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Proposed Plan for the Lower Three Runs Integrator Operable Unit (U)

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LIST OF ABBREVIATIONS AND ACRONYMS

~	approximate, approximately
ac	acre
ARF	Administrative Record File
ARAR	Applicable or Relevant and Appropriate Requirement
BMP	Best Management Practices
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
EA	Exposure Area
EALUCIP	Early Action Land Use Control Implementation Plan
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESD	Explanation of Significant Difference
FFA	Federal Facility Agreement
ft	feet
FS	Feasibility Study
ha	hectare
HHRA	Human Health Risk Assessment
IOU	Integrator Operable Unit
IROD	Interim Record of Decision
K	thousand ($)
km	kilometer
LLC	Limited Liability Company
LUCs	Land Use Controls
LUCIP	Land Use Control Implementation Plan
LTR	Lower Three Runs
m	meter
M	million ($)
mg/kg	milligram per kilogram
MNR	Monitored Natural Recovery
msl	mean sea level
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
O&M	Operations & Maintenance
OU	Operable Unit
pCi/g	picocurie per gram
PP	Proposed Plan
PRG	Preliminary Remedial Goal
PTSM	Principal Threat Source Material
RAO	Remedial Action Objective
RCOC	Refined Constituent of Concern
RCRA	Resource Conservation and Recovery Act
RG	Remedial Goal
RI	Remedial Investigation
ROD	Record of Decision
RSL	regional screening level
RWS	River Water System

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

SCDHEC	South Carolina Department of Health and Environmental Control
SEMS	Superfund Enterprise Management System
SRARP	Savannah River Archaeological Research Program
SRNS	Savannah River Nuclear Solutions, LLC
SRS	Savannah River Site
TBC	To Be Considered
TCR	Total Cumulative Risk
USDOE	United States Department of Energy
USC	United States Code
USEPA	United States Environmental Protection Agency
WSRC	Washington Savannah River Company, LLC

I. INTRODUCTION AND BACKGROUND

Introduction

This Proposed Plan (PP) is being issued by the United States Department of Energy (USDOE), which functions as the lead agency for Savannah River Site (SRS) remedial activities, with concurrence by the United States Environmental Protection Agency (USEPA) and the South Carolina Department of Health and Environmental Control (SCDHEC). The purpose of this PP is to describe the preferred remedial alternative(s) for the Lower Three Runs (LTR) Integrator Operable Unit (IOU) (LTR IOU), and to provide for public involvement in the decision-making process.

SRS occupies approximately (~) 802.9 square kilometers (310 square miles) of land adjacent to the Savannah River, principally in Aiken and Barnwell counties of South Carolina. SRS is located ~40.2-kilometers (km [25-miles {mi}]) southeast of Augusta, Georgia, and 32.2-km (20-mi) south of Aiken, South Carolina.

SRS is owned by the USDOE. Management and operating services are provided by Savannah River Nuclear Solutions (SRNS). SRS has historically produced tritium, plutonium, and other special nuclear materials for national defense. Chemical and radioactive wastes are byproducts of nuclear material production processes. Hazardous substances, as defined by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), are currently present in the environment at SRS.

The LTR IOU is located in Barnwell and Allendale Counties, South Carolina. The LTR IOU consists of an Upper subunit, Middle subunit, and Lower subunit (Figure 1). Early remedial actions have already been completed for the Middle and Lower subunits; therefore, the Upper subunit is the focus of this PP.

For the Upper subunit, the LTR IOU is segregated into the following nine individual exposure areas (EAs) for evaluation purposes (Figure 2):

- EA1: Pond A – Including R-Area Discharge Canal
- EA2: Canal from Pond A to Pond B
- EA3: Pond B – Including canal to Pond C
- EA4: Canal from Pond B to North Arm of PAR Pond
- EA5: Joyce Branch (Old Discharge Canal)
- EA6: PAR Pond
- EA7: Canal from P-Area to Ponds 4 and 5 – Including Pond 2
- EA8: Ponds 4 and 5 – Including canal from Ponds 4 and 5 to Pond C
- EA9: Pond C

A remedial action is needed in the Upper subunit of the LTR IOU due to the presence of cesium-137 (Cs-137) and cobalt-60 (Co-60) in sediment/soil, and the presence of mercury and Cs-137 in fish tissue at levels that may pose a threat to human health and the environment. 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 preferred remedial alternative identified for specific EAs are as follows:

- For EA1, the Excavation, Treatment and Disposal of Principal Threat Source Material (PTSM) Sediment/Soil remedial alternative to address Cs-137 contamination above the PTSM threshold (i.e., risk ≥1E-03) in a sediment location.

- For EA3, Maintain Water in Ponds remedial alternative to address Cs-137 contamination above the PTSM threshold in sediment located at depth beneath the surface water in Pond B.

- For EA6, Maintain Water in Ponds remedial alternative due to elevated levels of Cs-137 contamination in the sediment beneath PAR Pond and acts as the final barrier for contaminant migration in the Upper Subunit.

In addition to the EA specific actions, the preferred remedial alternative for all nine EAs within the Upper subunit of the LTR IOU (i.e., EA1 thru EA9) is Land Use Controls (LUCs) with Monitored Natural Recovery (MNR) which is effective in reducing exposure of contaminated media to human receptors and will achieve the remedial action objectives (RAOs). The SRS Land Use Control Assurance Plan (WSRC 1999) ensures that LUCs will be maintained for as long as necessary to keep the selected remedy fully protective of human health and the environment.

As part of the selected remedy, the future land use for the Upper subunit of the LTR IOU will be non-residential. The IOU onsite worker was selected as the most likely receptor for exposure to contaminated sediment/soil in the Upper subunit. The hypothetical recreational fisherman was chosen as the most likely receptor for the ingestion of contaminated fish tissue.

The LTR IOU Record of Decision (ROD) will document the remedial actions for the entire LTR IOU including the remedial alternative(s) selected for the Upper subunit and the previous remedial decision selected for the Middle and Lower subunits as documented in an Explanation of Significant Differences (ESD) issued in 2012 (SRNS 2012b). The 2012 ESD documents the selection of LUCs as the final remedy for the Middle and Lower subunits following completion of a non-time critical removal action for contaminated soil/sediment. 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 Time Critical Removal Action for the Lower Three Runs Integrator Operable Unit Tail Portion (Middle and Lower Subunits), and the Removal Site Evaluation Report for the Lower Three Runs Integrator Operable Unit Tail Portion (Middle and Lower Subunits) (SRNS 2012a). An Early Action Land Use Control Implementation Plan (EALUCIP) is in place for the Middle and Lower subunits that describes the LUCs selected in the ESD and how the controls are implemented and maintained (SRNS 2013b). The remedial action implemented for the Middle and Lower subunits is protective of human health and the environment, and LUCs will be documented in the final ROD for the LTR IOU as the final remedial action for the Middle and Lower subunits.

SRS Compliance History

SRS manages certain waste materials that are regulated under the Resource Conservation and Recovery Act (RCRA), a comprehensive law requiring responsible management of hazardous waste. On December 21, 1989, SRS was included on the National Priorities List. The inclusion created a need to integrate the established RCRA Facility Investigation program with CERCLA requirements to provide for a focused environmental program. In accordance with Section 120 of CERCLA 42 U.S.C. §

9620, USDOE has negotiated a Federal Facility Agreement (FFA) (FFA 1993) with the USEPA and SCDHEC to coordinate remedial activities at SRS into one comprehensive strategy which fulfills these dual regulatory requirements. Appendix C of the SRS FFA lists the LTR IOU as a CERCLA unit.

CERCLA requires the public to be given an opportunity to review and comment on the proposed remedial alternative(s). Public participation requirements are listed in Sections 113 and 117 of CERCLA 42 U.S.C. § 9613 and 9617. These requirements include establishment of an Administrative Record File (ARF) that documents the investigation and selection of remedial alternatives and allows for review and comment by the public regarding those alternatives (See Section II). The ARF must be established at or near the facility at issue. The SRS FFA Community Involvement Plan (WSRC 2011) is designed to facilitate public involvement in the decision-making process for permitting, closure, and the selection of remedial alternatives. Section 117(a) of CERCLA, as amended, requires the notice of any proposed remedial action and provides the public an opportunity to participate in the selection of the remedial action. Because the LTR IOU is not a RCRA 3004(u) Solid Waste Management Unit, a RCRA permit modification is not required.

The final remedial decision for the Upper subunit will be made only after the public comment period has ended and all the comments have been received and considered. Selection of the remedial alternative(s) that will satisfy the FFA requirements will be made by USDOE, in consultation with USEPA and SCDHEC. It is important to note that the final action may be different from the preferred alternative(s) discussed in this plan depending on new information or public comments. The alternative(s) chosen will be protective of human health and the environment and comply with all federal and state laws.

II. COMMUNITY PARTICIPATION

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

U.S. Department of Energy
Public Reading Room
Gregg-Graniteville Library
University of South Carolina Aiken 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

Hard copies of the PP are available at the following locations:

Reese Library
Government Information Department
Augusta University
2500 Walton Way
Augusta, Georgia 30904
(706) 737-1744

Asa H. Gordon Library
Savannah State University
2200 Tompkins Road
Savannah, Georgia 31404
(912) 358-4324

The public will be 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.

