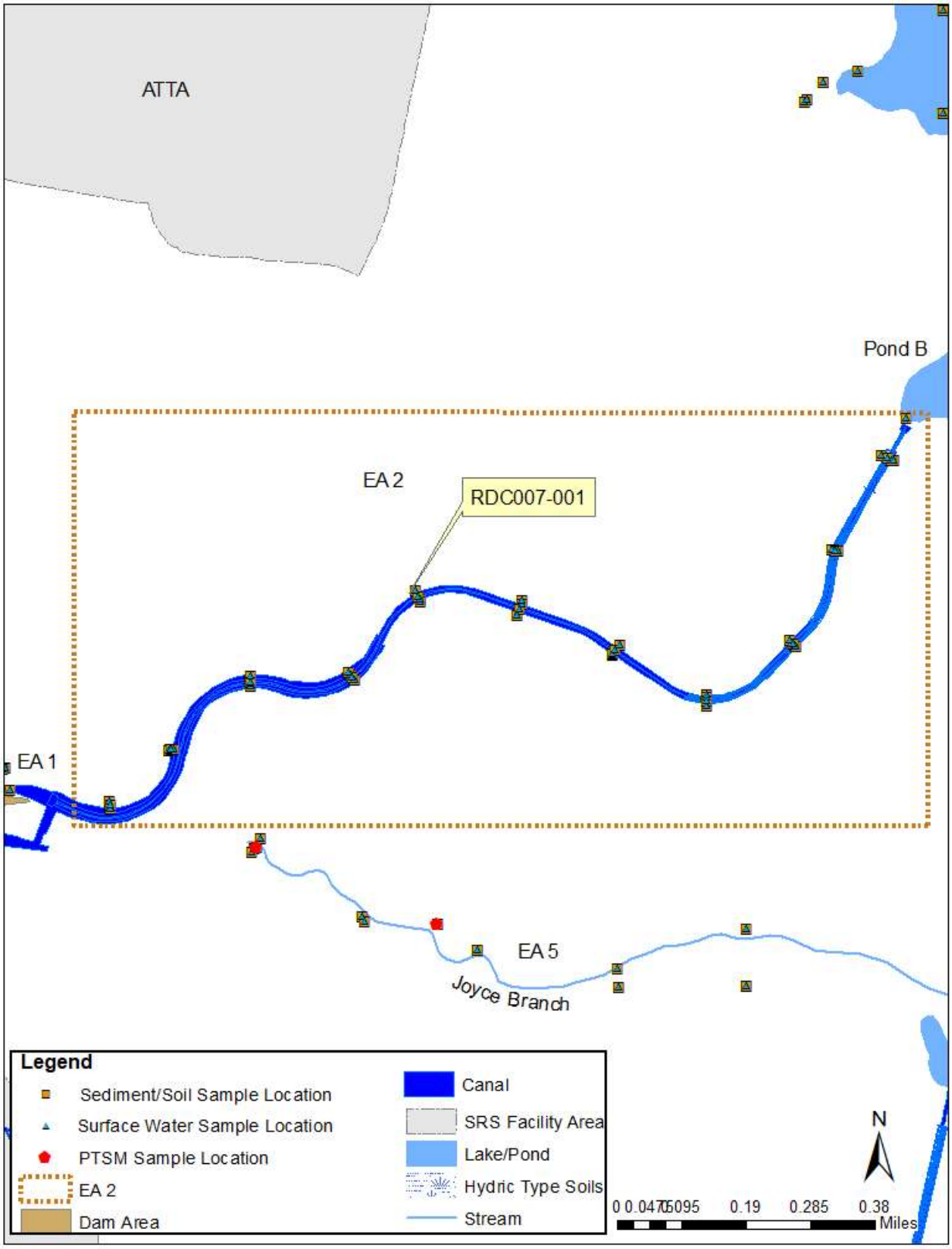

Figure 8. Sample Locations for EA2 in the Upper Subunit of the LTR IOU

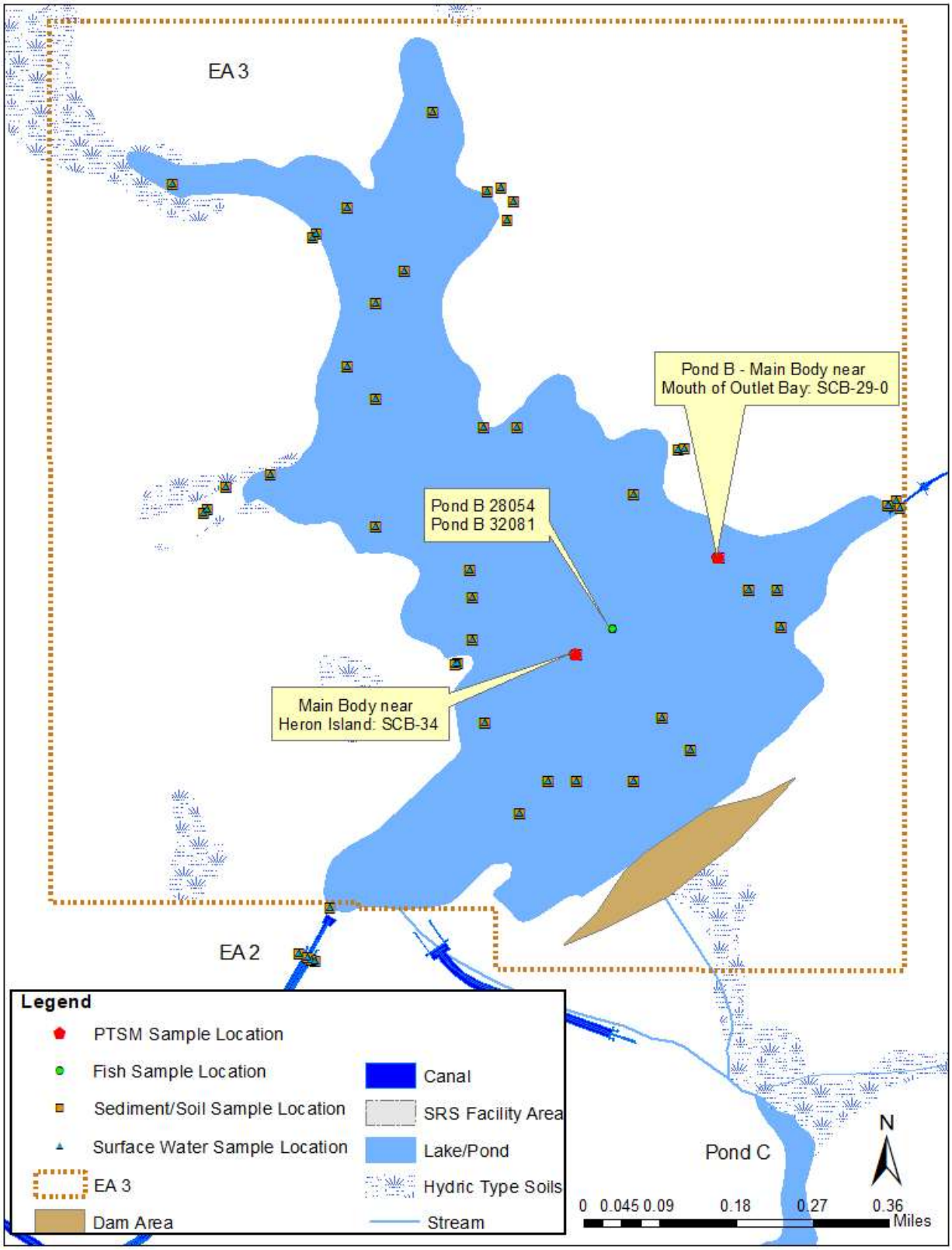

Figure 9. Sample Locations for EA3 in the Upper Subunit of the LTR IOU

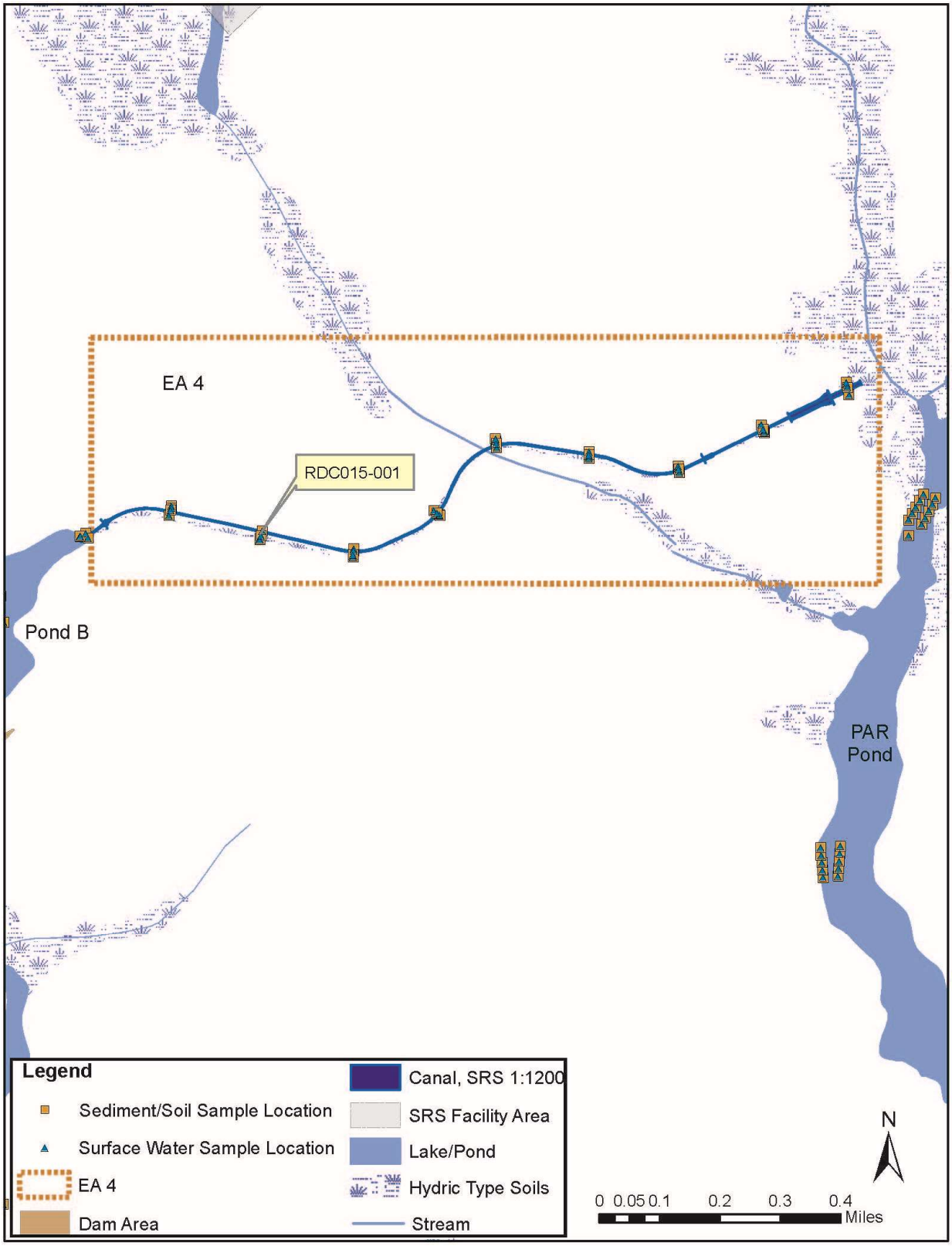

Figure 10. Sample Locations for EA4 in the Upper Subunit of the LTR IOU

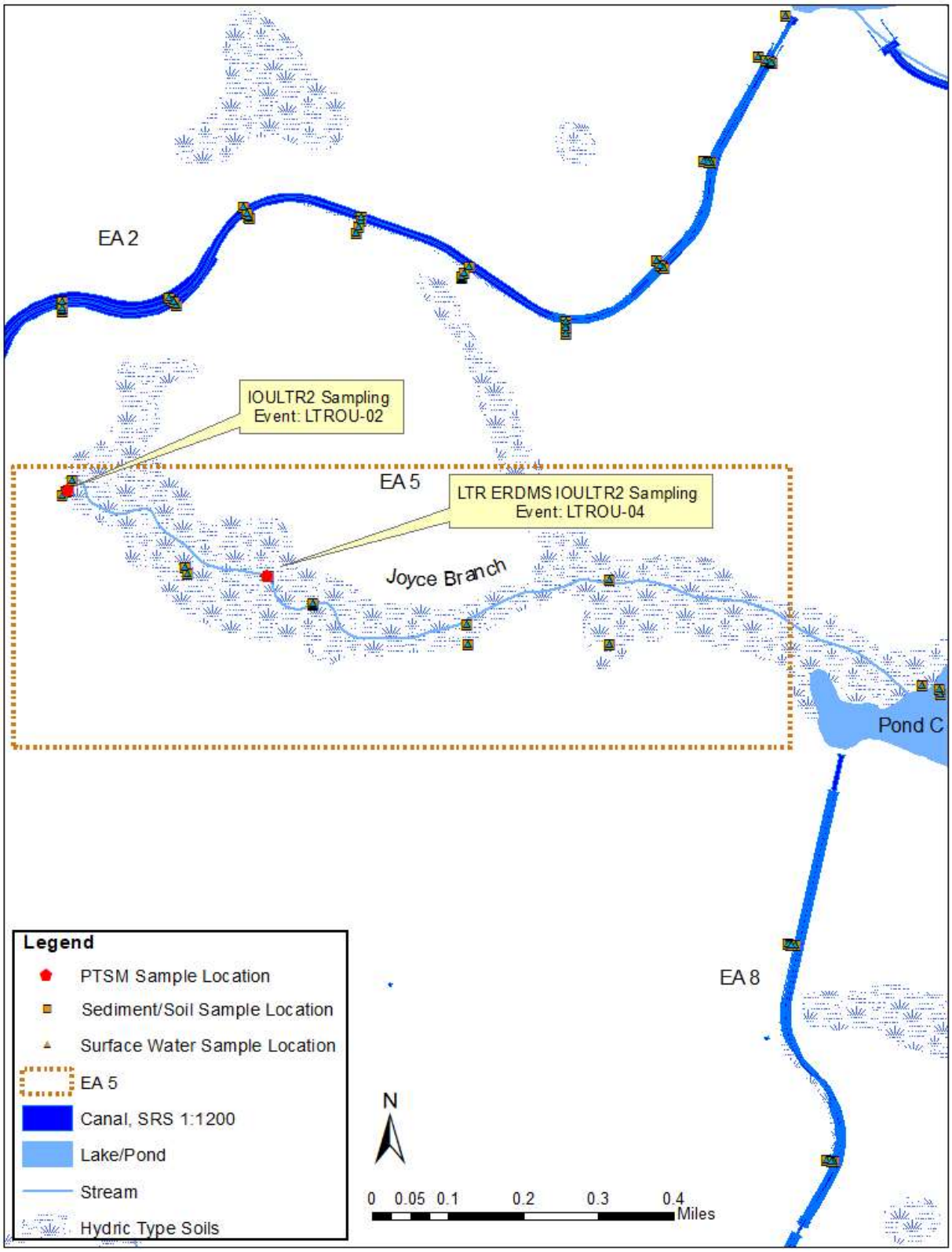

Figure 11. Sample Locations for EA5 in the Upper Subunit of the LTR IOU