USDOE will provide an opportunity for a public meeting during the public comment period if significant interest is expressed. The public will be notified of the date, time, and location. At the meetings, the proposed action will be discussed, and questions about the action will be answered.

To request a public meeting during the public comment period, to obtain more information concerning this document, or to submit written comments, contact the following:

Angie Benfield
Savannah River Nuclear Solutions, LLC
Savannah River Site
Building 730-1B
Aiken, South Carolina 29808
(803) 952-9830
Angela.Benfield@srs.gov

Following the public comment period, a ROD will be signed. The ROD will detail the remedial alternative(s) chosen for the LTR IOU and include responses to oral and written comments received during the public comment period in the Responsiveness Summary.

III. OPERABLE UNIT BACKGROUND

The LTR watershed is located in the southeastern portion of SRS. LTR is a large blackwater stream containing ponds and tributary systems that are waters of the state classified as freshwater. The stream originates in the northeast portion of SRS and follows a southerly direction for ~40 kilometers (km [24.5 miles {mi}]), discharging into the Savannah River.

The LTR IOU is delineated into Upper, Middle, and Lower subunits (Figure 1). The Upper subunit of the LTR IOU is the focus of this PP.

The Upper subunit is located upgradient of the PAR Pond Dam and includes PAR Pond and the pre-cooler ponds and canal system (Figure 2). The Middle and Lower subunits are located below the PAR Pond Dam. The Lower subunit includes and bounds the LTR stream system by a narrow buffer of USDOE property, an area referred to as the "tail portion" of the LTR IOU. The remedial action for the Middle and Lower subunits was previously addressed and documented in the Removal Action Report (SRNS 2013a), the Action Memorandum (SRNS 2012a), and 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 Subunits) (U)* (SRNS 2012b). As documented in the ESD, no additional data collection, risk assessment, or response evaluation is necessary for the Middle and Lower subunits, and the remedial action of LUCs will be documented as the final action in the LTR IOU ROD for the Middle and Lower subunits.

The LTR stream system received effluent discharges from reactor operations in both R Area and P Area. R-Reactor began operations in 1953 and was followed by P-Reactor in 1954. Both received cooling water from the Savannah River via the river water distribution system. R-Reactor discharged reactor effluent directly into Joyce Branch, while P-Reactor discharged reactor effluent directly into Steel Creek. In 1958, PAR Pond and a series of pre-cooler ponds and a canal system were constructed to address the cooling water requirements of both R- and P-Reactors. Effluent from R-Reactor was routed to the R-Area Discharge Canal and pre-cooler Pond B where it discharged into what was identified as the north arm

of PAR Pond (Figure 2). This effluent pathway was used for R-Reactor discharge from 1961 until the reactor was shut down in 1964. Since the shutdown of R-Reactor, R-Area Discharge Canal and Pond B have remained essentially undisturbed.

PAR Pond also served as a heat exchange/cooling reservoir for P-Reactor until 1988. Heated water was released through a series of man-made canals and smaller impoundments into the pre-cooler Pond C and released into PAR Pond (Figure 2). Effluent discharges from P-Reactor ceased in 1987. As with the R-Area Discharge Canal, the associated canal system and pre-cooler ponds have remained essentially undisturbed since the termination of P-Reactor discharges to PAR Pond.

Liquid releases before and after the construction of PAR Pond and the pre-cooler ponds and canal system included process leaks, reactor disassembly basin purges, and thermal discharges contaminated primarily with Cs-137, but also tritium, metallic contaminants, and other radiological contaminants in much smaller quantities. Past characterization efforts have shown that Cs-137 is the major contaminant in the LTR IOU (Figure 3).

During an inspection of the PAR Pond Dam in March 1991, 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- to 54-meters (m [200 to 181-feet [ft]) mean sea level (msl) to reduce the risk and consequences of an unlikely event of dam failure. A CERCLA interim ROD (IROD) for PAR Pond was issued in 1995 to address potential exposure to the 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 resulting NEPA 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 also 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 is evaluated in the Fifth Five-Year Remedy Review Report (SRNS 2015). The next Five-Year Remedy Review Report for the PAR Pond IROD is scheduled for issuance in 2020.

In 2009/2010, extensive sampling of the Upper subunit was undertaken to augment previously collected data to support the risk evaluation. In 2016, it was determined that additional sampling was needed to address data gaps in surface water and sediment in PAR Pond. The sampling was performed as outlined in 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 Lower Three Runs stream system below PAR Pond dam. Stream channel/floodplain sediment and floodplain/wetland soil (i.e., sediment/soil) are combined as a single medium and referred to as "sediment/soil." The results of the characterization activities and human health and ecological risk

evaluations are documented in the 2017 Remedial Investigation/Baseline Risk Assessment (RI/BRA) (SRNS 2017).

The comparative analysis of remedial alternatives evaluated for the Upper subunit is documented in the 2020 Feasibility Study (FS) for the LTR IOU (SRNS 2020). The CERCLA remedial action recommended in this PP for the Upper Subunit is based on the findings of the 2017 RI/BRA and 2020 FS.

The Upper subunit of the LTR IOU is used as a research site and is part of the National Environmental Research Park. The primary entities that conduct research within the Upper subunit are the Savannah River Ecology Laboratory and the Savannah River National Laboratory. Emphasis in recent years has primarily been on aspects of radioecology in the Pond A, Pond B, and PAR Pond systems.

IV. SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

Due to the complexity and size of multiple waste units located in different areas of the SRS, the site is divided into watersheds for the purpose of managing a comprehensive cleanup strategy. The SRS is segregated into six watersheds: Upper Three Runs, Lower Three Runs, Fourmile Branch, Steel Creek, Pen Branch, and the Savannah River and Floodplain Swamp. 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 Operable Unit (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. The LTR IOU is located within the LTR watershed (Figure 1).

The Upper subunit of the LTR IOU is segregated into the following nine individual EAs for evaluation purposes (Figure 2).

EA1: Pond A – Including R-Area Discharge Canal

EA1 includes Pond A and the R-Area Discharge Canal. Pond A is ~2.6 hectare (ha [6.4 acre {ac}]) and the canal from R-Reactor to Pond A is ~645-m (2,116.1-ft) long. The canal is ~3.0-m (9.8-ft) across the base of the canal. Pond A received water from the R-Area Discharge Canal and subsequently discharged to Pond B via a canal (EA2). Prior to construction of PAR Pond and the canal system, the effluent flowed into LTR via Joyce Branch (EA5). Water levels in Pond A fluctuate from year to year. Storm water runoff and groundwater provide a constant shallow water level in the R-Area Discharge Canal. Cs-137 and Co-60 are present in sediment/soil in EA1 at levels that exceed 1E-06 risk to an onsite worker. EA1 also contains one sample location where Cs-137 levels are above the PTSM threshold (Figure 3).

EA2: Canal from Pond A to Pond B

EA2 includes the canal from Pond A to Pond B. The canal is ~2,837-m (9,307-ft) long and ~3.0-m (9.8-ft) across at the base of the canal. The canal received water from Pond A (EA1) which flowed to and discharged into Pond B (EA3). Water levels in the canal fluctuate from year to year based on precipitation amounts. Cs-137 is present in sediment/soil in EA2 at levels that exceed 1E-06 risk to an onsite worker (Figure 3).

EA3: Pond B – Including Canal to Pond C

EA3 includes Pond B and the spillway outlet structure connecting Pond B to Pond C (EA9). Pond B is ~82.1 ha (202.8 ac) and the canal from Pond B to Pond C is ~547-m (1,794.6-ft) long and ~3.0-m (9.8-ft) across the base of the canal. Pond B received water from Pond A (EA1) and generally maintains its water level from year to year. Cs-137 is present in sediment/soil in EA3 at levels that exceed 1E-06 risk to an onsite worker. EA3 also contains two locations where Cs-137 levels are above the PTSM threshold, submerged below several feet of water (Figure 3).

In addition, Cs-137 and mercury are present in fish tissue that exceed the risk-based screening levels for the recreational fisherman.

EA4: Canal from Pond B to North Arm of PAR Pond

EA4 includes the canal from Pond B (EA3) to the North Arm of PAR Pond (EA6). The canal is ~2,305-m (7,562.3-ft) long and is ~3.0-m (9.8-ft) across the base of the canal. The canal received water from Pond B which flowed to, and discharged into, the North Arm of PAR Pond. Water levels within the canal fluctuate from year to year based on precipitation amounts. Cs-137 is present in sediment/soil in EA4 at levels that exceed 1E-06 risk to an onsite worker (Figure 3).

EA5: Joyce Branch (Old Discharge Canal)

EA5 includes the remnant of the natural stream (Joyce Branch) that flows into Pond C (EA9) and was initially used to convey reactor discharge water from R-Reactor directly to the LTR stream system prior to the construction of the canal system to Pond B. Joyce Branch is ~2,533-m (8,310.3-ft) long and is ~3.0-m (9.8-ft) across the base of the stream bed. The stream runs through a densely vegetated, deep valley flowing southeast away from EA1 and has no developed access points to its banks prior to emptying into a marshy area of Pond C. Water levels in Joyce Branch fluctuate throughout the year and certain areas may become dry during instances of low rainfall. Cs-137 and Co-60 are present in sediment/soil in EA5 at levels that exceed 1E-06 risk to an onsite worker. EA5 also contains two locations where Cs-137 levels are above the PTSM threshold (Figure 3).