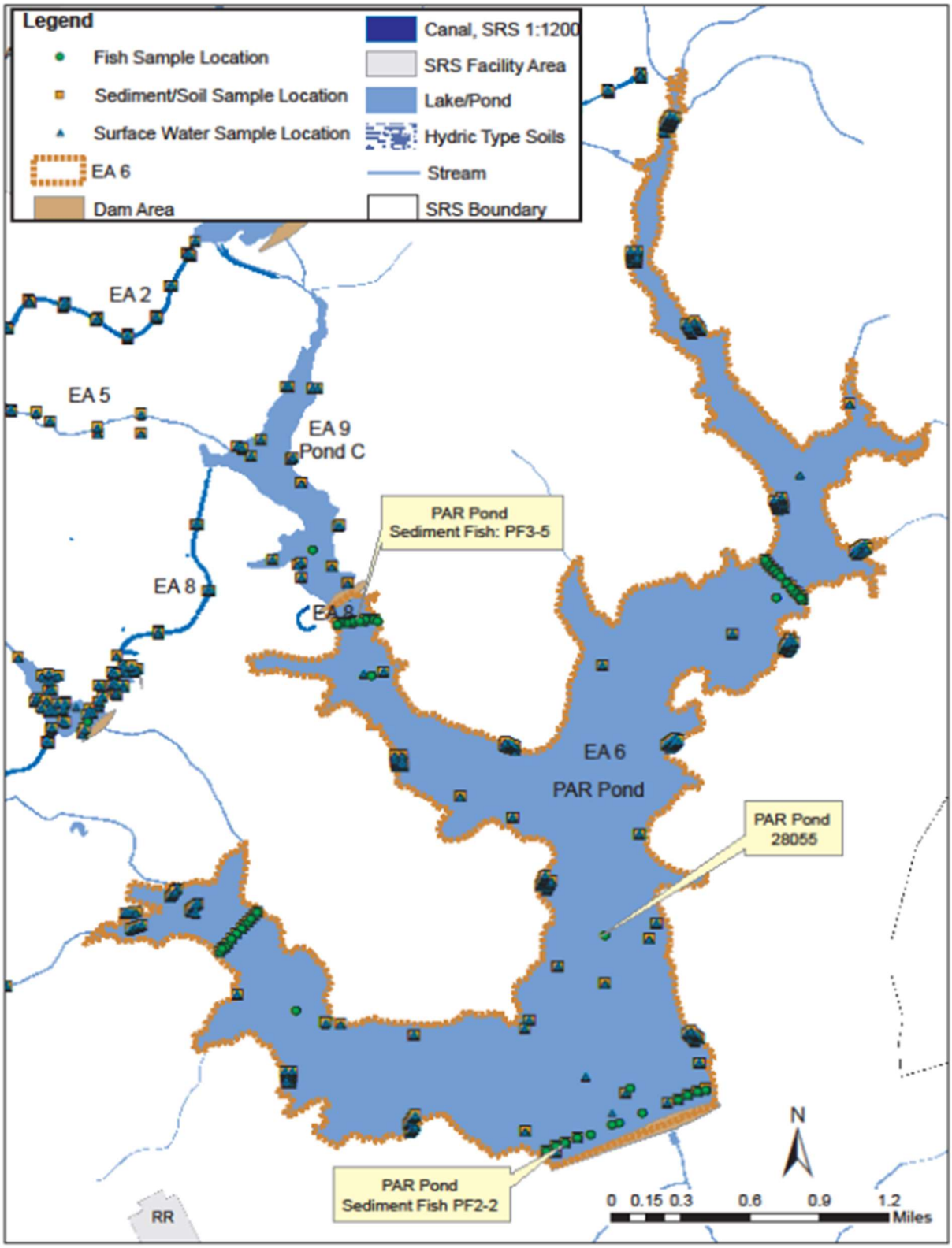

Figure 12. Sample Locations for EA6 in the Upper Subunit of the LTR IOU

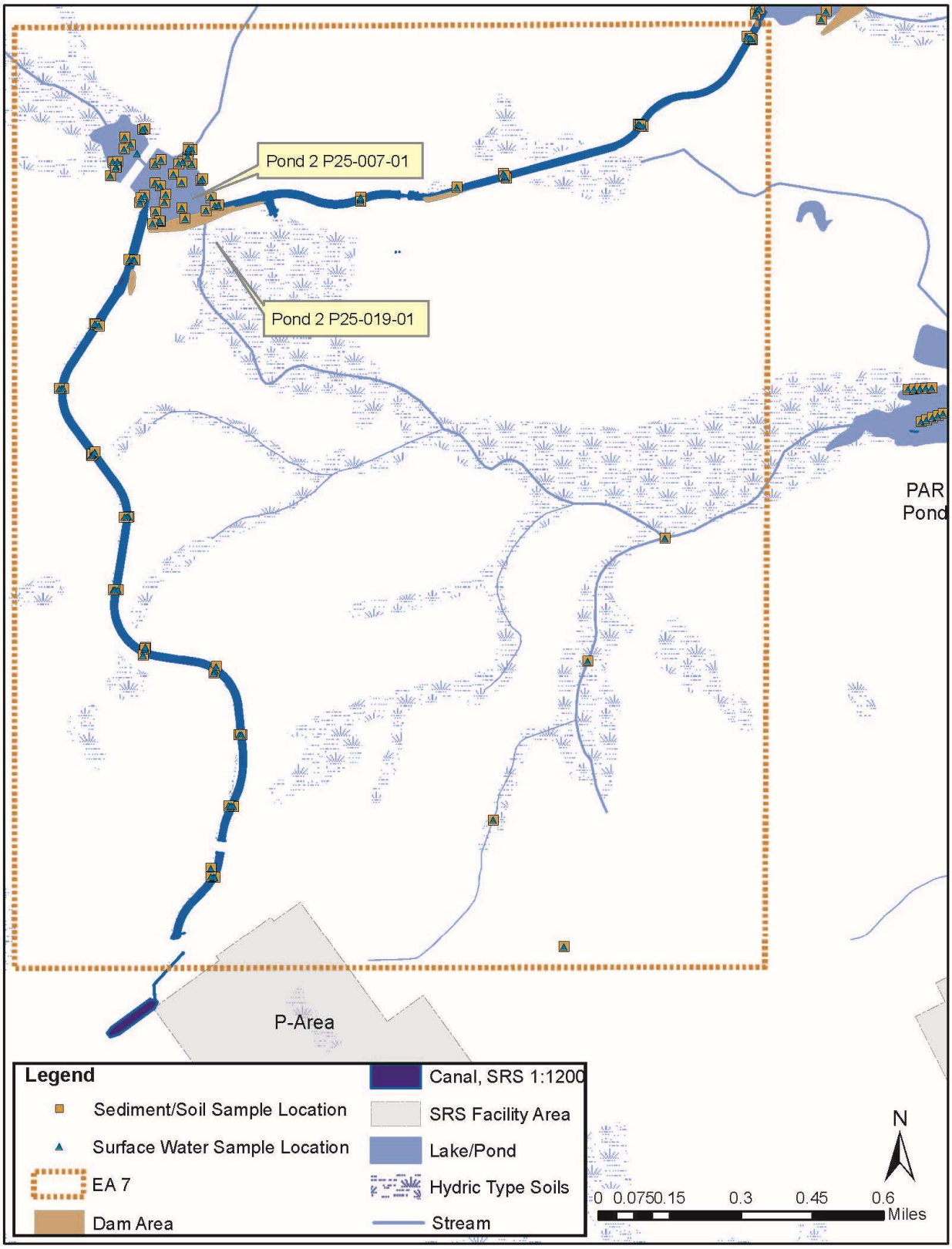

Figure 13. Sample Locations for EA7 in the Upper Subunit of the LTR IOU

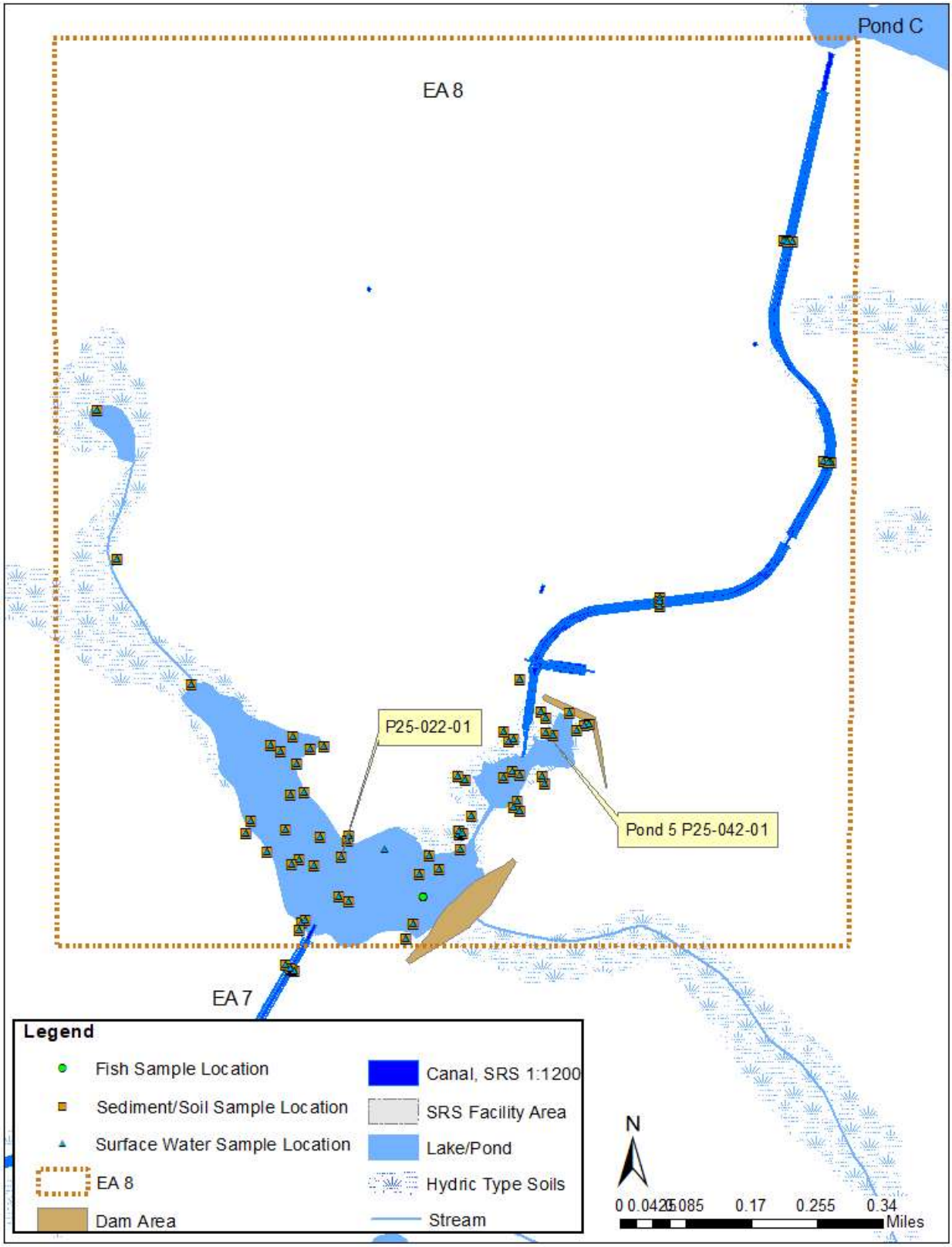

Figure 14. Sample Locations for EA8 in the Upper Subunit of the LTR IOU

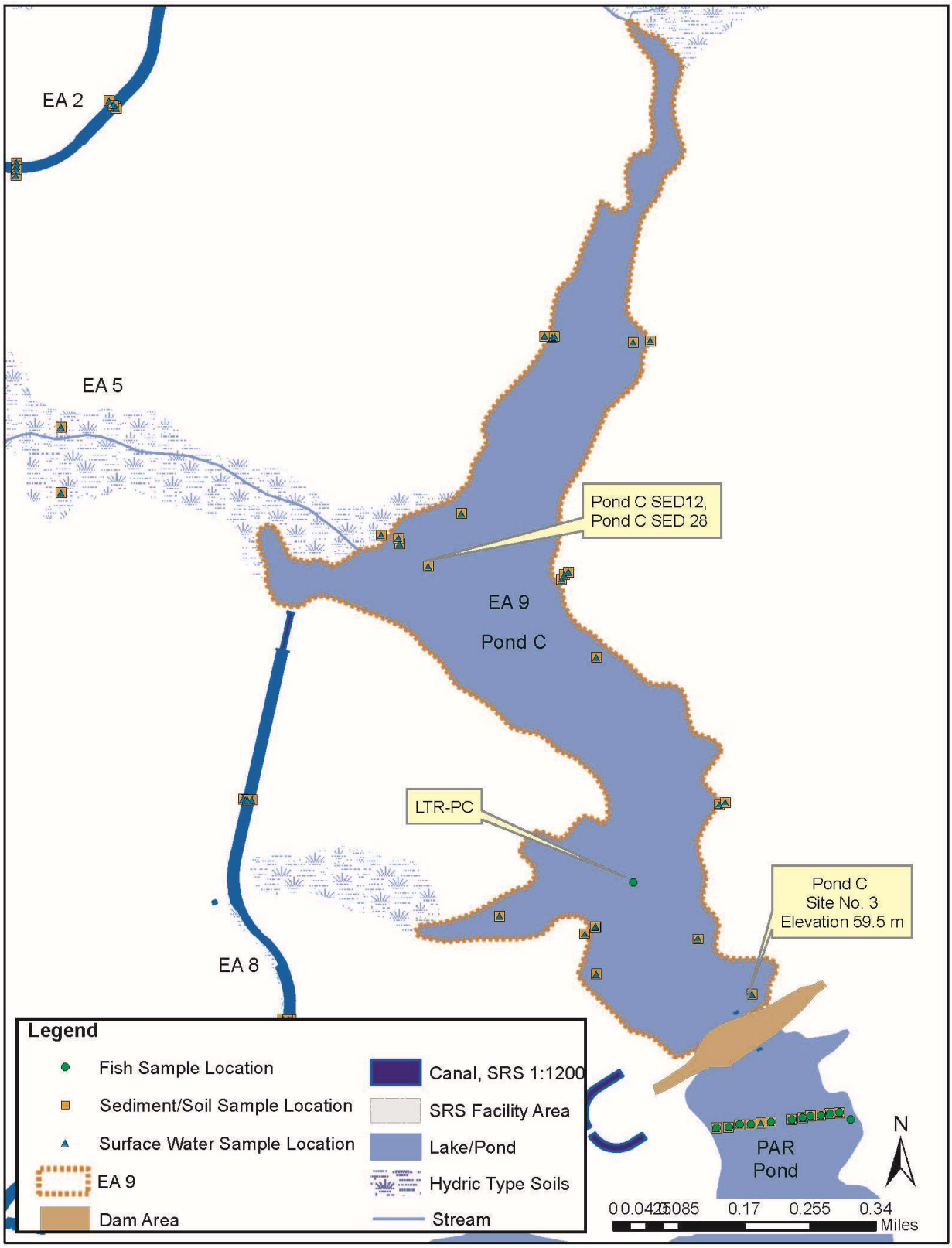

Figure 15. Sample Locations for EA9 in the Upper Subunit of the LTR IOU

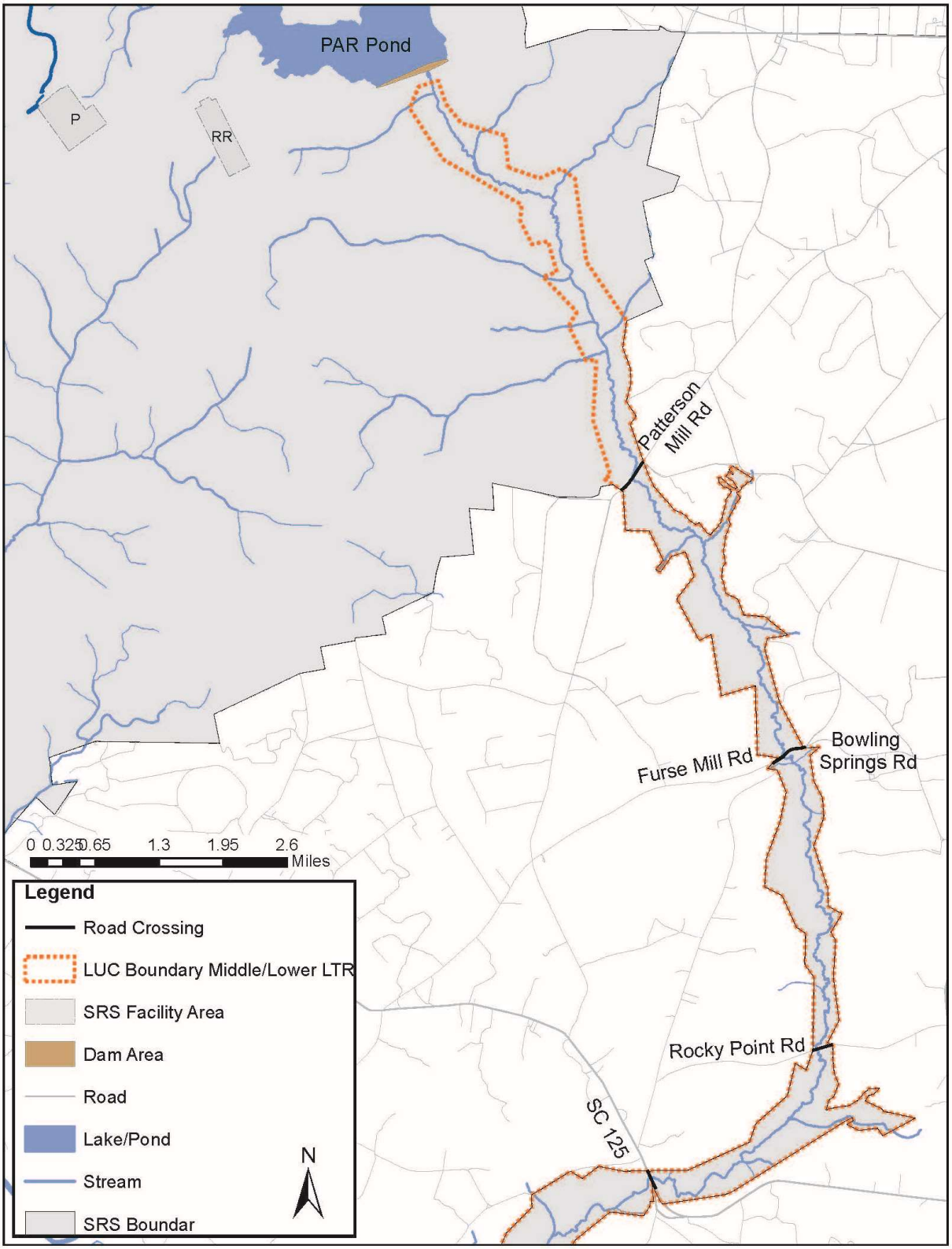