EA6: PAR Pond

PAR Pond is a ~1,068-ha (2,640-ac) cooling water reservoir that historically received thermal discharges from R-Reactor and P-Reactor. Water levels in PAR Pond naturally fluctuate between 59- to 60- m (195- to 200-ft) msl. Cs-137 and Co-60 are present in sediment/soil in EA6 at levels that exceed 1E-06 risk to an onsite worker. In addition, Cs-137 and mercury are present in fish tissue that exceed the risk-based screening levels for the recreational fisherman.

EA7: Canal from P-Area to Ponds 4 and 5 – Including Pond 2

EA7 includes the canal from P-Area to Pond 2 and the canal to Ponds 4 and 5. Pond 2 received water from the canal leading from P-Area and discharged into a canal that emptied into Ponds 4 and 5. Pond 2 is ~7.9 ha (19.6 ac) and the canal leading from P-Area to Pond 2 is ~3,582-m (11,751.9-ft) long. The canal from the Pond 2 to Ponds 4 and 5 is ~2,081-m (6,827.4-ft) long. The canals are ~3.0-m (9.8-ft) across the base. Water levels fluctuate from year to year in Pond 2 and the canal system based on precipitation amounts. Cs-137 and Co-60 are present in sediment/soil in EA7

at levels that exceed 1E-06 risk to an onsite worker (Figure 3).

EA8: Ponds 4 and 5 – Including Canal from Ponds 4 and 5 to Pond C

EA8 includes Ponds 4 and 5 and the canal from Pond 5 to Pond C (EA9). Pond 4 received water from the canal leading from Pond 2 (EA7) and subsequently discharged to Pond 5. Pond 5 discharged to Pond C via a canal. Pond 4 is ~14.3 ha (35.3 ac). Pond 5 is ~4.0 ha (9.9 ac) and received water from Pond 4 and subsequently discharged to the canal from Pond 4 to Pond C is ~1,887-m (6,190.9-ft) long. The canal is ~3.0-m (9.8-ft) across the base of the canal. Water levels fluctuate from year to year in Pond 4, Pond 5, and the canal based on the amount of precipitation. Cs-137 is present in sediment/soil in EA8 at levels that exceed 1E-06 risk to an onsite worker (Figure 3).

EA9: Pond C

Pond C is a ~53.5 ha (132.4 ac) pre-cooler pond that received water from P-Reactor and R-Reactor. Pond C is hydraulically connected to PAR Pond (EA6) through a reverse riser conveyance at the Pond C dam that allows water to flow from Pond C into PAR Pond. The riser uses hydraulic pressure to stabilize water elevation between the two ponds. Pond C maintains its water level from year to year. Cs-137 and Co-60 are present in sediment/soil in EA9 at levels that exceed 1E-06 risk to an onsite worker (Figure 3). In addition, Cs-137 and mercury are present in fish tissue that exceed the risk-based screening levels for the recreational fisherman.

V. SUMMARY OF SITE RISKS

This section identifies the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial actions. Additional information pertaining to the risk assessment can be found in the RI/BRA (SRNS 2017).

Summary of Human Health Risk Assessment

The human health risk assessment evaluates the potential for adverse effects associated with exposure to constituents present at the LTR IOU. The assessment for each subunit estimates the risk potential in the absence of any remedial action and provides a basis for determining whether or not a remedial action is necessary. A streamlined approach that considered both standardized and site-specific receptor scenarios/exposure assumptions was used for this evaluation. The receptors evaluated for the HHRA included a future industrial worker, onsite worker, and recreational fisherman. As a point of comparison, a HHRA for the hypothetical future resident was also evaluated in the RI/BRA as a point of comparison (SRNS 2017).

For the entire Upper subunit of the LTR IOU, the IOU onsite worker was selected as the most likely receptor for exposure to contaminated sediment/soil. The primary pathway of concern is external exposure to radionuclides in the contaminated sediment/soil. Surface water was determined to not be a media of concern and did not pose an unacceptable risk to the IOU onsite worker. The IOU onsite worker is based on an SRS wetland researcher scenario and is also protective of an adolescent trespasser. The risk for the onsite worker conservatively assumes no shielding of radionuclides from water coverage. The IOU onsite worker scenario is applicable to the entire Upper

subunit. Because it is known that some contaminants could bioaccumulate in fish and fish are a mobile medium, the hypothetical recreational fisherman was chosen as the most likely receptor for the ingestion of contaminated fish tissue. The pathway of concern is contaminated sediment/soil to benthic/aquatic organisms to fish and ultimately to the recreational fisherman. Surface water was determined to not be a media of concern and did not pose an unacceptable risk to the receptors evaluated. The recreational fisherman scenario was determined to only be viable for EAs that can sustain populations of consumable fish specifically EA3, EA6, and EA9.

EA1: Pond A – Including R-Area Discharge Canal

As documented in the RI/BRA (SRNS 2017), Cs-137 and Co-60 were identified as human health refined constituents of concern (RCOCs) in sediment/soil for the IOU onsite worker receptor. RCOCs are contaminants that are considered for remedial action. Concentrations in EA1 pose a Total Cumulative Risk (TCR) of 8.2E-04 to the IOU onsite worker (decay corrected to 6.4E-04 to account for radioactive decay from the time the sample was collected). The risk to the IOU onsite worker from Cs-137 (Exposure Point Concentration [EPC] = 148 pCi/g) is 8.2E-04 (decay corrected to 6.4E-04). The risk to the IOU onsite worker from Co-60 (EPC = 0.144 pCi/g) is 1.7E-06 (decay corrected to <1E-06).

Using maximum concentrations [max] and maximum activity concentrations of detected constituents, the only constituent that exceeds the PTSM threshold (i.e., risk ≥1E-03) in EA1 is Cs-137 (max = 685.8 pCi/g) at one location. The single submerged location (Figure 3) had five separate samples above the PTSM threshold for the IOU onsite worker and was taken into consideration for the remedial alternative evaluation.

EA2: Canal from Pond A to Pond B

As documented in the RI/BRA (SRNS 2017), Cs-137 was identified as a human health RCOC in sediment/soil for the IOU onsite worker receptor. Cs-137 in sediment/soil (EPC = 48.8 pCi/g) poses a 2.7E-04 risk to the IOU onsite worker (decay corrected to 2.3E-04).

Results of the PTSM evaluation for EA2 indicated no PTSM RCOCs were present.

EA3: Pond B – Including Canal to Pond C

As documented in the RI/BRA (SRNS 2017), Cs-137 was identified as a human health RCOC in sediment/soil for the IOU onsite worker receptor. Cs-137 in sediment/soil (EPC = 98.3 pCi/g) poses a 5.5E-04 risk to the IOU onsite worker (decay corrected to 3.3E-04).

Cs-137 and mercury were identified as human health RCOCs in fish tissue for the recreational fisherman receptor. Cs-137 in fish tissue (max = 113 pCi/g) exceeded the USEPA preliminary remedial goal (PRG) of 0.054 pCi/g (USEPA 2018a). Mercury (max = 1.83 mg/kg) exceeded the USEPA regional screening level (RSL) of 0.154 mg/kg for the recreational fisherman (USEPA 2018b).

Two locations (Figure 3) had sample results above the PTSM threshold (i.e., risk ≥1E-03) for the IOU onsite worker and were conservatively taken into consideration for the remedial alternative evaluation. Based on an evaluation of the exposure area in its entirety (decay corrected risk = 3.3E-04) and the

subsequent refinement/uncertainty evaluation, there were no PTSM RCOCs identified for EA3.

EA4: Canal from Pond B to North Arm of PAR Pond

Based on the RI/BRA (SRNS 2017), Cs-137 was identified as a human health RCOC in sediment/soil for the IOU onsite worker receptor. Cs-137 in sediment/soil (EPC = 18.3 pCi/g) poses a 1.0E-04 risk to the IOU onsite worker (decay corrected to 8.8E-05).

Results of the PTSM evaluation for EA4 indicated no PTSM RCOCs were present.

EA5: Joyce Branch (Old Discharge Canal)

Cs-137 and Co-60 were identified as human health RCOCs in sediment/soil for the IOU onsite worker receptor in the RI/BRA (SRNS 2017). Concentrations pose a TCR of 1.3E-03 to the IOU onsite worker (decay corrected to 9.4E-04). The risk to the IOU onsite worker from Cs-137 (EPC = 228 pCi/g) is 1.3E-03 (decay corrected to 9.4E-04). The risk to the IOU onsite worker from Co-60 (EPC = 0.76 pCi/g) is 9.1E-06 (decay corrected to 1.7E-06).

Two locations (Figure 3) had sample results above the PTSM threshold (i.e., risk ≥1E-03) for the IOU onsite worker and were conservatively taken into consideration for the remedial alternative evaluation. Based on an evaluation of the exposure area in its entirety (decay corrected risk = 3.3E-04) and the subsequent refinement/uncertainty evaluation, there were no PTSM RCOCs identified for EA3.