Figure 16. Road Crossings Along the Middle/Lower Subunits of the LTR IOU

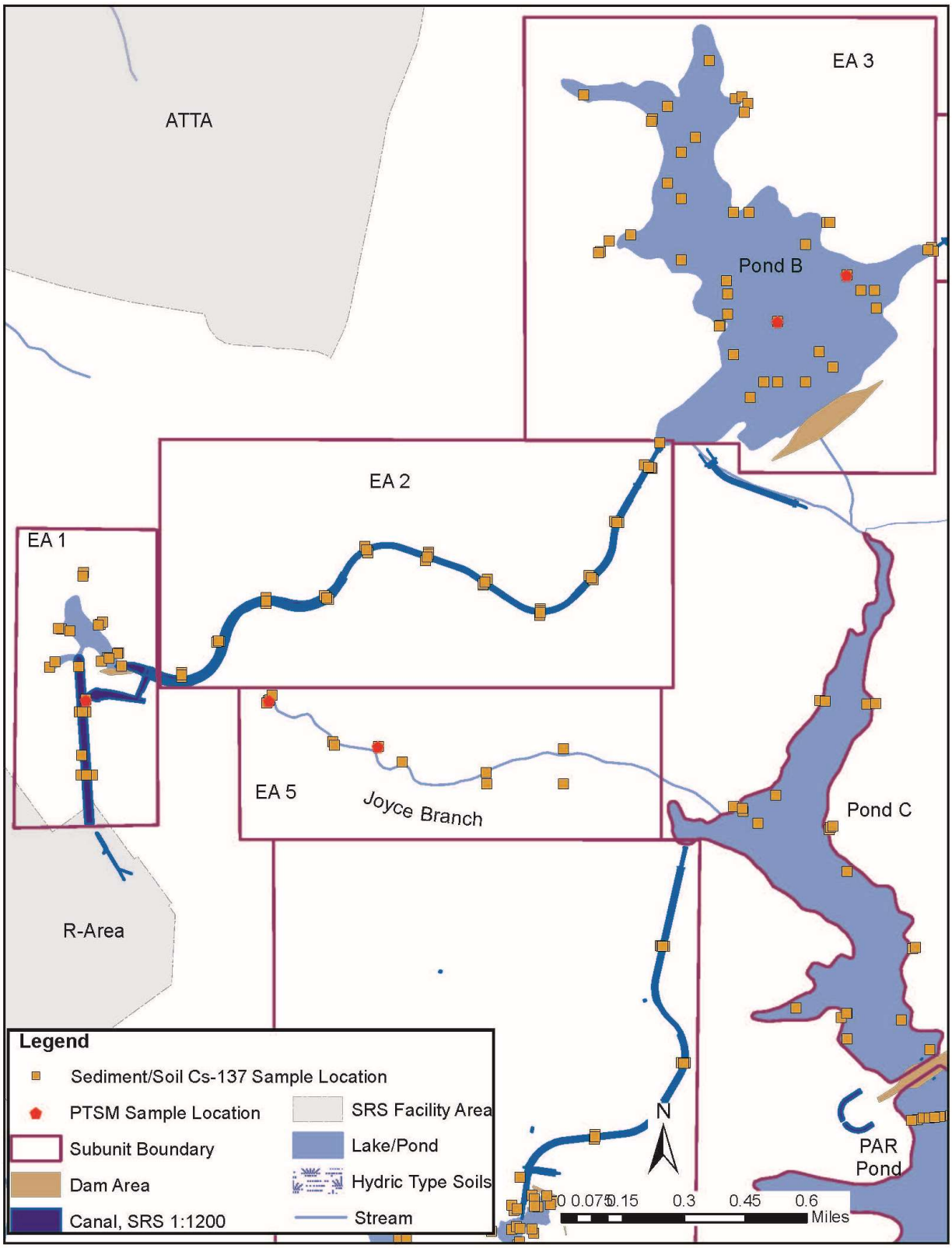

Figure 17. PTSM Locations for the Upper Subunit of the LTR IOU

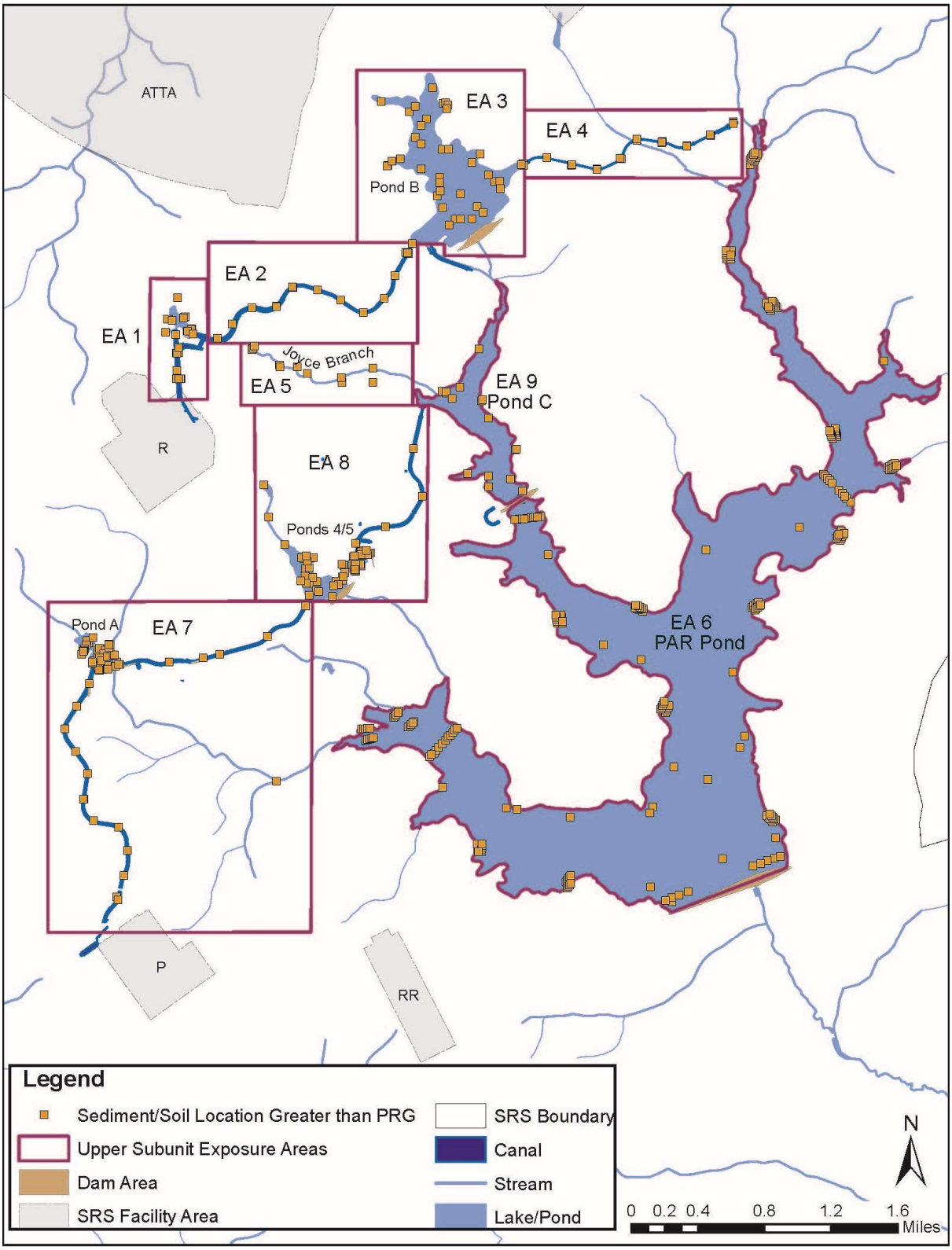

Figure 18. Sample Locations Exceeding HH PRGs for the Sediment/Soil Medium for the IOU Onsite Worker

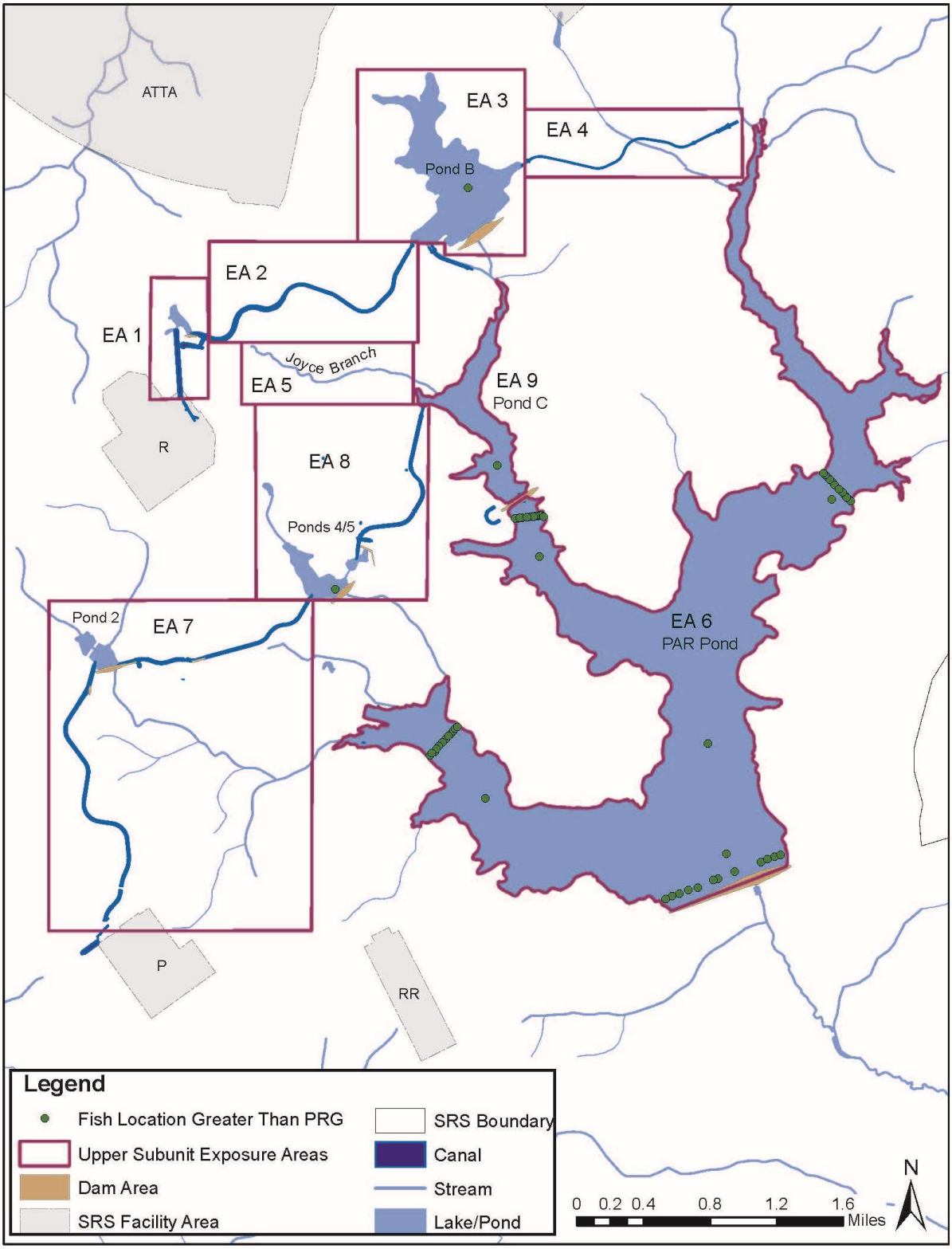

Figure 19. Sample Locations Exceeding HH PRGs for the Fish Medium for the Recreational Fisherman

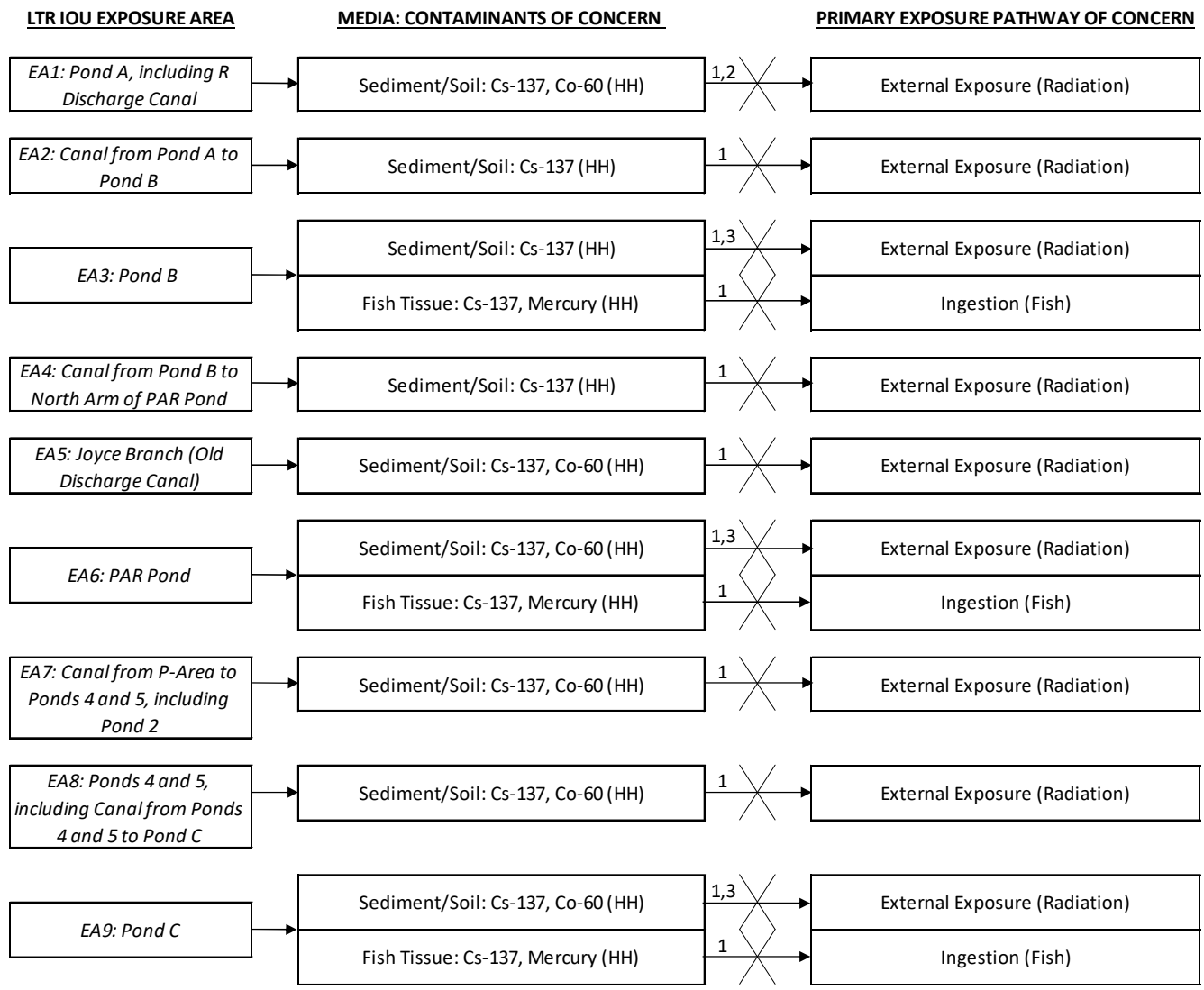

Figure 20. Conceptual Site Model Following Implementation of the Selected Remedy

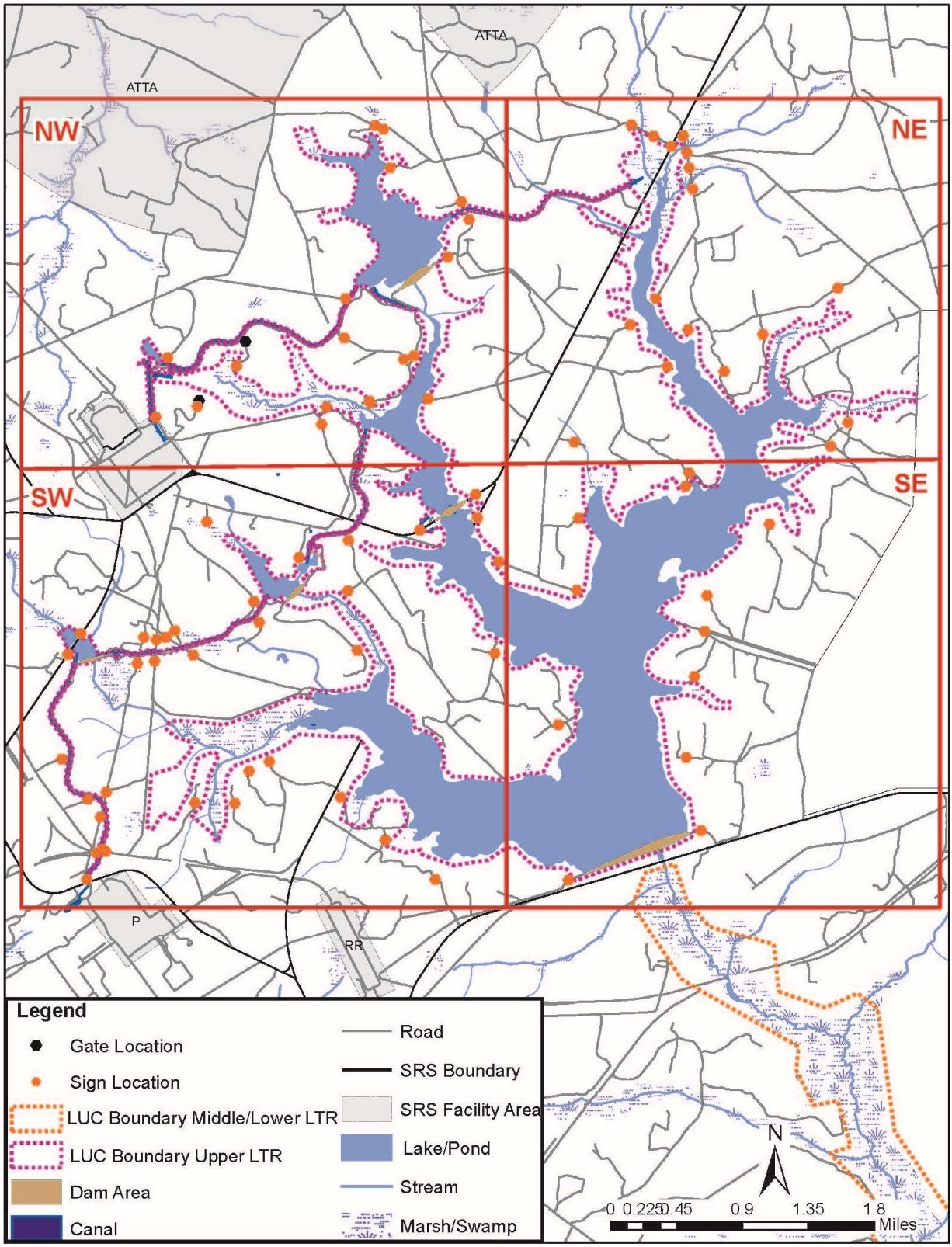

Figure 21. LUC Boundaries for the Upper Subunit of the LTR

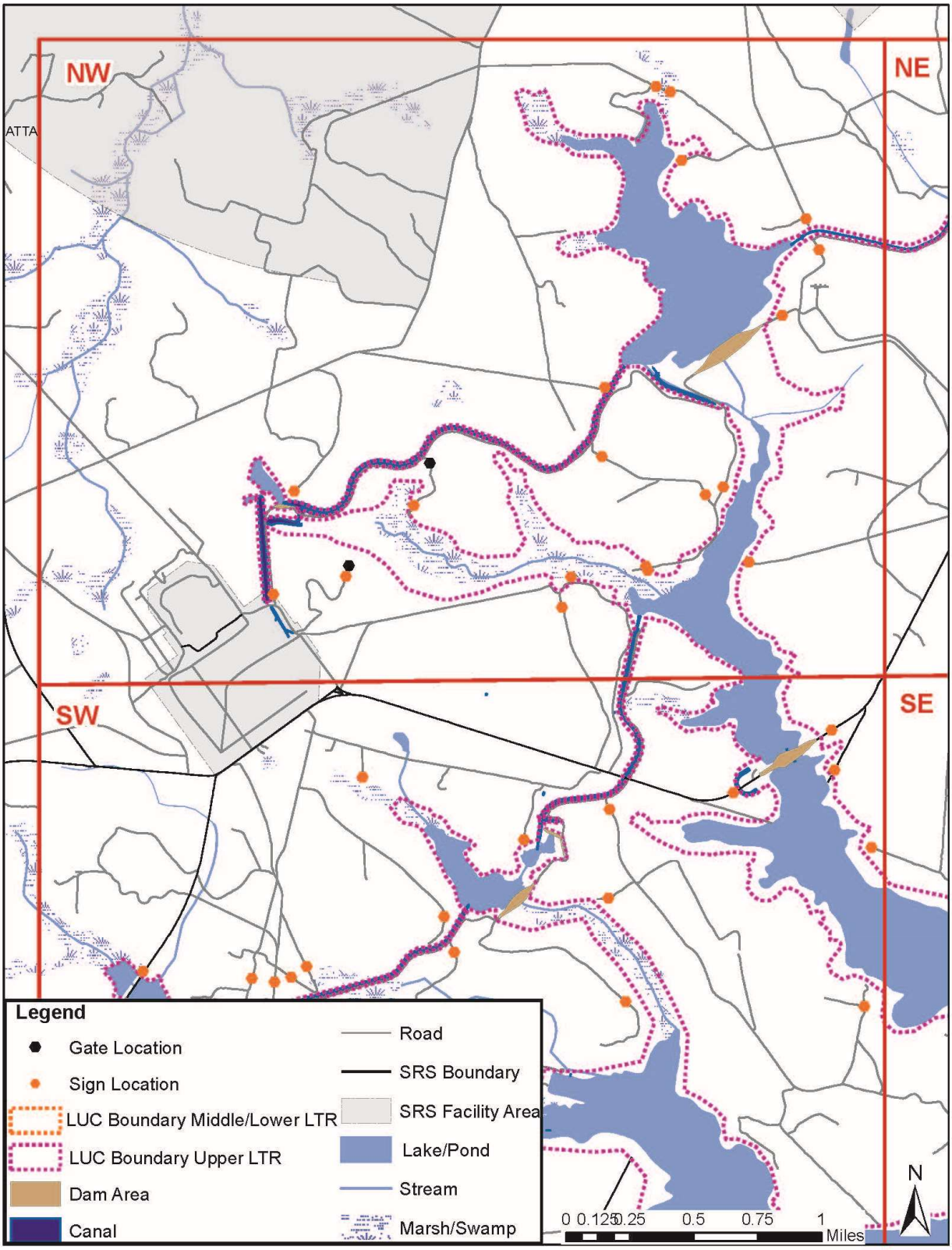

Figure 22. LUC Boundaries Upper Subunit of the LTR – NW Quadrant

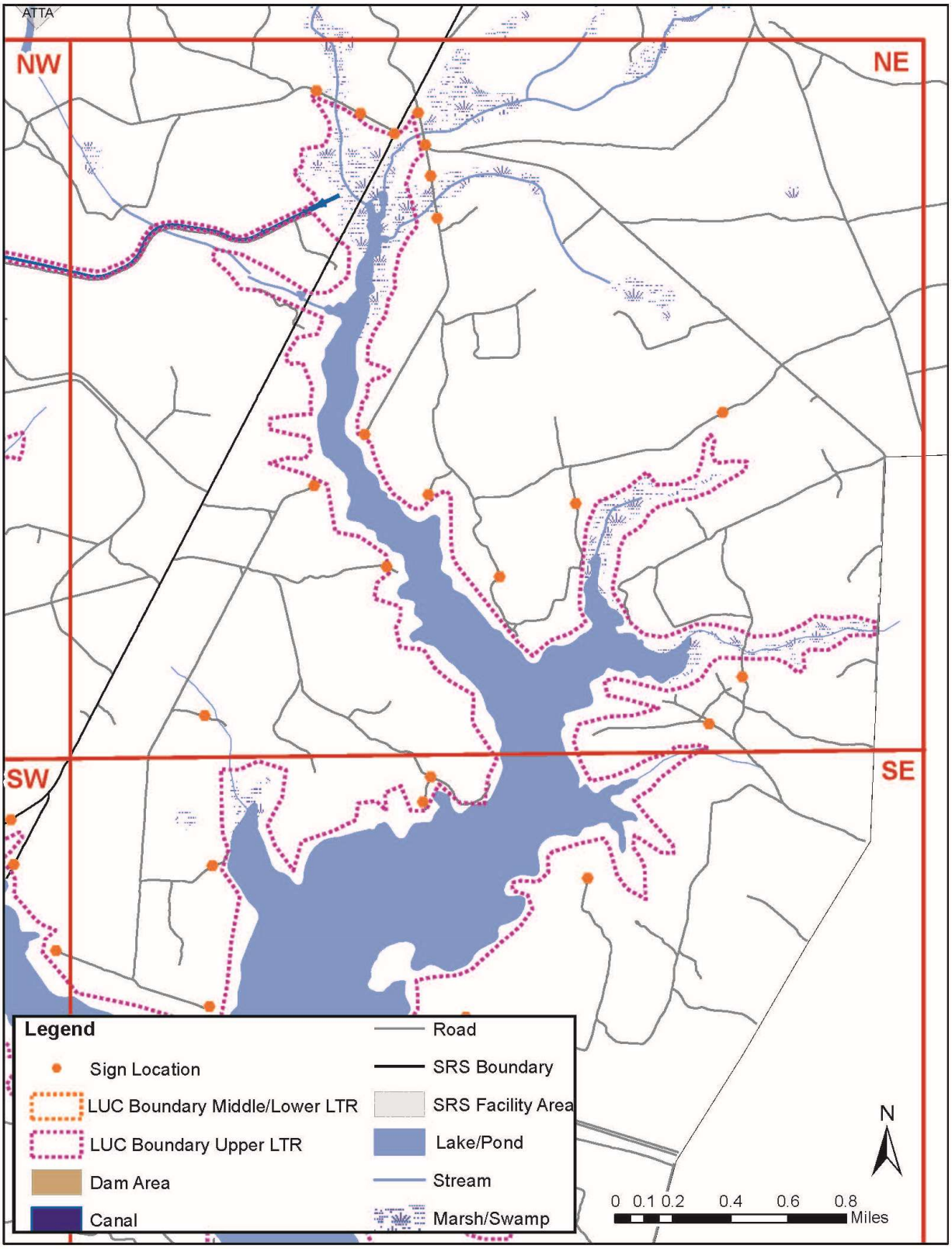

Figure 23. LUC Boundaries Upper Subunit of the LTR – NE Quadrant

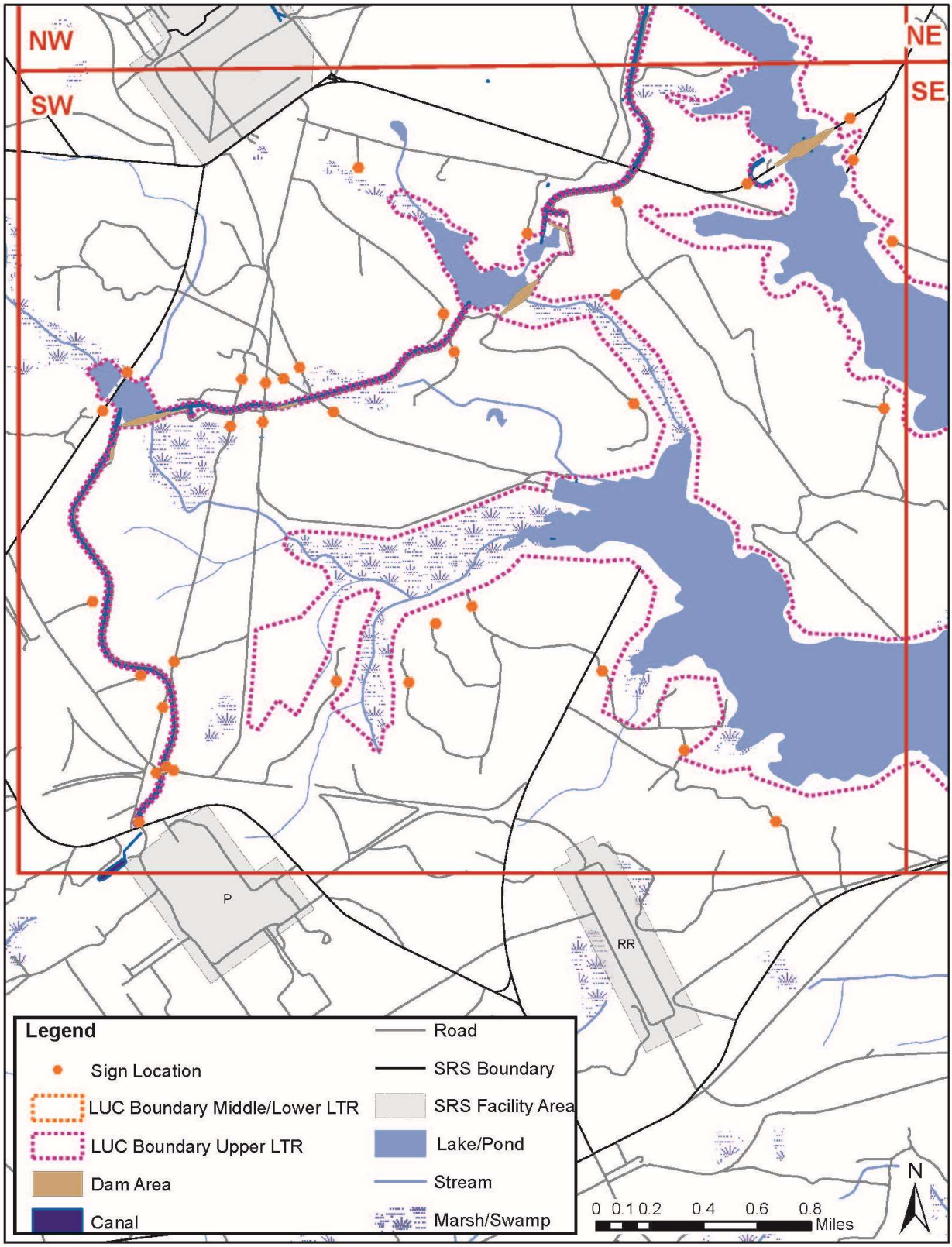

Figure 24. LUC Boundaries Upper Subunit of the LTR – SW Quadrant

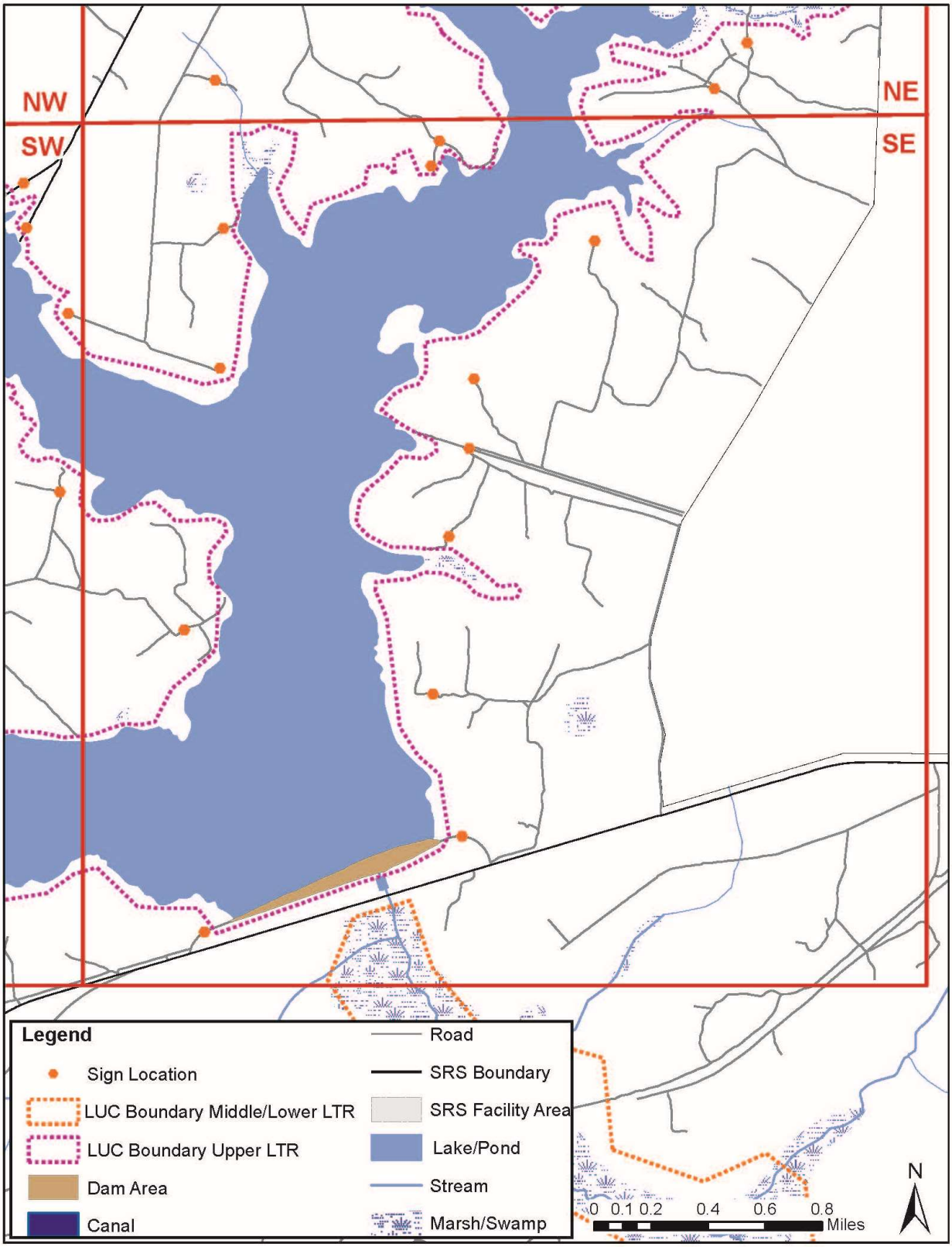

Figure 25. LUC Boundaries Upper Subunit of the LTR – SE Quadrant

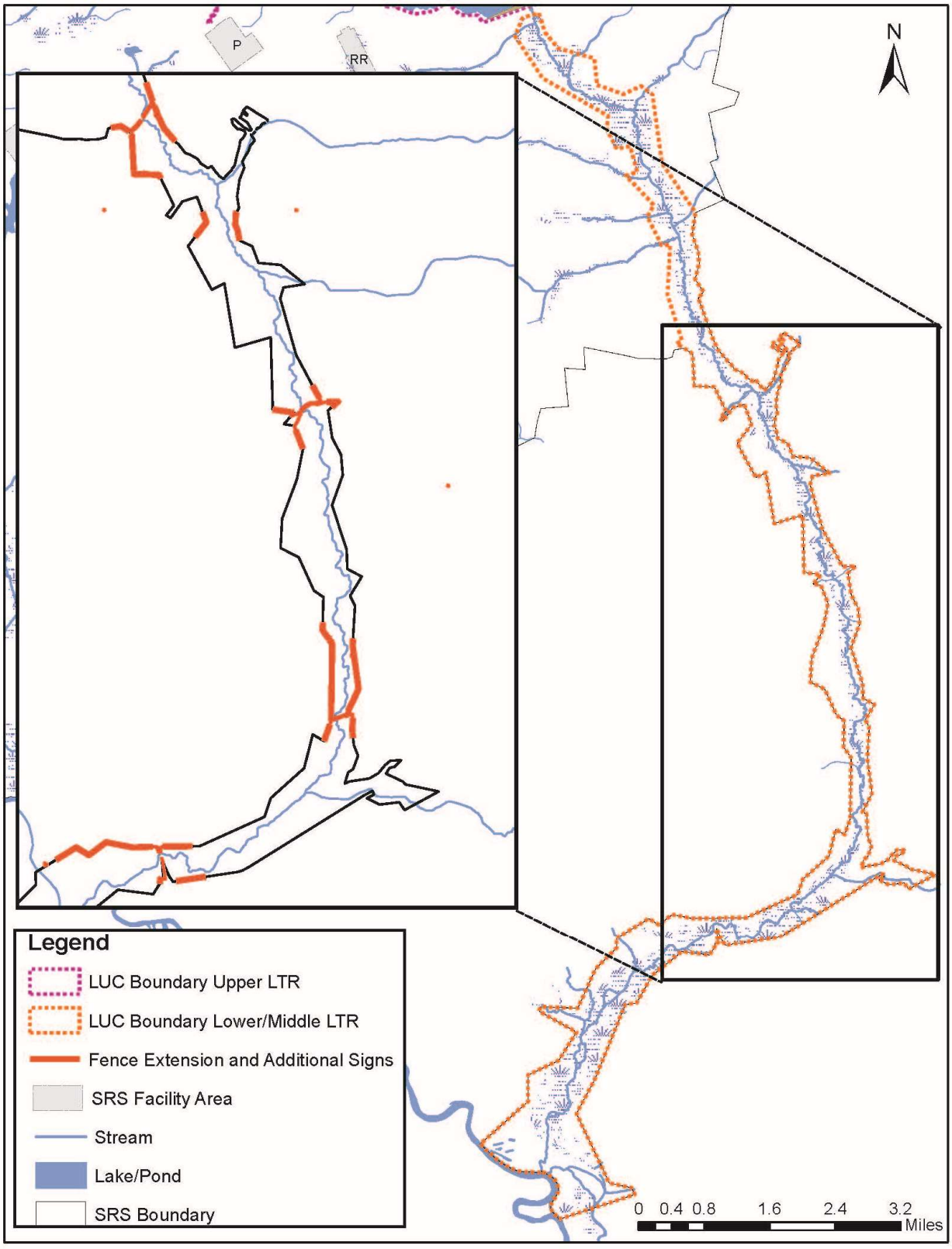

Figure 26. LUC Boundary for the Middle/Lower Subunits of the LTR IOU

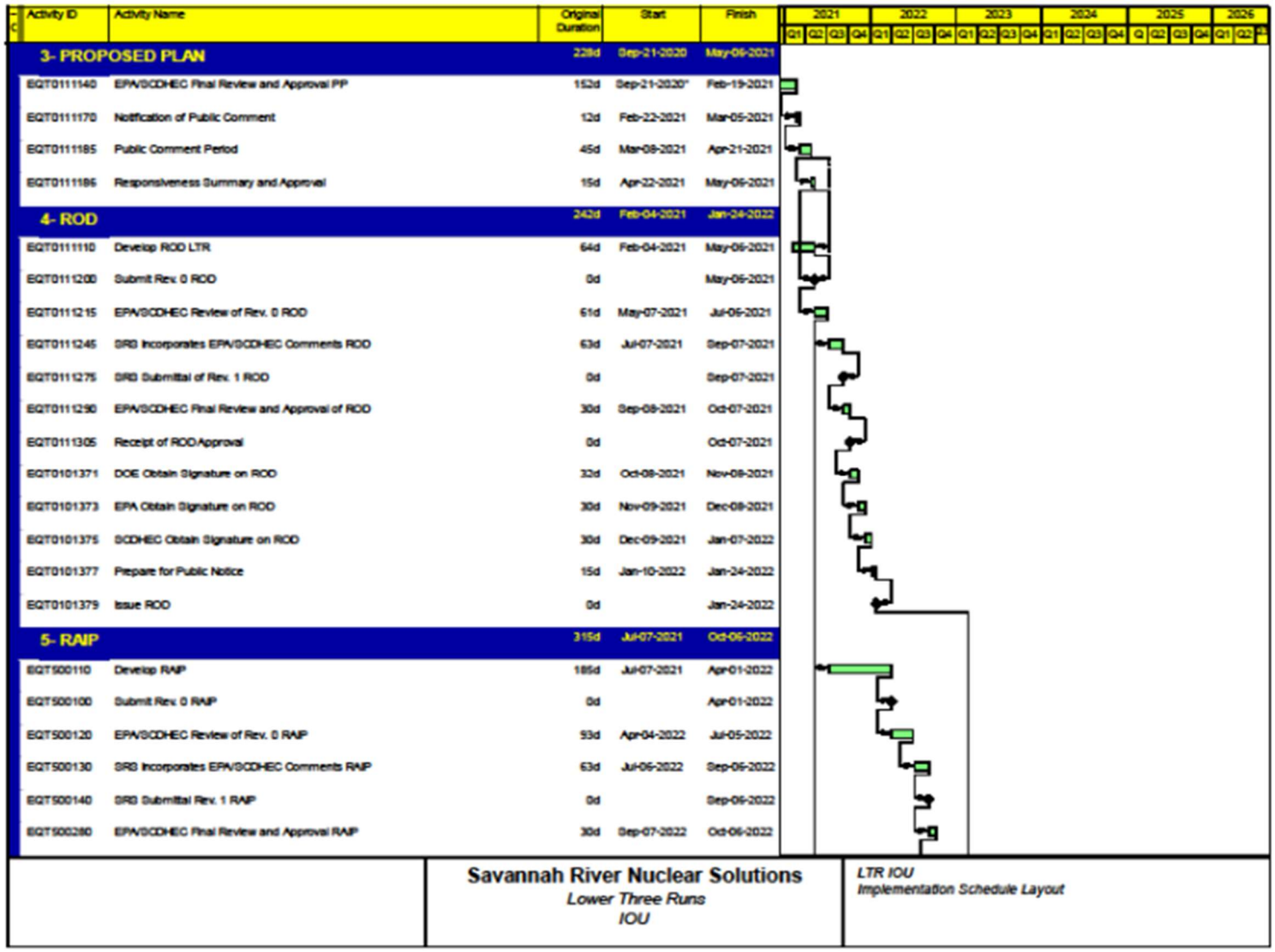

Figure 27. Scheduled FFA Milestones for the Lower Three Runs IOU

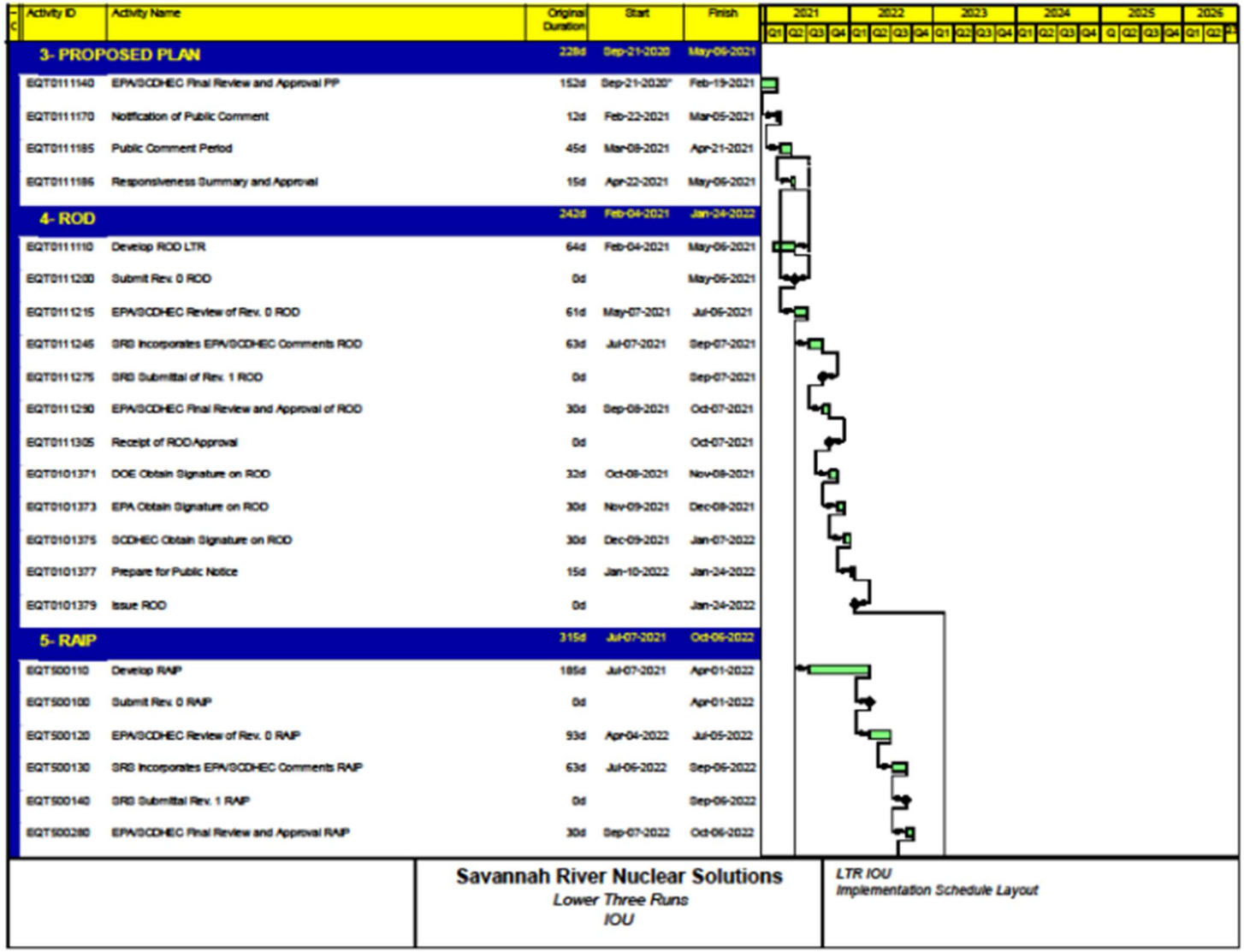

Figure 27. Scheduled FFA Milestones for the Lower Three Runs IOU *(Continued)*

Table 1. Summary of Disposition of LTR IOU Source Waste Sites

Area	Unit ID	Unit Name	Unit Status	Response Selected/ Implemented
G	39	Gunsite 218 Rubble Pile, 631-23G	ROD (No Action) issued November 3, 2010	Yes
G	110	PAR Pond (Including The Pre-Cooler Ponds and Canals), 685-G	Part of the LTR IOU	No
G	111	PAR Pond Sludge Land Application Site, 761-5G	No Action Approved	Yes
G	152	Second PAR Pond Site, 761-8G	NFA Approved	Yes
G	163	Gunsite 012 Rubble Pile, NBN	Combined with ECODS G-3, Rubble Pile across from Gunsite 012. ROD for LUCs, LUCIP approved by SCDHEC 8/2011 & USEPA 9/2011.	Yes