EA6: PAR Pond

The RI/BRA identified Cs-137 and Co-60 as human health RCOCs in sediment/soil for the IOU onsite worker receptor (SRNS 2017). Concentrations pose a TCR of 5.0E-05 to the IOU onsite worker (decay corrected to 2.9E-05). The risk to the IOU onsite worker from Cs-137(EPC = 8.82 pCi/g) is 4.9E-05 (decay corrected to 2.9E-05). The risk to the IOU onsite worker from Co-60 (EPC = 0.097 pCi/g) is 1.2E-06 (decay corrected to <1E-06).

Cs-137 and mercury were identified as human health RCOCs in fish tissue for the recreational fisherman receptor. Cs-137 (max = 18.4 pCi/g; PRG = 0.054 pCi/g) and mercury (max = 3.18 mg/kg; RSL = 0.154 mg/kg) in fish tissue exceed risk-based screening levels for the recreational fisherman.

Results of the PTSM evaluation for EA6 indicated no PTSM RCOCs were present.

EA7: Canal from P-Area to Ponds 4 and 5 – Including Pond 2

Cs-137 and Co-60 were identified as human health RCOCs in sediment/soil for the IOU onsite worker receptor as documented in the RI/BRA (SRNS 2017). Concentrations pose a TCR of 7.8E-04 to the IOU onsite worker (decay corrected = 4.5E-04). Risk to the onsite worker from Cs-137 (EPC = 139 pCi/g) is 7.7E-04 (decay corrected to 4.5E-04). Risk to the onsite worker to Co-60 (EPC = 0.802 pCi/g) is 9.6E-06 (decay corrected to 1.0E-06).

Results of the PTSM evaluation for EA7 indicated no PTSM RCOCs were present.

EA8: Ponds 4 and 5 – Including Canal from Ponds 4 and 5 to Pond C

The RI/BRA identified Cs-137 as a human health RCOC in sediment/soil for the IOU onsite worker receptor (SRNS 2017). Cs-137 in sediment/soil (EPC = 50.3 pCi/g) poses a 2.8E-04 risk to the IOU onsite worker (decay corrected to 1.9E-04).

Results of the PTSM evaluation for EA8 indicated no PTSM RCOCs were present.

EA9: Pond C

Cs-137 and Co-60 were identified as human health RCOCs in sediment/soil for the IOU onsite worker receptor as documented in the RI/BRA (SRNS 2017). Concentrations pose a TCR of 1.2E-04 to the IOU onsite worker (decay corrected = 6.7E-05). Risk to the onsite worker from Cs-137 (EPC = 20.9 pCi/g) is 1.2E-04 (decay corrected to 6.7E-05). Risk to the onsite worker from Co-60 (EPC = 0.114 pCi/g) is 1.4E-06 (decay corrected to <1E-06).

Cs-137 and mercury were identified as human health RCOCs in fish tissue for the recreational fisherman receptor. Cs-137 (max = 42.5 pCi/g; PRG = 0.054 pCi/g) and mercury (max = 0.214 mg/kg; RSL = 0.154 mg/kg) in fish tissue exceed risk-based screening levels for the recreational fisherman.

Results of the PTSM evaluation for EA9 indicated no PTSM RCOCs were present.

Summary of Ecological Risk Assessment

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 exposure areas for these receptors. The thresholds were derived from several published sources and were used in a tiered approach to evaluate No- and Low-Adverse Effect Levels. 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, mercury, 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. The results of the of the ecological risk assessment (ERA) showed that no ecological refined constituents of concern (RCOCs) were identified for any EA within the LTR IOU. Although fish in certain areas of the LTR IOU are contaminated with mercury and Cs-137, no problems warranting action were identified from an ecological risk perspective.

No ecological RCOCs were identified for either the sediment/soil or surface water medium.

Summary of Contaminant Fate and Transport Analysis

Fate and transport of contaminants from source units was previously evaluated in the individual OU assessments. With respect to the IOU, remedial alternatives were considered that would mitigate transport of soil/sediments downstream and prevent harm to receptors and the public. The alternative

evaluation included the use of best management practices (BMPs) to reduce sediment/soil migration during the implementation stage that may cause disturbance of contaminated media.

Conclusion

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 maximum contaminant level. 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 proposed 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).

As determined in the RI/BRA (SRNS 2017), Cs-137 was identified as a human health RCOC in sediment/soil for all nine EAs for the IOU onsite worker. Co-60 was identified as a human health RCOC in EA5, EA6, EA7 and EA9. In addition, Cs-137 and mercury were identified as human health RCOCs in fish tissue for the recreational fisherman in EA3, EA6, and EA9.

Because Co-60 was collocated with Cs-137, any remedial action selected for Cs-137 in sediment/soil will also address the Co-60 contamination. The presence of mercury is the result of atmospheric deposition (i.e., regional issue/problem) and from the use of the elevated levels of mercury in Savannah River water as part of the river water distribution system for reactor cooling. Therefore, mercury was introduced into the LTR system not as a result of site operations but rather a combination of atmospheric deposition and the use of Savannah River water.

No PTSM RCOCs are identified for any EA within the LTR IOU. This determination is based on an evaluation of each exposure area as a whole and the associated decay-corrected risks that are <1E-03, not individual sample results. However, EA1, EA3, and EA5 had specific locations where Cs-137 levels were above the PTSM threshold (i.e., risk ≥1E-03) and were taken into consideration for the remedial alternative evaluation. No ecological RCOCs were identified for either the sediment/soil or surface water medium.

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

VI. REMEDIAL ACTION OBJECTIVES

RAOs are media- or OU-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 conceptual site model 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 future land use of the LTR IOU is anticipated to be non-residential and primarily used for environmental/ecological research with USDOE maintaining control of the land. The following RAOs have been identified for the LTR IOU to support the future land use.

- Protect IOU onsite workers from exposure to Cs-137 and Co-60 in sediment/soil that exceed 1E-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 mercury in fish tissue. The primary route of exposure is the ingestion of fish pathway.

Preliminary Remedial Goals

Preliminary remedial goals (PRGs), referred to as remedial goal options in the RI/FS, serve to provide a range of cleanup goals for each constituent of concern and are typically identified along with the RAOs. These cleanup goals are either concentration levels that correspond to a specific risk or hazard or are based on Applicable, or Relevant and Appropriate Requirements (ARARs). Following public comment and approval of the PP, the PRGs for the selected remedy are documented as final cleanup goals or remedial goals (RGs) in the ROD.

The FS for the LTR IOU (SRNS 2020) developed risk-based PRGs for the IOU onsite worker for sediment/soil media and recreational fisherman for fish tissue media developed to correspond to a risk of 1E-06 for carcinogens (i.e., Cs-137 and Co-60) and a hazard quotient of 1 for noncarcinogens (i.e., mercury). The PRGs for the sediment/soil and fish tissue media are shown in Table 1. The risk-based PRGs were obtained using the calculator function available at the USEPA PRG website (USEPA 2018a) for the radiological constituents and the USEPA RSL website (USEPA 2018b) for mercury.

The most likely PRGs also consider a comparison to background levels. The SRS soil background (two times [2x] the 95th percentile concentration) is identified as the most likely PRG for Cs-137 in sediment/soil media for the onsite worker since this is the generally accepted concentration for "typical" anthropogenic fallout, and has been accepted as the RG for other SRS projects, specifically the *SRS Wetland Area at Dunbarton Bay In Support of Steel Creek Integrator Operable Unit* (SRNS 2013c).

Applicable or Relevant and Appropriate Requirements

ARARs are cleanup standards, standards of control and other substantive requirements, criteria or limitations promulgated under federal, state, or local environmental laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Section 121(d) of CERCLA, as amended by the Superfund Amendments Reauthorization Act, requires that remedial actions comply with requirements and standards set forth under federal and state environmental laws.

Three categories of ARARs are identified to clarify how to identify and comply with environmental requirements. They include action-specific, location-specific, and chemical-specific requirements:

- Action-specific ARARs control or restrict the design, performance, and other aspects of implementation of specific remedial activities;
- Location-specific ARARs reflect the physiographic and environmental characteristics of the unit or the immediate area, and may restrict or preclude remedial actions depending on the location or the characteristics of the unit:
- Chemical-specific ARARs are media-specific concentration limits promulgated under federal or state law.

Proposed ARARs are presented in the LTR IOU FS for the preferred alternative(s) (SRNS 2020). Final ARARs for the selected alternative(s) will be documented in the ROD for the LTR IOU.

VII. SUMMARY OF REMEDIAL ALTERNATIVES

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 National Contingency Plan (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 2020). 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 and are summarized below. A summary of the

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 constituents of concern 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 to monitor decay of Cs-137 at all nine EAs.

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 (Ponds B, C, and PAR) that maintain fishable fish populations. Compliance with the Site Use Program and other associated procedures will be ensured, and deed restrictions will 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. 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 will 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 (remote gamma surveys) and ground truthing (sediment/soil sampling or collection of field measurements) to measure and document the decay of Cs-137 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 mercury. 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 thru EA9).

Alternative A-2, LUCs with MNR may 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. 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 thru 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, BMPs (e.g. silt curtains) will be implemented to reduce sediment/soil migration. Placement of an in-situ cap in deeper water will 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
EA3	
Capital	$2,536,207
O&M Cost	$92,500
Total Present-Worth Cost	$2,678,707
EA5	
Capital	$662,690
O&M Cost	$142,500
Total Present-Worth Cost	$805,190

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 will 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., E-Area 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	$485,986
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 will 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 will 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	$2,082,616
EA6	
Capital	$18,500
O&M Cost	$2,817,422
Total Present-Worth Cost	$2,835,922
EA9	
Capital	$18,500
O&M Cost	$572,676
Total Present-Worth Cost	$591,176

VIII. EVALUATION OF ALTERNATIVES

This section summarizes the results of the evaluation of the remedial alternatives in the LTR IOU FS (SRNS 2020).

The NCP (40 Code of Federal Regulations [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 2.

Comparative Analysis of Alternatives

The potential remedial alternatives have been evaluated against the threshold and primary balancing criteria. Modifying criteria (i.e. state or support agency acceptance and community acceptance) will be evaluated after the public comment period on the PP. 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.

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, in the absence of conjunction with other remedial actions does not break all exposure pathways; however, rigorous enforcement of the controls would prevent human exposure to all contaminated sediment/soil and fish. Contaminated sediment/soil would be left in place, but exposure pathways would be mitigated for human exposure but still be bioavailable for eco-receptors. MNR would ensure that any unexpected changes to the system that would allow for human exposure to contaminated sediment/soil or fish would be identified and mitigated.

Alternative A-3 would install an integrated soil amendment/physical capping system over PTSM level contaminated sediment/soil. This will reduce the bioavailability of Cs-137 for fish and subsequently human receptors who may eat the fish. Alternative A-3 is only protective for PTSM contaminated sediment/soil and would need to be implemented with Alternative A-2 to achieve overall protection of human health and the environment.

Alternative A-5 prescribes excavation, treatment and disposal of sediment/soil that exceed PTSM levels. This alternative will remove the most highly contaminated sediment/soil (i.e., ≥1E-03 risk) but will not provide protection of remaining contaminants (i.e., ≥1E-06 risk). Therefore, Alternative A-5 would need to be implemented with Alternative A-2 to achieve overall protection of human health and the environment.

Alternative A-6 consists of maintaining dam structures to sustain water levels. This alternative minimizes access and limits exposure to submerged, contaminated sediment/soil. This alternative also prevents the transport of contaminated sediment downstream of the dam structures. This alternative is not meant to address surface water but breaks the direct contact pathway to the contaminated sediments. The 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. Alternative A-6 provides an additional layer of protection when implemented with Alternative A-2.

Compliance with ARARs

There are no ARARs associated with Alternatives A-1 or A-2. Alternatives A-3, A-5, and A-6 are expected to comply with the identified ARARs as shown in the comparative analysis evaluation in Table 3.

Short-Term Effectiveness

Short-term effectiveness addresses the time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy.

Short-term effectiveness considers the risks the remedial alternative poses to workers, the community (i.e., public) and whether the alternative will disturb, mitigate, increase or cause injury to a natural resource. Alternative A-1 will not implement an action so there is no risk to remedial workers or residents and no disturbance to a natural resource. Alternative A-2 will consist of administrative controls, signs, and long-term monitoring. These activities are minimally invasive and will result in minimal exposure to workers during installation and monitoring, and no injury to a natural resource. Alternative A-3 consists of applying a cap of sand and soil amendments and is expected have minimal risk to workers and create minimal disturbance. Alternative A-5 has the highest potential for worker exposure during dewatering, staging, and transportation of excavated sediment soil. Alternative A-6 consists of maintaining the existing dams with no risk identified for workers, the community, or environment

Long-Term Effectiveness and Permanence

Alternative A-1 is a no action alternative that does not provide long-term effectiveness or permanence.

Alternative A-2 will break the exposure pathway and provide long-term effectiveness provided LUCs remain in place until the contaminated sediment/soil reaches RGs. The MNR component of the remedy will identify any unexpected long-term changes in the system to ensure continued long-term effectiveness.

Alternatives A-3 and A-6 provide additional barriers to exposure but do not shorten the time-frame for reaching RGs. Alternative A-5 will permanently remove sediment/soil with the highest concentrations of contamination and thereby effectively shorten the time-frame for the radioactive decay mechanism to reach RGs. However, the reduction in time to meet RGs is relatively small.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives A-1, A-2, and A-6 do not include treatment as a component of the remedy. Alternatives A-3 and A-5 include treatment of the contaminants in sediment/soil as a component of the remedy. For Alternative A-3, a reduction of mobility is accomplished via the addition of in situ amendments to the hybrid cap over the PTSM sediment/soil. This would be effective to sequester the sediment/soil to reduce mobility until it decays to a level below the PTSM threshold. For Alternative A-5, the excavated sediment/soil will be treated with a drying agent to reduce contaminant mobility during transportation and disposal.

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, available technology, and ability to obtain the necessary permits and approvals. All of the alternatives with the exception of Alternative A-1 No Action are implementable. Alternative A-1 No Action does not require

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

Alternative A-3 will require mobilization of heavy equipment and installation of a sand/soil amendment type cap system over contaminated sediment/soil. Alternative A-5 will require mobilization of heavy equipment, excavation of sediment/soil, treatment of sediment/soil via the application of a drying agent, transport, and disposal of contaminated sediment/soil. The relative difficulty of implementation of these alternatives varies depending on the site-specific conditions. In order of least to most difficult are EA1, EA5, and EA3.

Cost

A total present worth cost for each alternative was calculated for each applicable EA and presented in Table 3. 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, costs associated with monitoring, sampled and analyzed, 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 (SI) 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 Alternative A-2 for the Upper subunit which includes all nine exposure areas (EA1 thru EA9) is ~$17 million (M). The cost of this alternative is in addition to any additional remedy selected for any individual EA.

Costs associated with Alternatives A-3, A-5, and A-6 are provided by individual EAs on Table 3. In general, costs associated with Alternatives A-3, A-5, and A-6 are in the same range at a specific EA, but vary widely between EAs. Estimated costs of these alternatives range from ~$500 thousands (K) to $2.5M depending on the EA.

IX. PREFERRED ALTERNATIVE

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. Alternative A-2 LUCs with MNR will be used in combination with other alternatives that target PTSM or maintain water levels to reduce exposure and mitigate sediment/soil migration where appropriate. For this reason, preferred alternatives will vary between the EAs. The preferred alternatives for the Upper Subunit of the LTR IOU are as follows:

- Alternative A-2 LUCs with MNR is the preferred alternative for all nine EAs (EA1 thru EA9);
- In addition to Alternative A-2 LUCs with MNR, Alternative A-5 Excavation, Treatment and Disposal of PTSM Sediment/Soil is the preferred alternative for the single PTSM location in EA1 (Pond A – Including R Discharge Canal); and
- In addition to Alternative A-2 LUCs with MNR, Alternative A-6 Maintain Water in Ponds is the preferred alternative for EA3 (Pond B) and EA6 (PAR Pond).

Each of these alternatives is discussed below.

Alternative A-2 – LUCs with MNR

Alternative A-2 is the preferred 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.

LUCs with MNR for the Upper subunit of the LTR IOU includes the following:

- Administrative/Worker Access Controls: Includes SRS administrative controls and land use restrictions for onsite workers as implemented under the Site Use/Site Clearance Program and other controls that are in place to ensure worker safety including work controls/work packages that includes worker training, and health and safety requirements and pre-work briefings.
- Engineering controls (signs, gates): SRS access controls that limit and inform SRS workers and inadvertent 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.

  Warning signs posted at each EA at access points: Signage includes Warning signs, and Soil Contamination Area signs, and LUC sign notifications placed at access points to the LTR IOU. No Unauthorized Fishing signs will be posted at access points that approach viable surface water bodies (Ponds B, C, and PAR) that maintain fishable fish populations.

For EA5 – Joyce Branch, PTSM is present in two locations (Figure 3). 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.

- MNR: Includes sampling methods such as remote sensing (remote aerial gamma surveys) and ground truthing (sediment/soil sampling or collection of field measurements) to measure and document the decay of Cs-137 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 mercury. The MNR remedy includes

a single comprehensive monitoring plan to be developed for all nine EAs.

Monitoring data would be presented in the five-year remedy reviews and would be used to document the protectiveness of the 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 (~50 years).

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

For EA1 (Pond A Including R Discharge Canal), the preferred 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 time-frame for radioactive decay to reach RGs from 290 years to 225 years in EA1.

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

For EA3 (Pond B) and EA6 (PAR Pond), the preferred alternative is Alternative A-6 Maintain Water in Ponds in addition to Alternative A-2 LUCs with MNR. This alternative was evaluated for EA3, EA6, and EA9 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. EA6 and EA9 have no PTSM sediment/soil locations. 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 in Pond C 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.