G	172	Miscellaneous Rubble Pile at Dunbarton, NBN	NFA Approved	Yes
G	173	Miscellaneous Trash at Snapp, NBN	NFA Approved	Yes
G	177	Pond B Dam Rubble Pile, NBN	NFA Approved	Yes
G	321	Patterson Mill Road Rubble Pile, NBN	NFA Approved	Yes
G	337	Rubble Pile across from Gunsite 012, NBN	Combined with ECODS G-3, Gunsite 012 Rubble Pile. ROD for LUCs, LUCIP approved by SCDHEC Aug 2011 & USEPA Sept 2011.	Yes
G	455	Stadia Lights With Poles, NBN	NFA Approved	Yes
G	505	Lower Three Runs Integrator Operable Unit	Final Action	No
G	544	ECODS G-3 (Adjacent To Gunsite 012, NBN)	Combined with Rubble Pile Across from Gunsite 012, Gunsite 012 Rubble Pile. ROD for LUCs, LUCIP approved by SCDHEC Aug 2011 and USEPA Sept 2011.	Yes
G		General Area Outfalls GS-012	Deactivated as part of Gunsite 12 Project	Yes
G		Par Pond Outfalls PP-1, PP-2	Outfalls retired, no longer discharging.	Yes
G	546	Dunbarton Railroad Yard, NBN; Outfalls Y-003 and Y-004	FFA Field Start/Site Evaluation Report date of December 2035. Part of the Steel Creek IOU.	No
P	17	P-Area Acid/Caustic Basin, 904-78G	NFA Approved	Yes
P	107	P-Area Bingham Pump Outage Pit, 643-4G	NFA Approved	Yes
P	143	P-Area Groundwater	RCRA/CERCLA unit, Removal Action Report for Non-Time Critical Removal Action, date of November 2020. Part of the Steel Creek IOU	No
P	221	Sandblast Area CMP-003	NFA Approved	Yes
P	259	Combined Spills from 183-2P, NBN	NFA Approved	Yes
P	287	P-Area Acid/Caustic Basin (Groundwater)	NFA Approved	Yes

Table 1. Summary of Disposition of LTR IOU Source Waste Sites *(Continued)*

Area	Unit ID	Unit Name	Unit Status	Response Selected/ Implemented
P	314	Potential Release from P-Area Disassembly Basin, 105-P	ROD issued 7/22/2011 for PAOU with LUCs, remediation complete.	Yes
P	316	Potential Release From The P-Area Reactor Cooling Water System, 186/190-P	ROD issued 7/22/2011 for PAOU with LUCs, remediation complete.	Yes
P	428	Spill on 05/24/82 of 10 gal of 31.5% Acid from 183-P, NBN	NFA Approved	Yes
P	439	Spill on 06/26/86 of 1 gal of Tritiated Waste Oil from 110-P, NBN	NFA Approved	Yes
P	477	P Reactor Area: P-Area Reactor Area Cask Car Railroad Tracks As Abandoned, NBN	ROD issued 7/22/2011 for PAOU with LUCs, remediation complete.	Yes
P	498	Sandblast Area CMP-002, NBN	NFA Approved	Yes
P	557	P-Area Process Sewer Lines As Abandoned, NBN	ROD issued 7/22/2011 for PAOU with LUCs, remediation complete.	Yes
P	587	P-Area Operable Unit	ROD issued 7/22/2011 for PAOU with LUCs, remediation complete except PSA-3A and PSA-3B ongoing soil vapor extraction. April 2013 PER report documented completion of soil vapor extraction.	Yes
P		P-Area Production Area Incidents and Unplanned Releases	All potential sources address under PAOU Completion.	Yes
P		P-Area Outfalls P-1, P-2, P-3, P-4, P-19, P-14	Outfalls retired. All potential sources address under PAOU completion.	Yes
R	42	108-4R Overflow Basin, 108-4R	NFA Approved	Yes
R	112	R-Area Acid/Caustic Basin, 904-77G	NFA Approved	Yes
R	113	R-Area Bingham Pump Outage Pits, 643-10G	Final Remediation Report Approved, LUCs	Yes
R	114	R-Area Bingham Pump Outage Pits, 643-8G	Final Remediation Report Approved, LUCs	Yes
R	115	R-Area Bingham Pump Outage Pits, 643-9G	Final Remediation Report Approved, LUCs	Yes
R	116	R-Area Burning/Rubble Pits, 131-1R	ROD Submittal 5/1/04 /RA Complete/ LUCs	Yes
R	117	R-Area Burning/Rubble Pits, 131-R	ROD Submittal 5/1/04 /RA Complete/ Continue Post-Closure Maintenance Activities	Yes
R	118	R-Area Rubble Pile, 631-25G	ROD Submittal 5/1/04 /RA Complete/ Continue Post-Closure Maintenance Activities	Yes
R	119	R-Area Reactor Seepage Basins, 904-103G	Biennial Groundwater Mixing Zone Reporting/ RA Complete	Yes

Table 1. Summary of Disposition of LTR IOU Source Waste Sites *(Continued)*

Area	Unit ID	Unit Name	Unit Status	Response Selected/ Implemented
R	120	R-Area Reactor Seepage Basins, 904-104G	Biennial Groundwater Mixing Zone Reporting/ RA Complete	Yes
R	121	R-Area Reactor Seepage Basins, 904-57G	Biennial Groundwater Mixing Zone Reporting/ RA Complete	Yes
R	122	R-Area Reactor Seepage Basins, 904-58G	Biennial Groundwater Mixing Zone Reporting/ RA Complete	Yes
R	123	R-Area Reactor Seepage Basins, 904-59G	Biennial Groundwater Mixing Zone Reporting/ RA Complete	Yes
R	124	R-Area Reactor Seepage Basins, 904-60G	Biennial Groundwater Mixing Zone Reporting/ RA Complete	Yes
R	178	R-Area Asbestos Pit, 080-01R	NFA Approved	Yes
R	179	R-Area Rubble Pit, 131-2R	NFA Approved	Yes
R	230	Potential Release from the R-Area Concrete Lake, 183-1R/186R	NFA Approved	Yes
R	231	Area on the North Side of Building 105-R, NBN	ROD issued for RAOU 4/10/2011 with LUCs; remediation complete	Yes
R	233	Laydown Area North of 105-R, NBN	ROD issued for RAOU 4/10/2011 with LUCs; remediation complete	Yes
R	271	Cooling Water Effluent Sump, 107-R	ROD issued for RAOU 4/10/2011 with LUCs; remediation complete	Yes
R	288	R-Area Groundwater, NBN	ROD issued for RAOU 4/10/2011 with LUCs; MNA for Groundwater	Yes
R	312	Old R-Area Discharge Canal, NBN	Part of the LTR IOU. Also known as Joyce Branch.	No
R	324	Potential Release of NaOH/H_2 SO_4 from 183-2R, NBN	ROD issued for RAOU 4/10/2011 with LUCs; remediation complete	Yes
R	328	Purge Water Storage Basin, 109-R	D&D Unit #1924 – part of RAOU – no longer a source.	Yes
R	329	R-Area Ash Basin, 188-0R	ROD issued for RAOU 4/10/2011 with LUCs; remediation complete	Yes
R	330	Potential Release from R-Area Disassembly Basin, 105-R	ROD issued for RAOU 4/10/2011 with LUCs; remediation complete	Yes
R	478	R Reactor Area: R-Area Reactor Area Cask Car Railroad Tracks As Abandoned, NBN	ROD issued for RAOU 4/10/2011 with LUCs; remediation complete	Yes
R	513	Release from the Decontamination of R-Area Reactor Disassembly Basin, NBN	ROD issued for RAOU 4/10/2011 with LUCs; remediation complete	Yes
R	517	Combined Spills North of Building 105-R, NBN	ROD issued for RAOU 4/10/2011 with LUCs; remediation complete	Yes
R	540	ECODS R-1A, -1B, -1C (East of R Reactor)	CMIR/RACR documenting completion of RA for closure approved by USEPA (4/13/2011) and SCDHEC (3/30/2011)	Yes
R	550	R-Area Unknown Pit #1 (Runk-1), NBN	ROD Approved	Yes
R	551	R-Area Unknown Pit #2 (Runk-2), NBN	ROD Approved	Yes

Table 1. Summary of Disposition of LTR IOU Source Waste Sites *(Continued/End)*

Area	Unit ID	Unit Name	Unit Status	Response Selected/ Implemented
R	552	R-Area Unknown Pit #3 (Runk-3), NBN	ROD Approved	Yes
R	556	R-Area Process Sewer Lines As Abandoned, NBN	ROD issued for RAOU 4/10/2011 with LUCs; remediation complete	Yes
R	588	R-Area Operable Unit	ROD issued for RAOU 4/10/2011 with LUCs; remediation complete	Yes
R		R-Area Incidents and Unplanned Releases	All potential sources addressed under RAOU completion.	Yes
R		R-Area Outfalls R-1 through R-4	Outfalls retired. R-4 has no discharge (basin is capped).	Yes

Table 2. LTR IOU Risk Summary / Refined Constituents of Concern

Upper Exposure Area	Human Health[1] Sediment/Soil RCOCs	Human Health Surface Water RCOCs	Human Health Fish Tissue RCOCs	PTSM RCOCs	Ecological RCOCs
EA1: Pond A Including R Discharge Canal	Cs-137(+D) risk = 8.2E-04 (Decay adj. risk = 6.4E-04) Co-60 risk = 1.7E-06 (Decay adj. risk = 3.8E-07) TCR = 8.2E-04 (Decay adj. risk = 6.4E-04)	None	None	None[2]	None
EA2: Canal from Pond A to Pond B	Cs-137(+D) risk = 2.7E-04 (Decay adj. risk = 2.3E-04)	None	None	None	None
EA3: Pond B	Cs-137(+D) risk = 5.5E-04 (Decay adj. risk = 3.3E-04)	None	Cs-137(+D), Hg	None[2]	None
EA4: Canal from Pond B to North Arm of PAR Pond	Cs-137(+D) risk = 1.0E-04 (Decay adj. risk = 8.8E-05)	None	None	None	None
EA5: Joyce Branch (Old R-Area Discharge Canal)	Cs-137(+D) risk = 1.3E-03 (Decay adj. risk = 9.4E-04) Co-60 risk = 9.1E-06 (Decayed adj. risk = 1.7E-06) TCR = 1.3E-03 (Decay adj. TCR = 9.4E-04)	None	None	None[2]	None
EA6: PAR Pond	Cs-137(+D) risk = 4.9E-05 (Decay adj. risk = 2.9E-05) Co-60 risk = 1.2E-06 (Decay adj. risk = 7.2E-08) TCR = 5.0E-05 (Decay adj. TCR = 2.9E-05)	None	Cs-137(+D), Hg	None	None

Table 2. LTR IOU Risk Summary / Refined Constituents of Concern *(Continued/End)*

Upper Exposure Area	Human Heallth[1] Sediment/Soil RCOCs	Human Health Surface Water RCOCs	Human Health Fish Tissue[2] RCOCs	PTSM[3] RCOCs	Ecological RCOCs
EA7: Canal from P-Area to Ponds 4 and 5 – Including Pond 2	Cs-137(+D) risk = 7.7E-04 (Decay adj. risk = 4.5E-04) Co-60 risk = 9.6E-06 (Decay adj. risk = 1.0E-06) TCR = 7.8E-04 (Decay adj. TCR = 4.5E-04)	None	None	None	None
EA8: Ponds 4 and 5 – Including Canal from Ponds 4 and 5 to Pond C	Cs-137(+D) risk = 2.8E-04 (Decay adj. risk = 1.9E-04)	None	None	None	None
EA9: Pond C	Cs-137(+D) risk = 1.2E-04 (Decay adj. risk = 6.7E-05) Co-60 risk = 1.4E-06 (Decay adj. risk = 9.6E-08) TCR = 1.2E-04 (Decay adj. TCR = 6.7E-05)	None	Cs-137(+D), Hg	None	None

1 HH RCOCs and risk levels identified for IOU onsite worker receptor scenario.
2 HH RCOCs and risk levels identified for hypothetical recreational fishman receptor scenario.
3 No PTSM RCOCs were identified, but Cs-137 samples > 1.0E-03 risk level were identified at EA1, EA3 and EA5.

RCOC = Refined constituent of concern
TCR = total cumulative risk

Table 3a. Summary of Refined Constituents of Concern and Medium-Specific Exposure Point Concentrations: Exposure Area 1

Scenario Timeframe: Current/Future
Medium: Exposure Area 1: Pond A, including R Discharge Canal
Exposure Medium: Surface Sediment/Soil (0-1 ft)

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Sediment/ Soil Onsite – Direct Contact	Cesium-137(+D)	ND	685.8 (526.1)	pCi/g	44/45	148.0 (115.6)	pCi/g	95% UCL
	Cobalt-60	ND	0.648 (0.079)	pCi/g	15/45	0.144 (0.032)	pCi/g	95% UCL

Key:
pCi/g = picocuries per gram
95% UCL = 95% upper confidence limit of the mean concentration
(+D) = plus daughters
ND = nondetect
(##) = Numbers in parenthesis are decay corrected concentrations. Decay corrected dataset to January 1, 2017, as appropriate.

Table 3b. Summary of Refined Constituents of Concern and Medium-Specific Exposure Point Concentrations: Exposure Area 2

Scenario Timeframe: Current/Future
Medium: Exposure Area 2: Canal from Pond A to Pond B
Exposure Medium: Surface Sediment/Soil (0-1 ft)

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Sediment/ Soil Onsite – Direct Contact	Cesium-137(+D)	ND	180 (154.6)	pCi/g	21/44	48.8 (41.92)	pCi/g	95% UCL

Key:
pCi/g = picocuries per gram
95% UCL = 95% upper confidence limit of the mean concentration
(+D) = plus daughters
ND = nondetect
(##) = Numbers in parenthesis are decay corrected concentrations. Decay corrected dataset to January 1, 2017, as appropriate.

Table 3c. Summary of Refined Constituents of Concern and Medium-Specific Exposure Point Concentrations: Exposure Area 3

Scenario Timeframe: Current/Future
Medium: Exposure Area 3: Pond B
Exposure Medium: Surface Sediment/Soil (0-1 ft)

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Sediment/ Soil Onsite – Direct Contact	Cesium-137(+D)	0.0929	456.8 (276.0)	pCi/g	44/44	98.3 (59.2)	pCi/g	95% UCL

Scenario Timeframe: Current/Future
Medium: Exposure Area 3: Pond B
Exposure Medium: Fish Tissue

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Fish Tissue – Ingestion	Cesium-137(+D)	9.35	113	pCi/g	54/54	79.2	pCi/g	95% UCL
	Mercury	ND	1.83	mg/kg	77/81	0.734	mg/kg	95% UCL

Key:
pCi/g = picocuries per gram
95% UCL = 95% upper confidence limit of the mean concentration
(+D) = plus daughters
ND = nondetect
(##) = Numbers in parenthesis are decay corrected concentrations. Decay corrected dataset to January 1, 2017, as appropriate.

Table 3d. Summary of Refined Constituents of Concern and Medium-Specific Exposure Point Concentrations: Exposure Area 4

Scenario Timeframe: Current/Future
Medium: Exposure Area 4: Canal from Pond B to North Arm of Par Pond
Exposure Medium: Surface Sediment/Soil (0-1 ft)

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Sediment/ Soil Onsite – Direct Contact	Cesium-137(+D)	ND	50.0 (43.0)	pCi/g	24/36	18.33 (15.76)	pCi/g	95% UCL

Key:
pCi/g = picocuries per gram
95% UCL = 95% upper confidence limit of the mean concentration
(+D) = plus daughters
ND = nondetect
(##) = Numbers in parenthesis are decay corrected concentrations. Decay corrected dataset to January 1, 2017, as appropriate.

Table 3e. Summary of Refined Constituents of Concern and Medium-Specific Exposure Point Concentrations: Exposure Area 5

Scenario Timeframe: Current/Future
Medium: Exposure Area 5: Joyce Branch (Old Discharge Canal)
Exposure Medium: Surface Sediment/Soil (0-1 ft)

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Sediment/ Soil Onsite – Direct Contact	Cesium-137(+D)	1.7	405 (304.1)	pCi/g	17/17	227.9 (168.3)	pCi/g	95% UCL
	Cobalt-60	ND	1.83 (0.345)	pCi/g	6/17	0.76 (0.143)	pCi/g	95% UCL

Key:
pCi/g = picocuries per gram
95% UCL = 95% upper confidence limit of the mean concentration
(+D) = plus daughters
ND = nondetect
(##) = Numbers in parenthesis are decay corrected concentrations. Decay corrected dataset to January 1, 2017, as appropriate.

Table 3f. Summary of Refined Constituents of Concern and Medium-Specific Exposure Point Concentrations: Exposure Area 6

Scenario Timeframe: Current/Future
Medium: Exposure Area 6: PAR Pond
Exposure Medium: Surface Sediment/Soil (0-1 ft)

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Sediment/ Soil Onsite – Direct Contact	Cesium-137(+D)	ND	124.0 (76.6)	pCi/g	510/540	8.82 (5.23)	pCi/g	95% UCL
	Cobalt-60	ND	1.13 (0.069)	pCi/g	132/259	0.0966 (0.006)	pCi/g	95% UCL

Scenario Timeframe: Current/Future
Medium: Exposure Area 6: PAR Pond
Exposure Medium: Fish Tissue

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Fish Tissue – Ingestion	Cesium-137(+D)	ND	18.4	pCi/g	160/165	5.51	pCi/g	95% UCL
	Mercury	ND	3.18	mg/kg	224/227	0.689	mg/kg	95% UCL

Key:
pCi/g = picocuries per gram
mg/kg = milligrams per kilogram
95% UCL = 95% upper confidence limit of the mean concentration
(+D) = plus daughters
ND = nondetect
(##) = Numbers in parenthesis are decay corrected concentrations. Decay corrected dataset to January 1, 2017, as appropriate.

Table 3g. Summary of Refined Constituents of Concern and Medium-Specific Exposure Point Concentrations: Exposure Area 7

Scenario Timeframe: Current/Future
Medium: Exposure Area 7: Canal from P-Area to Ponds 4 and 5, including Pond 2
Exposure Medium: Surface Sediment/Soil (0-1 ft)

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Sediment/ Soil Onsite – Direct Contact	Cesium-137(+D)	ND	149.04 (101.9)	pCi/g	97/138	139.0 (80.6)	pCi/g	95% UCL
	Cobalt-60	ND	15.525 (1.698)	pCi/g	18/109	0.802 (0.087)	pCi/g	95% UCL

Key:
pCi/g = picocuries per gram
95% UCL = 95% upper confidence limit of the mean concentration
(+D) = plus daughters
ND = nondetect
(##) = Numbers in parenthesis are decay corrected concentrations. Decay corrected dataset to January 1, 2017, as appropriate.

Table 3h. Summary of Refined Constituents of Concern and Medium-Specific Exposure Point Concentrations: Exposure Area 8

Scenario Timeframe: Current/Future
Medium: Exposure Area 8: Ponds 4 and 5, including Canal from Ponds 4 and 5 to Pond C
Exposure Medium: Surface Sediment/Soil (0-1 ft)

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Sediment/ Soil Onsite – Direct Contact	Cesium-137(+D)	ND	125.55 (85.96)	pCi/g	59/71	50.31 (34.5)	pCi/g	95% UCL
	Cobalt-60	ND	0.5859	pCi/g	5/73	0.0564 (0.007)	pCi/g	95% UCL

Key:
pCi/g = picocuries per gram
95% UCL = 95% upper confidence limit of the mean concentration
(+D) = plus daughters
ND = nondetect
(##) = Numbers in parenthesis are decay corrected concentrations. Decay corrected dataset to January 1, 2017, as appropriate.