Preferred Alternatives (A-2, A-5, and A-6)

The preferred remedy for the Upper subunit of the LTR IOU leaves hazardous substances in place that pose a potential future risk and will require land use restrictions. 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 Land Use Control Assurance Plan (WSRC 1999) to ensure that land use restrictions are maintained and periodically verified.

The unit-specific Land Use Control Implementation Plan (LUCIP) for the Upper subunit of the LTR IOU will be referenced in the ROD and will provide the details and specific measures required for the LUCs selected as part of this preferred 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 required for any modification or termination of the LUCs.

Based on the information currently available, the lead agency believes that Alternative A-2 LUCs with MNR for the entire Upper subunit (EA1 thru 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 3). The USDOE expects the Preferred 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.

A detailed cost estimate, representative of an order of magnitude estimate with an assumed accuracy in the range of +50/-30%, for the preferred alternative is provided in Appendix A.

X. POST-ROD SCHEDULE

Key milestones include the following:

Deliverable	Submittal Date
Submit Revision 0 ROD	December 7, 2020
Issuance of ROD	August 20, 2021
Submit Revision 0, Remedial Action Implementation Plan	October 29, 2021
Submit Revision 0, LUCIP	October 29, 2021
Remedial Action Start	November 18, 2022
Submit Revision 0, Post-Construction Report/Remedial Action Completion Report	August 20, 2024

Five-Year Remedy Reviews

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 COCs 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.

XI. REFERENCES

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XII. GLOSSARY

Administrative Record File: A file that is maintained and contains all information used to make a decision on the selection of a response action under the Comprehensive Environmental Response, Compensation and Liability Act. This file is to be available for public review, and a copy is to be established at or near the Site, usually at one of the information repositories. Also a duplicate file is held in a central location, such as a regional or state office.

ARARs: Applicable or Relevant and Appropriate Requirements. Refers to the federal and state requirements that a selected remedy will attain. These requirements may vary from site to site. Refer to 40 CFR 300.5 Definitions, "Applicable requirements" and "Relevant and appropriate requirements" for more detail.

Baseline Risk Assessment: Analysis of the potential adverse health effects (current or future) caused by hazardous substance release from a site in the absence of any actions to control or mitigate these releases.

Characterization: The compilation of all available data about the waste units to determine the rate and extent of contaminant migration resulting from the waste site, and the concentration of any contaminants that may be present.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 1980: A federal law passed in 1980 and modified in 1986 by the Superfund Amendments and Reauthorization Act.

Corrective Action: A USEPA requirement to conduct remedial procedures under RCRA 3004(u) at a facility when there has been a release of hazardous waste or constituents into the environment. Corrective action may be required beyond the facility boundary and can be required regardless of when the waste was placed at the facility.

Exposure: Contact of an organism with a chemical or physical agent. Exposure is quantified as the amount of the agent available at the exchange boundaries of the organism (e.g., skin, lungs, digestive tract, etc.) and available for absorption.

Exposure Point Concentration (EPC): Risk and hazard calculations are based on the RME (reasonable maximum exposure) exposure point concentrations, which is defined as the lesser of the maximum detected concentration and the 95% upper confidence level (UCL) of the mean concentration. The 95% UCL is a statistically derived number based on the sampling data for each exposure area.

Federal Facility Agreement (FFA): The legally binding agreement between regulatory agencies (USEPA and SCDHEC) and regulated entities (USDOE) that sets the standards and schedules for the comprehensive remediation of the SRS.

Land Use Controls: Legal and/or administrative mechanisms as well as physical installations that modify or guide human behavior at operable units where residual contamination remains in place. Institutional controls and engineering controls are types of land use controls.

Media: Pathways through which contaminants are transferred. Five media to which a release of contaminants may occur are groundwater, soil, surface water, sediments, and air.

Monitored Natural Recovery (MNR): Remedy that uses an ongoing, naturally occurring process to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment/soil.

National Priorities List: USEPA's formal list of the nation's most serious uncontrolled or abandoned waste sites, identified for possible long-term remedial response, as established by CERCLA.

Operable Unit (OU): A discrete action taken as one part of an overall site cleanup. The term is also used in USEPA guidance documents to refer to distinct geographic areas or media-specific units within a site. A number of operable units can be used in the course of a cleanup.

Operation and Maintenance (O&M): Activities conducted at a site after a response action occurs to ensure that the cleanup and/or systems are functioning properly.

Overall Protection of Human Health and the Environment: The assessment against this criterion describes how the alternative, as a whole, achieves and maintains protection of human health and the environment.

Proposed Plan: A legal document that provides a brief analysis of remedial alternatives under consideration for the site/operable unit and proposes the preferred alternative. It actively solicits public review and comment on all alternatives under consideration.

Principal Threat Source Material (PTSM): The NCP establishes an expectation that the remedial action use treatment to address the principal threats posed by a site wherever practicable (40 CFR §300.430(a)(1)(iii)(A)). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure. No threshold level of toxicity/risk has been established to equate to principal threat. However, USEPA guidance does state that treatment alternatives for source materials should generally be evaluated where the combined toxicity and mobility pose a potential risk of 1E-03 or greater. At the Savannah River Site (SRS), source material is preliminarily considered to be PTSM if the cumulative risk is greater than 1E-03 for carcinogens and/or if the hazard index (HI) is greater than 10 for noncarcinogens.

Reasonable Maximum Exposure (RME): This is the value that the average concentration will fall below 95 percent of the time.

Record of Decision (ROD): A legal document that explains to the public which alternative will be used at a site/operable unit. The ROD is based on information and technical analysis generated during the remedial investigation/ feasibility study and consideration of public comments and community concerns.

Resource Conservation and Recovery Act (RCRA), 1976: A Federal law that established a regulatory system to track hazardous substances from their generation to disposal. The law requires safe and secure procedures to be used in treating, transporting, storing, and disposing of hazardous substances. RCRA is designed to prevent the creation of new, uncontrolled hazardous waste sites.

Responsiveness Summary: A summary of oral and/or written comments received during the proposed plan comment period and includes responses to those comments. The responsiveness summary is a key part of the ROD, highlighting community concerns.

Superfund: The common name used for CERCLA; also referred to as the Trust Fund. The Superfund program was established to help fund cleanup of hazardous waste sites. It also allows for legal action to force those responsible for the sites to clean them up.

Target Risk Range: USEPA guidance for carcinogenic risk due to exposure to a known or suspected carcinogen between one excess cancer in an exposed population of ten thousand (1.0×10^{-4}) and one excess cancer in an exposed population of one million (1.0×10^{-6}). Risks within this range require risk management evaluation of remedial action alternatives to determine if risks can be reduced below one excess cancer in one million (1.0×10^{-6}). Risks greater than 1.0×10^{-4} indicate that remedial action is generally warranted.

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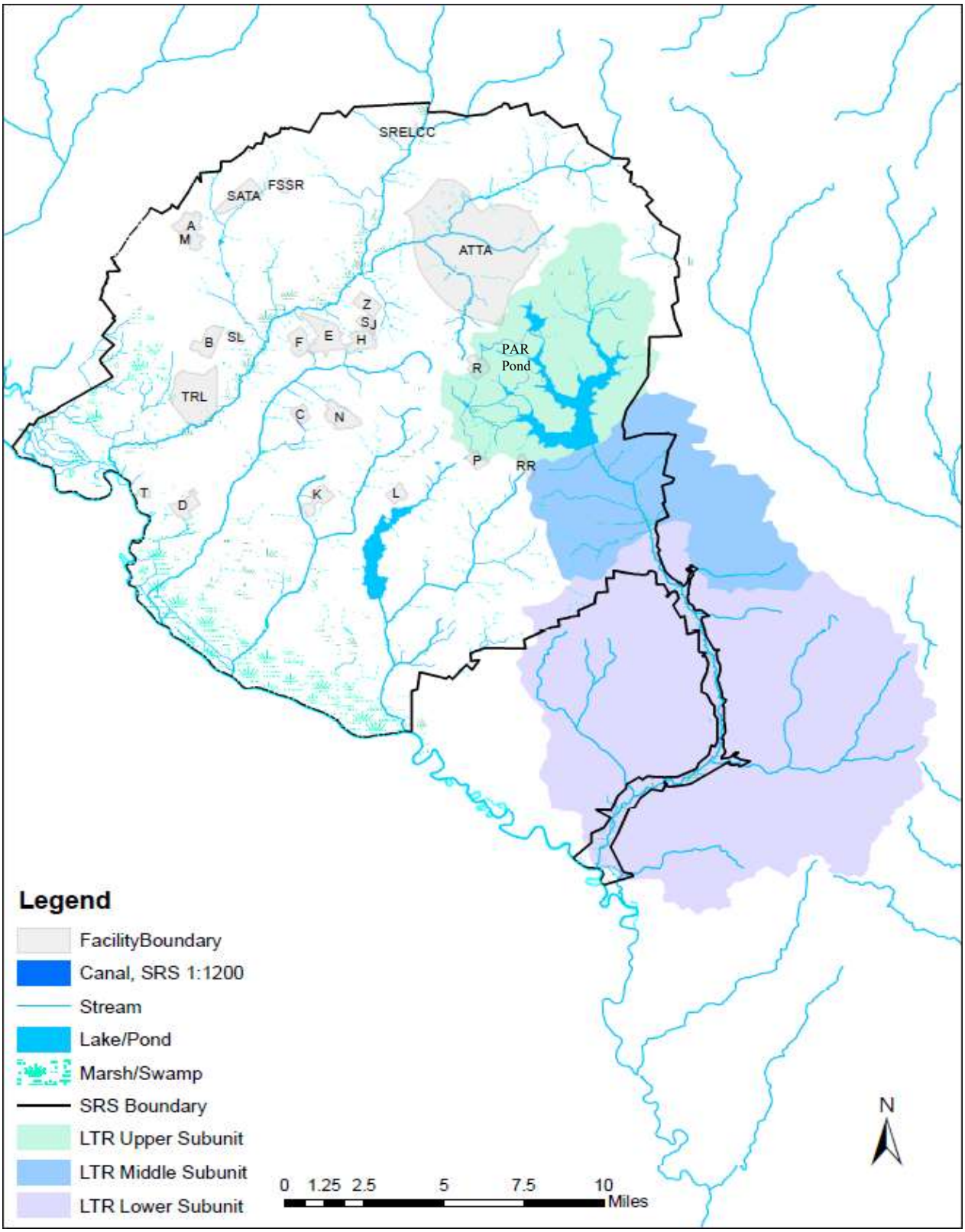