Table 3i. Summary of Refined Constituents of Concern and Medium-Specific Exposure Point Concentrations: Exposure Area 9

Scenario Timeframe: Current/Future
Medium: Exposure Area 9: Pond C
Exposure Medium: Surface Sediment/Soil (0-1 ft)

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Sediment/ Soil Onsite – Direct Contact	Cesium-137(+D)	ND	116.5 (65.59)	mg/kg	51/54	20.87 (11.98)	pCi/g	95% UCL
	Cobalt-60	ND	0.448 (0.025)	pCi/g	4/24	0.114 (0.008)	pCi/g	95% UCL

Scenario Timeframe: Current/Future
Medium: Exposure Area 9: Pond C
Exposure Medium: Fish Tissue

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Fish Tissue – Ingestion	Cesium-137(+D)	1.18	42.5	pCi/g	2/2	42.5	pCi/g	Max
	Mercury	0.0206	0.244	mg/kg	2/2	0.244	mg/kg	Max

Key:
pCi/g = picocuries per gram
mg/kg = milligrams per kilogram
95% UCL = 95% upper confidence limit of the mean concentration
Max = maximum detected concentration
(+D) = plus daughters
ND = nondetect
(##) = Numbers in parenthesis are decay corrected concentrations. Decay corrected dataset to January 1, 2017, as appropriate.

Table 4. Cancer Toxicity Data Summary

Pathway: Ingestion, Dermal (Soil)

Constituent of Concern	Ingestion Cancer Slope Factor	Dermal Cancer Slope Factor	Slope Factor Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (Mo/Yr)
Cs-137(+D)	4.26E-11[a] 3.18E-11[b]	---	risk/pCi	A	USEPA PRG website	Nov., 2014
Co-60	3.81E-11[a] 1.51E-11[b]	---	risk/pCi	A	USEPA PRG website	Nov., 2014

Pathway: Ingestion (Food)

Cs-137(+D)	3.74E-11	---	risk/pCi	A	USEPA PRG website	Nov., 2014

Pathway: Inhalation

Constituent of Concern	Unit Risk	Units	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (Mo/Yr)
Cs-137(+D)	---	---	1.12E-10	risk/pCi	A	USEPA PRG website	Nov., 2014
Co-60	---	---	1.10E-10	risk/pCi	A	USEPA PRG website	Nov., 2014

Pathway: External (Radiation)

Constituent of Concern	Cancer Slope or Conversion Factor	Exposure Route	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (Mo/Yr)
Cs-137(+D)	2.53E-06	External exposure	risk/year per pCi/g	A	USEPA PRG website	Nov., 2014
Co-60	1.24E-05	External exposure	risk/year per pCi/g	A	USEPA PRG website	Nov., 2014

Key

--- = no information available
A = human carcinogen
NA = not applicable
pCi = picocurie
risk/pCi = risk per picocurie
risk/year per pCi/g = risk per year per picocurie per gram

a = resident (child + adult) slope factor
b= industrial worker and IOU onsite worker (adult) slope factor

USEPA, November 2014. *Preliminary Remediation Goals for Radionuclides* website, United States Environmental Protection Agency http://epa-prg-ornl.gov/radionuclides/. Website accessed October 14 and October 23, 2016.

Table 5. Non-Cancer Toxicity Data Summary

Pathway: Ingestion (food)

Constituent of Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Dermal RfD	Dermal RfD Units	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (M/D/Y)
Mercury (methyl)	Chronic	1.0E-04	mg/kg-day	---	---	CNS	10/1	USEPA RSL website	May, 2016

Key
--- = no information available
RfD = reference dose
mg/kg = milligram per kilogram
CNS = central nervous system

USEPA, May 2016. *Regional Screening Levels* website, United States Environmental Protection Agency https://www.epa.gov/risk/regional-screening-levels-rsls. Website accessed October 23, 2016.

Table 6. Resident Risk Characterization Summary – Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Route	Constituent of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Exposure Area 1	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	2.4E-03 (1.9E-03)
			Co-60	NC	NC	NA	NC	4.4E-06 (9.7E-07)
Exposure Area 1 Resident Sediment/Soil Total Cumulative Risk =								**2.4E-03 (1.9E-03)**
Exposure Area 2	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	8.1E-04 (6.9E-04)
Exposure Area 2 Resident Sediment/Soil Total Cumulative Risk =								**8.1E-04 (6.9E-04)**
Exposure Area 3	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	1.6E-03 (9.8E-04)
Exposure Area 3 Resident Sediment/Soil Total Cumulative Risk =								**1.6E-03 (9.8E-04)**
Exposure Area 4	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	3.0E-04 (2.6E-04)
Exposure Area 4 Resident Sediment/Soil Total Cumulative Risk =								**3.0E-04 (2.6E-04)**
Exposure Area 5	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	3.8E-03 (2.8E-03)
			Co-60	NC	NC	NA	NC	2.3E-05 (4.3E-06)
Exposure Area 5 Resident Sediment/Soil Total Cumulative Risk =								**3.8E-03 (2.8E-03)**
Exposure Area 6	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	1.5E-04 (8.6E-05)
			Co-60	NC	NC	NA	NC	2.9E-06 (1.8E-07)
Exposure Area 6 Resident Sediment/Soil Total Cumulative Risk =								**1.5E-04 (8.7E-05)**
Exposure Area 7	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	2.3 E-03 (1.3E-03)
			Co-60	NC	NC	NA	NC	2.4E-05 (2.6E-06)
Exposure Area 7 Resident Sediment/Soil Total Cumulative Risk =								**2.3E-03 (1.3E-03)**

Table 6. Resident Risk Characterization Summary – Carcinogens *(Continued/End)*

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Route	Constituent of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Exposure Area 8	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	8.3E-04 (5.7E-04)
			Co-60	NC	NC	NA	NC	1.7E-06 (2.1E-07)
Exposure Area 8 Resident Sediment/Soil Total Cumulative Risk =								**8.3E-04 (5.7E-04)**
Exposure Area 9	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	3.4E-04 (2.0E-04)
			Co-60	NC	NC	NA	NC	3.5E-06 (2.4E-07)
Exposure Area 9 Resident Sediment/Soil Total Cumulative Risk =								**3.5E-04 (2.0E-04)**

Key

NA = not applicable.

NC = not calculated. Risk was not calculated separately for each exposure pathway. The USEPA preliminary remediation goals (PRGs) for radionuclides that were used to calculate risk are risk-based concentrations (activities) that are derived from standardized equations which combine all of the exposure pathways and assumptions with USEPA toxicity data. Use of the PRG provides an exposure routes total risk estimate for each constituent.

(##) = Numbers in parenthesis are decay corrected risk estimates based on decay adjusted dataset to January 1, 2017, as appropriate.

USEPA, November 2014. *Preliminary Remediation Goals for Radionuclides* website, United States Environmental Protection Agency http://epa-prg-ornl.gov/radionuclides/. Website accessed October 23, 2016.

Table 7. Industrial Worker Risk Characterization Summary – Carcinogens

Scenario Timeframe: Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Route	Constituent of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Exposure Area 1	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	1.6E-03 (1.3E-03)
			Co-60	NC	NC	NA	NC	3.0E-06 (6.7E-07)
Exposure Area 1 Industrial Worker Sediment/Soil Total Cumulative Risk =								**1.6E-03 (1.3E-03)**
Exposure Area 2	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	5.4E-04 (4.6E-04)
Exposure Area 2 Industrial Worker Sediment/Soil Total Cumulative Risk =								**5.4E-04 (4.6E-04)**
Exposure Area 3	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	1.1E-03 (6.5E-04)
Exposure Area 3 Industrial Worker Sediment/Soil Total Cumulative Risk =								**1.1E-03 (6.5E-04)**
Exposure Area 4	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	2.0E-04 (1.7E-04)
Exposure Area 4 Industrial Worker Sediment/Soil Total Cumulative Risk =								**2.0E-04 (1.7E-04)**
Exposure Area 5	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	2.5E-03 (1.8E-03)
			Co-60	NC	NC	NA	NC	1.6E-05 (3.0E-06)
Exposure Area 5 Industrial Worker Sediment/Soil Total Cumulative Risk =								**2.5E-03 (1.9E-03)**
Exposure Area 6	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	9.7E-05 (5.8E-05)
			Co-60	NC	NC	NA	NC	2.0E-06 (1.3E-07)
Exposure Area 6 Industrial Worker Sediment/Soil Total Cumulative Risk =								**9.9E-05 (5.8E-05)**
Exposure Area 7	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	1.5E-03 (8.9E-04)
			Co-60	NC	NC	NA	NC	1.7E-05 (1.8E-06)
Exposure Area 7 Industrial Worker Sediment/Soil Total Cumulative Risk =								**1.5E-03 (8.9E-04)**

Table 7. Industrial Worker Risk Characterization Summary – Carcinogens *(Continued/End)*

Scenario Timeframe: Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Route	Constituent of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Exposure Area 8	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	5.5E-04 (3.8E-04)
			Co-60	NC	NC	NA	NC	1.2E-06 (1.5E-07)
Exposure Area 8 Industrial Worker Sediment/Soil Total Cumulative Risk =								**5.5E-04 (3.8E-04)**
Exposure Area 9	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	2.3E-04 (1.3E-04)
			Co-60	NC	NC	NA	NC	2.4E-06 (1.7E-07)
Exposure Area 9 Industrial Worker t Sediment/Soil Total Cumulative Risk =								**2.3E-04 (1.3E-04)**

Key
NA = not applicable.
NC = not calculated. Risk was not calculated separately for each exposure pathway. The USEPA preliminary remediation goals (PRGs) for radionuclides that were used to calculate risk are risk-based concentrations (activities) that are derived from standardized equations which combine all of the exposure pathways and assumptions with USEPA toxicity data. Use of the PRG provides an exposure routes total risk estimate for each constituent.
(##) = Numbers in parenthesis are decay corrected risk estimates based on decay adjusted dataset to January 1, 2017, as appropriate.

USEPA, November 2014. *Preliminary Remediation Goals for Radionuclides* website, United States Environmental Protection Agency http://epa-prg-ornl.gov/radionuclides/. Website accessed October 14, 2016.

Table 8. IOU Onsite Worker Risk Characterization Summary – Carcinogens

Scenario Timeframe: Current/Future
Receptor Population: Onsite Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Route	Constituent of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Exposure Area 1	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	8.2E-04 (6.4E-04)
			Co-60	NC	NC	NA	NC	1.7E-06 (3.8E-07)
Exposure Area 1 IOU Onsite Worker Sediment/Soil Total Cumulative Risk =								**8.2E-04 (6.4E-04)**
Exposure Area 2	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	2.7E-04 (2.3E-04)
Exposure Area 2 IOU Onsite Worker Sediment/Soil Total Cumulative Risk =								**2.7E-04 (2.3E-04)**
Exposure Area 3	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	5.5E-04 (3.3E-04)
Exposure Area 3 IOU Onsite Worker Sediment/Soil Total Cumulative Risk =								**5.5E-04 (3.3E-04)**
Exposure Area 4	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	1.0E-04 (8.8E-05)
Exposure Area 4 IOU Onsite Worker Sediment/Soil Total Cumulative Risk =								**1.0E-04 (8.8E-05)**
Exposure Area 5	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	1.3E-03 (9.4E-04)
			Co-60	NC	NC	NA	NC	9.1E-06 (1.7E-06)
Exposure Area 5 IOU Onsite Worker Sediment/Soil Total Cumulative Risk =								**1.3E-03 (9.4E-04)**
Exposure Area 6	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	4.9E-05 (2.9E-05)
			Co-60	NC	NC	NA	NC	1.2E-06 (7.2E-08)
Exposure Area 6 IOU Onsite Worker Sediment/Soil Total Cumulative Risk =								**5.0E-05 (2.9E-05)**
Exposure Area 7	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	7.7E-04 (4.5E-04)
			Co-60	NC	NC	NA	NC	9.6E-06 (1.0E-06)
Exposure Area 7 IOU Onsite Worker Sediment/Soil Total Cumulative Risk =								**7.8E-04 (4.5E-04)**

Table 8. IOU Onsite Worker Risk Characterization Summary – Carcinogens *(Continued/End)*

Scenario Timeframe: Current/Future
Receptor Population: Onsite Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Route	Constituent of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Exposure Area 8	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	2.8E-04 (1.9E-04)
Exposure Area 8 IOU Onsite Worker Sediment/Soil Total Cumulative Risk =								**2.8E-04 (1.9E-04)**
Exposure Area 9	Sediment/ Soil	Ingestion, Inhalation, External Exposure	Cs-137(+D)	NC	NC	NA	NC	1.2E-04 (6.7E-05)
			Co-60	NC	NC	NA	NC	1.4E-06 (9.6E-08)
Exposure Area 9 IOU Onsite Worker Sediment/Soil Total Cumulative Risk =								**1.2E-04 (6.7E-05)**

Key
NA = not applicable.
NC = not calculated. Risk was not calculated separately for each exposure pathway. The USEPA preliminary remediation goals (PRGs) for radionuclides that were used to calculate risk are risk-based concentrations (activities) that are derived from site-specific equations which combine all of the exposure pathways and assumptions with USEPA toxicity data. Use of the PRG provides an exposure routes total risk estimate for each constituent.
(##) = Numbers in parenthesis are decay corrected risk estimates based on decay adjusted dataset to January 1, 2017, as appropriate.

USEPA, November 2014. *Preliminary Remediation Goals for Radionuclides* website, United States Environmental Protection Agency http://epa-prg-ornl.gov/radionuclides/. Website accessed October 23, 2016.

Table 9. Summary of the PRGs for the Upper Subunit of the LTR IOU

Media	RCOC	Units	IOU Onsite Worker PRG[1]	Recreational Fisherman PRG[1]	SRS BKGRD 95th %tile[2]	2X SRS BKGRD 95th %tile[2]	SRS BKGRD Max[2]	IOU BKGRD Max[3]	Selected Cleanup Level[4]
Sediment/ Soil	Cesium-137 (+D)	pCi/g	0.144	NA	0.34	*0.68*	3.3	0.623	*0.68*
	Cobalt-60	pCi/g	*0.0295*	NA	NA	NA	NA	0.011	*0.0295*
Fish Tissue	Cesium-137 (+D)	pCi/g	NA	*0.0544*	NA	NA	NA	0.488	*0.0544*
	Mercury	mg/kg	NA	*0.154*	NA	NA	NA	0.24	*0.154*

Notes:
The IOU onsite worker scenario is based on the most likely human receptor for the Upper Subunit: an SRS worker/researcher (exposure assumptions: 20 years, 150 days/year, 8 hours/day). Because it is known that some contaminants could bioaccumulate in fish, and fish are a mobile media, the evaluation of human exposure also included a hypothetical recreational fisherman scenario for the ingestion of fish (exposure assumptions: 26 years, 350 days/year, 54 g/day).

NA = not applicable

[1] Risk-based PRGs obtained using the calculator function available at the USEPA Preliminary Remediation Goals website (USEPA 2018a) for the radiological constituents and the USEPA Regional Screening Levels website (USEPA 2018b) for mercury.

[2] SRS background concentrations obtained from the *Background Soils Statistical Summary Report for the Savannah River Site*, Table B-1 (WSRC 2006) and the IOU Background Dataset (SRNS 2017), as available.

[3] IOU Background maximum concentrations from the *Remedial Investigation/Baseline Risk Assessment for the Lower Three Runs Integrator Operable Unit* (SRNS 2017).

[4] Selected cleanup levels are italicized

Table 10. Description of CERCLA Evaluation Criteria

Threshold Criteria:
• *Overall Protectiveness of Human Health and the Environment* determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.
• *Compliance with ARARs* evaluates whether the alternative meets Federal and State environmental statutes, regulations, and other requirements that pertain to the site. ARARs may be waived under certain circumstances. ARARs are divided into chemical-specific, location-specific, and action-specific criteria.
Primary Balancing Criteria:
• *Long-Term Effectiveness and Permanence* considers the ability of an alternative to maintain protection of human health and the environment over time. It evaluates magnitude of residual risk and adequacy of reliability of controls.
• *Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment* evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.
• *Short-Term Effectiveness* considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.
• *Implementability* considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services.
• *Cost* includes estimated capital and annual operations and maintenance costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.
Modifying Criteria:
• *State Support/Agency Acceptance* considers whether USEPA and SCDHEC agree with the analyses and recommendations by the USDOE. Approval of the Record of Decision constitutes approval of the selected alternative by the regulatory agencies.
• *Community Acceptance* considers whether the local community agrees with the Preferred Alternative. Comments received on the Proposed Plan during the public comment period are an important indicator of community acceptance. Comments from the public are considered in the final remedy selection in the Record of Decision.