Figure 1. Location of the LTR IOU within the Savannah River Site

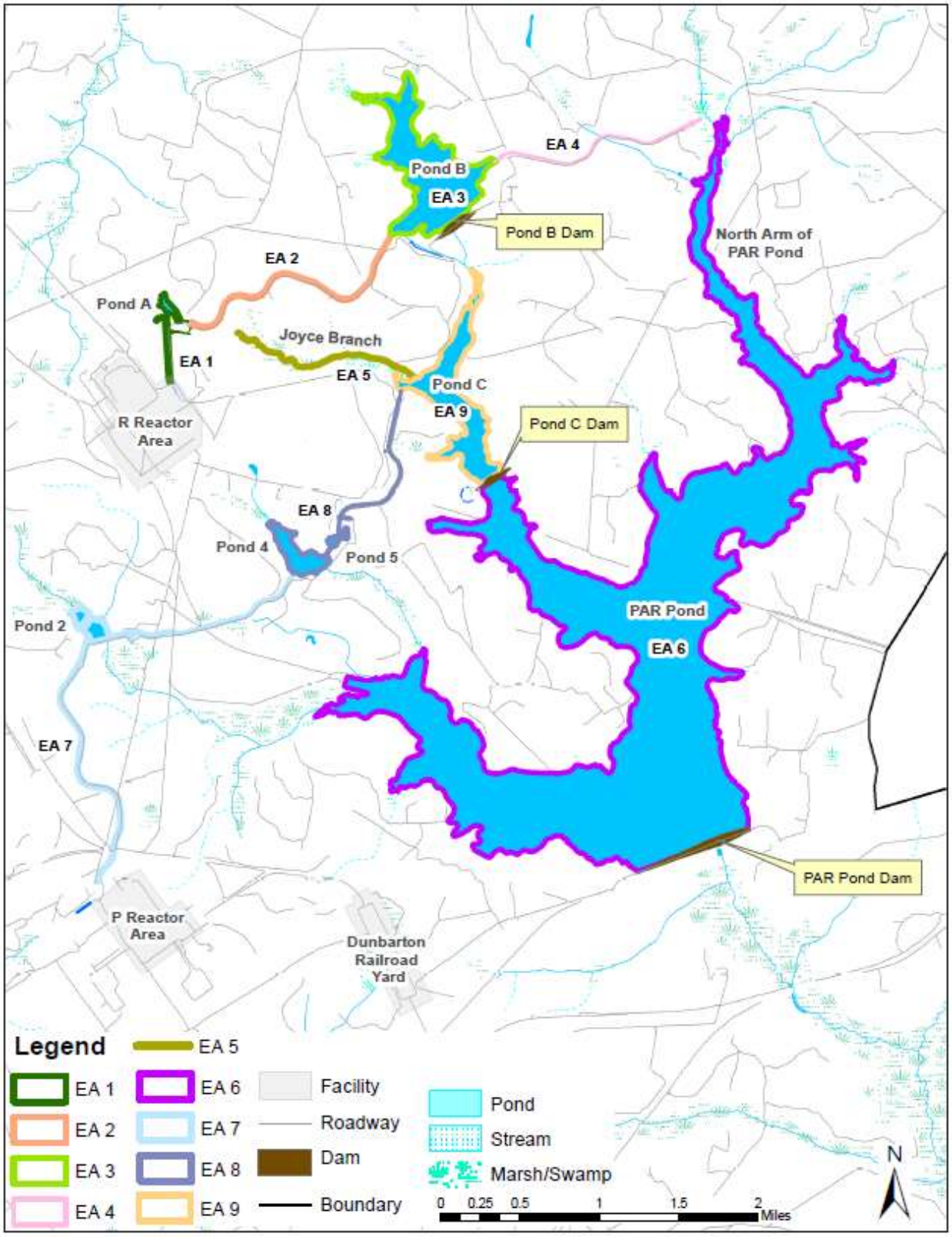

Figure 2. Layout of the Upper Subunit of the LTR IOU

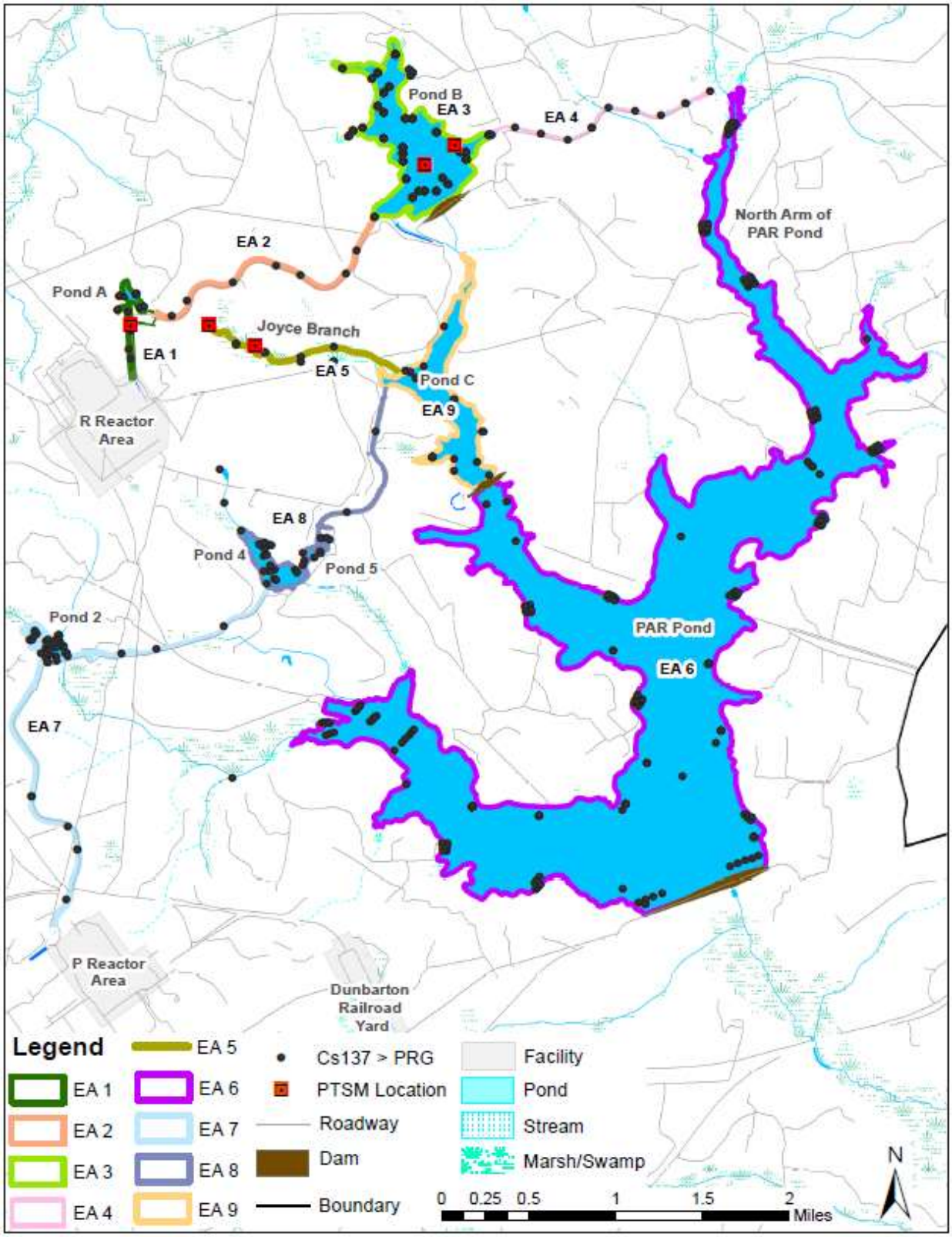

Figure 3. Location of Samples with Levels above the PRG and PTSM Threshold for Cs-137

Table 1. 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]	Most Likely PRG
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).
Sources of the most likely PRG are italicized
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).