Table 11. Summary of the Comparative Analyses of the Alternatives

LTR IOU Alternatives		Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness	Reduction of Toxicity, Mobility, and Volume through Treatment	Short-term Effectiveness	Implementability	Cost
Alternatives That Apply to Entire Upper Subunit of the LTR IOU (EA1 through EA9)								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	$17,321,141
EA by EA evaluation								
EA1: Pond A – Including R-Area Discharge Canal								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
A-3	Capping of PTSM Sediment/Soil[1]	High	Yes	High	Yes	High	Moderate Level of Effort	$416,566
A-5	Excavation of PTSM Sediment/Soil[1]	High	Yes	High	Yes	Medium	High Level of Effort	$485,986
EA2: Canal from Pond A to Pond B								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
EA3: Pond B – Including Canal to Pond C								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
A-3	Capping of PTSM Sediment/Soil[1]	High	Yes	High	Yes	High	High Level of Effort	$2,678,707
A-5	Excavation of PTSM Sediment/Soil[1]	High	Yes	High	Yes	Medium	High Level of Effort	$1,990,626
A-6	Maintain Pond Level[1]	High	Yes	High	None	High	Low Level of Effort	2,082,616
EA4: Canal from Pond B to North Arm of PAR Pond								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit

Table 11. Summary of the Comparative Analyses of the Alternatives *(Continued/End)*

LTR IOU Alternatives		Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness	Reduction of Toxicity, Mobility, and Volume through Treatment	Short-term Effectiveness	Implementability	Cost
EA5: Joyce Branch (Old Discharge Canal)								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR[1]	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
A-3	Capping of PTSM Sediment/Soil[1]	High	Yes	High	Yes	High	Moderate Level of Effort	$805,190
A-5	Excavation of PTSM Sediment/Soil[1]	High	Yes	High	Yes	Medium	High Level of Effort	$795,537
EA6: PAR Pond								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
A-6	Maintain Pond Level[1]	High	Yes	High	None	High	Low Level of Effort	$2,835,922
EA7: Canal from P-Area to Ponds 4 and 5 – Including Pond 2								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
EA8: Ponds 4 and 5 – Including Canal from Ponds 4 and 5 to Pond C								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
EA9: Pond C								
A-1	No Action	None	No	None	None	None	None	$0
A-2	LUCs with MNR	High	Yes	High	None	High	Low Level of Effort	*see Upper subunit
A-6	Maintain Pond Level[1]	High	Yes	High	None	High	Low Level of Effort	$591,176

[1] Alternative is evaluated under the condition that LUCs with MNR is also applied.
Note: Range is Low to High, where Low = worst and High = best.
ARAR = applicable or relevant and appropriate requirement.

Table 12. ARARs for the Selected Remedial Alternative for the LTR IOU

LOCATION-SPECIFIC ARARs/TBC						
Location Characteristics	**Requirements**	**Prerequisite**	**Citation**	**A-2**	**A-5**	**A-6**
Presence of Wetlands as Defined in 10 *CFR* 1022.4	Avoid, to the extent possible, the long- and short-term adverse effects associated with destruction, occupancy, and modification of wetlands and floodplains.	USDOE actions that involve potential impacts to, or take place within, wetlands – applicable.	10 *CFR* 1022.3(a)		√	
	Take action, to extent practicable, to minimize destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands.		10 *CFR* 1022.3(a)(7) and (8)		√	
	Undertake a careful evaluation of the potential effects of any new construction in wetlands. Identify, evaluate, and as appropriate, implement alternative actions that may avoid or mitigate adverse impacts on wetlands.		10 *CFR* 1022.3(b) and (d)		√	
	Measures that mitigate the adverse effects of actions in a wetland including, but not limited to, minimum grading requirements, runoff controls, design and construction constraints, and protection of ecologically-sensitive areas.		10 *CFR* 1022.13(a)(3)		√	
	If no practicable alternative to locating or conducting the action in the wetland is available, then before taking action, design or modify the action in order to minimize potential harm to or within the wetland, consistent with the policies set forth in E.O. 11990.		10 *CFR* 1022.14(a)		√	
Location Encompassing Aquatic Ecosystem as Defined in 40 *CFR* 230.3(c)	Except as provided under section Clean Water Act (CWA) 404(b)(2), no discharge of dredged or fill material is permitted if there is a practicable alternative that would have less adverse impact on the aquatic ecosystem or if it will cause or contribute to significant degradation of the waters of the United States. Except as provided under section CWA 404(b)(2), no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken that will minimize potential adverse impacts of the discharge on the aquatic ecosystem. 40 CFR 230.70 *et seq*. identifies such possible steps.	Action that involves the discharge of dredged or fill material into *waters of the United States* including jurisdictional wetlands – relevant and appropriate.	40 *CFR* 230.10(a) and (c) 40 *CFR* 230.10(d)		√	

Table 12. ARARs for the Selected Remedial Alternatives for the LTR IOU*(Continued)*

LOCATION-SPECIFIC ARARs/TBC *(cont'd)*						
Location Characteristics	**Requirements**	**Prerequisite**	**Citation**	**A-2**	**A-5**	**A-6**
Nationwide Permit (NWP) Program	Must comply with the substantive requirements of the NWP 38, General Conditions, as appropriate.	Discharge of dredged or fill material into *waters of the United States*, including jurisdictional wetlands – relevant and appropriate.	Nationwide Permit (38) – Cleanup of Hazardous and Toxic Waste 33 *CFR* 323.3(b)		√	
Presence of Wetlands	Requires Federal agencies to evaluate action to minimize the destruction, loss or degradation of wetlands and to preserve and enhance beneficial values of wetlands.	Actions that involve potential impacts to, or take place within, wetlands – To Be Considered (TBC).	Executive Order 11990 – *Protection of Wetlands* – Section 1(a)		√	
Presence of Floodplains	Shall consider alternatives to avoid, to the extent possible adverse effects and incompatible development in the floodplain.	Federal actions that involve potential impacts to, or take place within, floodplains –TBC.	Executive Order 11988 – Floodplain Management – Section 2(a)(2)		√	
Presence of Migratory Birds and Their Habitats	No person may take, possess, import, export, transport, sell, purchaser, barter or offer for sale, purchase or barter, any migratory bird, or the parts, nests, or eggs of such bird except as may be permitted under the terms of a valid permit.	If action is likely to impact migratory birds – applicable.	16 *USC* 703-704 – Migratory Bird Treaty Act	√	√	√
Presence of Archeological or Cultural Artifacts	No person may excavate, remove, damage, or otherwise alter or deface, or attempt to excavate, remove, damage, or otherwise alter or deface any archaeological resource located on public lands unless such activity is pursuant to a permit issued under § 7.8 or exempted by § 7.5(b) of this part. Note: Prior to removal activities existing Site Use process requires approval by the Savannah River Archaeological Research Program (SRARP). The SRARP is a division of the South Carolina Institute of Archaeology and Anthropology at the University of South Carolina. The SRARP manages the archaeological and other historic resources for the USDOE.	Excavation and/or removal of archaeological resources from public lands – applicable.	43 *CFR* Part 7 – implementing the Archaeological Resources Protection Act of 1979.		√	
Presence of Historically Significant Resources	Federal agencies must take into account the effects of their projects on historic and culturally significant properties. USDOE must determine whether the proposed action is an "undertaking" as defined in 36 *CFR* 800.16(y) and, if so, whether it is a type of activity that has the potential to cause effects on historic properties. If such potential effects exist, USDOE must comply with the further obligations under this Part.	Potential presence of historical or cultural resources – applicable.	36 *CFR* Part 800 – implementing the National Historic Preservation Act of 1966, as amended.	√	√	√

Table 12. ARARs for the Selected Remedial Alternatives for the LTR IOU*(Continued)*

LOCATION-SPECIFIC ARARs/TBC *(cont'd)*						
Location Characteristics	**Requirements**	**Prerequisite**	**Citation**	**A-2**	**A-5**	**A-6**
Location Encompassing Navigable Waters	Activities shall not block or obstruct navigation or the flow of any waters unless specifically authorized herein. No spoil, dredged material, or any other fill material shall be placed below the mean high water or ordinary highwater elevation, unless specifically authorized herein. Shall make every reasonable effort to perform the authorized work in a manner to minimize adverse impact on fish, wildlife, or water quality.	Actions that involve any dredging, filling, or construction or alteration activity in, on, or over a navigable water, as defined in R.19-450.2.C, or in, or on the bed under navigable waters, or in, or on lands or waters subject to a public navigational servitude under Article 14 Section 4 of the South Carolina Constitution and 49-1-10 of the 1976 S.C. Code of Laws including submerged lands under the navigable waters of the state, or for any activity significantly affecting the flow of any navigable water – relevant and appropriate.	SCDHEC R. 19-450.4(7) SCDHEC R. 19-450.4(8)		√	
ACTION-SPECIFIC ARARs/TBC						
Managing storm water runoff from land-disturbing activities	Must comply with the substantive requirements for stormwater management and sediment/soil control of *NPDES General Permit No. SCR100000.*	Large and small construction activities (as defined in R. 61-9) of >1 ac of land – applicable.	SCDHEC R. 61-9.122.41 NPDES General Permit No. SCR100000		√	
	The stormwater management and sediment/soil control plan shall contain at a minimum the information provided in the following subsections:	Activities involving >2 ac and <5 ac of actual land disturbance which are not part of a larger common plan of development or sale – applicable.	SCDHEC R. 72-307 I. – South Carolina Storm Water Management and sediment/soil Reduction Regulations		√	
	A plan for temporary and permanent vegetative and structural erosion and sediment/soil control measures which specify the erosion and sediment/soil control measures to be used during all phases of the land disturbing activity and a description of their proposed operation;		SCDHEC R. 72-307 I.(3)(d)		√	
	Provisions for stormwater runoff control during the land disturbing activity and during the life of the facility meeting the following requirements of subsections (e)1 and 2.		SCDHEC R. 72-307 I.(3)(e)		√	

Table 12. ARARs for the Selected Remedial Alternatives for the LTR IOU*(Continued)*

ACTION-SPECIFIC ARARs/TBC *(cont'd)*						
Action	**Requirements**	**Prerequisite**	**Citation**	**A-2**	**A-5**	**A-6**
Managing fugitive dust emissions from land disturbing activities	Emissions of fugitive particulate matter shall be controlled in such a manner and to the degree that it does not create an undesirable level of air pollution.	Activities that will generate fugitive particulate matter (Statewide) – applicable.	SCDHEC R. 61-62.6 Section III(a)- Control of Fugitive Particulate Matter Statewide		√	
Excavation activities causing radionuclide emissions	Emissions of radionuclides to ambient air from USDOE facilities shall not exceed amounts that would cause any member of the public to receive an effective dose equivalent of 10 millirem/year. (Excavation of Cs-137-contaminated soil may cause airborne contamination).	Radionuclide emissions at a USDOE facility – applicable.	40 *CFR* 61.92		√	
Characterization of solid waste	Must determine if the solid waste is excluded from regulation under 40 *CFR* 261.4.	Generation of solid waste as defined in 40 *CFR* 261.2 – applicable.	40 *CFR* 262.11(a) SCDHEC R. 61-79 262.11*(a)*		√	
	Must determine if waste is listed as hazardous waste in subpart D of 40 *CFR* Part 261.	Generation of solid waste which is not excluded under 40 *CFR* 261.4(a) – applicable.	40 *CFR* 262.11(b) SCDHEC R. 61-79 262.11*(b)*		√	
	Must determine whether the waste is identified in subpart C of 40 *CFR* Part 261 by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used.	Generation of solid waste that is not listed in subpart D of 40 *CFR* Part 261 and not excluded under 40 *CFR* 261.4 – applicable.	40 *CFR* 262.11(c) SCDHEC R. 61-79 262.11*(c)*		√	
Characterization of Low-Level Waste	Shall be characterized using direct or indirect methods and the characterization documented in sufficient detail to ensure safe management and compliance with the waste acceptance criteria of the receiving facility.	Generation of USDOE Low-Level Waste – TBC.	USDOE M 435.1-1(IV)(I)		√	

Table 12. ARARs for the Selected Remedial Alternatives for the LTR IOU*(Continued/End)*

ACTION -SPECIFIC ARARs/TBC *(cont'd)*						
Action	**Requirements**	**Prerequisite**	**Citation**	**A-2**	**A-5**	**A-6**
Characterization of Low-Level Waste *(cont'd)*	Characterization data shall, at a minimum, include the following information relevant to management of the waste: • physical and chemical characteristics; • volume, including the waste and any stabilization or absorbent media; • weight of the container and contents; • identifies, activities, and concentration of major radionuclides; • characterization date; • generating source; and • any other information needed to prepare and maintain the disposal facility performance assessment or demonstrate compliance with performance objectives.		USDOE M 435.1-1(IV)(I)(2)(a)-(g)		√	
Disposal of solid waste	Shall ultimately dispose of solid waste at facilities and/or sites permitted or registered by the Department for processing or disposal of that waste stream.	Generation of solid waste intended for off-site disposal – relevant and appropriate.	SCDHEC R. 61-107.5(D)(3)		√	
CHEMICAL-SPECIFIC ARARs/TBC						
Action/Media Characteristics	**Requirements**	**Prerequisite**	**Citation**	**A-2**	**A-5**	**A-6**
Removal of radionuclide-contaminated sediment/soil	Cleanups of radioactive contamination outside the risk range (in general, exceeding 12 millirem/year effective dose equivalent which equates to ~3E-04 increased lifetime cancer risk) are not protective.	Requires use of a risk range for developing cleanup standards for radioactive contamination – TBC.	USEPA OSWER Directive 9200.4-40		√	

ARAR = applicable or relevant and appropriate requirement
CFR = Code of Federal Regulations
CWA = Clean Water Act
NPDES = National Pollutant Discharge Elimination System
NWP = Nationwide Permit
OSWER = U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response
SCDHEC = South Carolina Department of Health and Environmental Control
TBC = to be considered
USC = United States Code
USDOE = U.S. Department of Energy
USEPA = U.S. Environmental Protection Agency
WAC = waste acceptance criteria

Table 13. Land Use Controls for the Lower Three Runs IOU

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

Table 13. Land Use Controls for the Lower Three Runs IOU *(Continued/End)*

Type of Control	Purpose of Control	Duration	Implementation	Affected Areas[a]
5. Physical Access Controls[f] (e.g., fences, gates, portals)	Control and restrict access to workers and the public to prevent unauthorized access.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Controls maintained by USDOE.	Security is provided at site boundaries in accordance with SRS procedures. Gates will be installed at access points to Joyce Branch. Signs will be placed at road access points leading to the LTR IOU.
6. Warning Signs[g]	Provide notice or warning to prevent unauthorized uses.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Signage maintained by USDOE.	Warning signs will be posted in accordance with applicable site procedures and will be placed at access roads leading to the LTR IOU.
7. Security Surveillance Measures	Control and monitor access by workers/public.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Established and maintained by USDOE Necessity of patrols evaluated upon completion of remedial actions or property transfer.	Patrol of LTR IOU as identified in this ROD, will be conducted as necessary.

[a]Affected areas – Specific locations identified in the OU-specific LUCIP or subsequent post-ROD documents.
[b]Property Record Notices – Refers to any non-enforceable, purely informational document recorded along with the original property acquisition records of USDOE and its predecessor agencies that alerts anyone searching property records to important information about residual contamination; waste disposal areas in the property.
[c]Property Record Restrictions – Includes conditions and/or covenants that restrict or prohibit certain uses of real property and are recorded along with original property acquisition records of USDOE and its predecessor agencies.
[d]Other Notices – Includes information on the location of waste disposal areas and residual contamination depicted on as survey plat, which is provided to a zoning authority (i.e., city planning commission) for consideration in appropriate zoning decisions for non-USDOE property.
[e]Site Use Program – Refers to the internal USDOE/USDOE contractor administrative program(s) that requires the permit requestor to obtain authorization, usually in the form of a permit, before beginning any excavation/penetration activity (e.g., well drilling) for the purpose of ensuring that the proposed activity will not affect underground utilities/structures, or in the case contaminated soil or groundwater, will not disturb the affected areas without the appropriate precautions and safeguards.
[f]Physical Access Controls – Physical barriers or restrictions to entry.
[g]Signs – Posted command, warning or direction.

APPENDIX A

RESPONSIVENESS SUMMARY

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Responsiveness Summary

The 45-day public comment period for the *Proposed Plan for the Lower Three Runs Integrator Operable Unit* began on January 27, 2021 and ended on March 12, 2021.

Public Comments

No comments were received from the public.

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