Table 2. 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 3. Comparison of Alternatives Against the CERCLA Evaluation Criteria

Criterion	Alternative A-1 No Action	Alternative A-2 LUCS with MNR	Alternative A-3 Capping of PTSM Sediment/soil	Alternative A-5 Excavation, Treatment and Disposal of PTSM Sediment/Soil	Alternative A-6 Maintain Water in Ponds
Overall Protection of Human Health and the Environment					
Protection of Human Health	Not protective	Protective.	Protective.	Protective.	Protective.
Protection of the Environment	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Compliance with ARARs					
Chemical-specific	Not preferred.	None identified.	None identified.	None identified.	None identified.
Action-specific	Not preferred.	None identified.	None identified.	Yes	None identified.
Location-specific	Not preferred.	None identified.	Yes	Yes	Yes
Long-Term Effectiveness and Permanence					
Magnitude of Residual Risks	Not applicable.	Effective in reducing risk of exposure to contaminated media by controlling exposure.	Effective in reducing risk of exposure to contaminated media by breaking exposure pathway.	Effective in reducing risk of exposure to contaminated media by removal of PTSM at specific locations.	Effective in reducing risk of exposure to contaminated media by breaking exposure pathway.
Adequacy of Controls	Not adequate	Adequate	Adequate	Adequate	Adequate
Permanence	Not permanent	Permanent	Permanent	Permanent	Permanent
Estimated Time Frame to Reach RG	290 years	290 years	290 years	235 years	290 years
Reduction of Toxicity, Mobility, or Volume Through Treatment					
Treatment Process	None	None	Treatment	Treatment	None
Degree of Expected Reduction in Toxicity, Mobility, or Volume	None	None	The use of an amendment in the cap will reduce the mobility of the PTSM sediment/soil.	The use of a drying agent will reduce mobilization during transportation and disposal.	None

Table 3. Comparison of Alternatives Against the CERCLA Evaluation Criteria *(Continued)*

Criterion	Alternative A-1 No Action	Alternative A-2 LUCS with MNR	Alternative A-3 Capping of PTSM Sediment/soil	Alternative A-5 Excavation, Treatment and Disposal of PTSM Sediment/Soil	Alternative A-6 Maintain Water in Ponds
Short-Term Effectiveness					
Risk to Remedial Workers	Not applicable; no remedial action involved.	None	Worker exposure to contaminated sediment/soil will be minimal as the cap will be installed from a barge or vessel from the surface of the water. An onsite disposal area.	Worker exposure to contaminated sediment/soil may be significant due to dewatering, staging, and transportation of excavated sediment/soil to an onsite disposal area.	None
Risk to Community	Not applicable; no remedial action involved.	None	Risk to the community would be mitigated by the use of a silt curtain during cap construction to control sediment/soil migration.	Risk to the community from sediment/soil migration would be mitigated by the use of a silt curtain during excavation.	Continued maintenance of the dam protects the community by preventing migration of contaminated sediment/soil.
Risk to Environment	Not applicable; no remedial action involved.	None	None	Disturbance would be limited to area of PTSM	None
Estimated Time Frame to Achieve RAOs	Readily Implementable	8 months	18-24 months	12-16 months	4 months
Implementability					
Availability of materials, equipment, and skilled labor	No implementation	Readily implemented	Readily implemented	Readily implemented	Readily implemented
Ability to construct and operate remedial technology	Not Applicable	Readily available. No specialized materials, equipment or labor required.	Availability of specialized equipment/contractors and mobilization of a barge may be difficult.	Readily available. No specialized materials, equipment or labor required.	Readily available. No specialized materials, equipment or labor required.
Ability to obtain permits/approvals from Agencies	Not Applicable	Not Applicable	Not Applicable	Readily implemented.	Not Applicable
Ease of undertaking additional actions	Compatible	Compatible	Compatible	Compatible	Compatible

Table 3. Comparison of Alternatives Against the CERCLA Evaluation Criteria *(Continued/End)*

Criterion	Alternative A-1 No Action	Alternative A-2 LUCS with MNR	Alternative A-3 Capping of PTSM Sediment/soil	Alternative A-5 Excavation, Treatment and Disposal of PTSM Sediment/Soil	Alternative A-6 Maintain Water in Ponds
Cost					
Total Present-Worth Costs	$0	$17M for entire Upper subunit	EA1 - $417K EA3 - $2.7M EA5 - $805K	EA1 - $486K EA3 - $2M EA5 - $796K	EA3 - $2.1M EA6 - $2.8M EA9 - $591K
Modifying Criteria					
State Support/Agency Acceptance	Not preferred.	USEPA and SCDHEC support Alternative A-2 for the entire Upper subunit (EA1 thru EA9).	Not preferred.	EPA and SCDHEC support Alternative A-5 for EA1.	EPA and SCDHEC support Alternative A-6 for EA3 and EA6.
Community Acceptance	This criterion will be completed following public review.	This criterion will be completed following public review.	This criterion will be completed following public review.	This criterion will be completed following public review.	This criterion will be completed following public review.

APPENDIX A

DETAILED COST ESTIMATE
FOR ELEMENTS OF THE PREFERRED ALTERNATIVE

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Lower Three Runs — Integrator Operable Unit - Upper Section
A-2: Land Use Controls and Monitored Natural Recovery

Item	Quantity	Units	Unit Cost	Total Cost	
Direct Capital Costs					
Land Use Controls					
Posting of Warning Signs EA1	5	ea	$200	$1,000	At access points - approximately 5 per EA except where noted differently
Posting of Warning Signs EA2	5	ea	$200	$1,000	At access points - approximately 5 per EA except where noted differently
Posting of Warning Signs EA3	5	ea	$200	$1,000	At access points - approximately 5 per EA except where noted differently
Posting of Warning Signs EA4	5	ea	$200	$1,000	At access points - approximately 5 per EA except where noted differently
Posting of Warning Signs EA5	5	ea	$200	$1,000	At access points - approximately 5 per EA except where noted differently
Posting of Warning Signs EA6	50	ea	$200	$10,000	At access points - estimated and reviewed with JK
Posting of Warning Signs EA7	15	ea	$200	$3,000	At access points - estimated and reviewed with JK
Posting of Warning Signs EA8	7	ea	$200	$1,400	At access points - estimated and reviewed with JK
Posting of Warning Signs EA9	10	ea	$200	$2,000	At access points - estimated and reviewed with JK
Land Use Control Implementation Plan	1	ea	$30,000	$30,000	3 times the normal cost due to the number of exposure areas
Deed Restrictions	1	lf	$40,000	$40,000	A little more than 5 times the normal cost due to fish advisories and number of Eas
Monitoring - Initial					
Development of Monitoring Plan	1	ea	$40,000	$40,000	Reference Nobis Engineering NH-2423-2010 Table 12-2
Initial monitoring - Sediment sampling & analyses	36	ea	$1,000	$36,000	4 Locations per EA
Initial monitoring -Fish Sampling and Analyses	12	ea	$1,000	$12,000	4 samples per fishable Pond (B, C, and Par)
Initial monitoring - Deposition measurements	20	ea	$500	$10,000	4 samples per Pond (A, B, C, and Par, 4 &5)
Data analysis & Reporting	1	ea	$45,000	$45,000	Reference Nobis Engineering NH-2423-2010 Table 12-2 Total number of signs is
Subtotal - Direct Capital Cost				$234,400	
Mobilization/Demobilization	10%	of subtotal direct capital		$23,440	Includes submittals, badging and training as well.
Site Preparation/Site Restoration	55%	of subtotal direct capital		$128,920	Includes GPR, site preparation, minor access roads, path clearing, boat usage, sample mobilizationetc.(See backup sheet).
Total Direct Capital Cost		(sum of * items)		**$386,760**	
Indirect Capital Costs					
Engineering & Design	15%	of direct capital		$58,014	Estimating Guideline Range 14-26%. Includes SU/SC sketches, placement sketches, workplan support (see backup sheet)
Project/Construction Management	5%	of direct capital		$19,338	Standard
Health & Safety	10%	of direct capital		$38,676	Increased percentage because of remote locations.
Overhead	30%	of direct capital		$116,028	Standard
Contingency	20%	of direct capital		$77,352	Standard
Total Indirect Capital Cost				**$309,408**	
Total Estimated Capital Cost				**$696,168**	
Direct O&M Costs					
Annual Costs (during implementation)	0.7%	discount rate for costs > 30 years duration[1]			
Access Controls	1	yr	$6,750	$6,750	Standard cost of $750 was ultiplied by 9 to account for the Eas
Subtotal - Annual Costs				$6,750	
Present Worth Annual Costs (-0.5% Discount Rate)				**$6,784**	
Annual Costs (Land Use Controls)	290	years O&M			Land Use Controls will last 290 years - until decay reaches 2x background
Access Controls	1	ea	$6,750	$6,750	Standard cost of $750 was ultiplied by 9 to account for the Eas
Subtotal - Annual Costs				$6,750	
Present Worth Annual Costs (0.7% Discount Rate)				**$830,925**	
Five Year Costs	58				
Inspections / Reporting (1 every 5 years)	1	ea	$13,500	$13,500	Assume 2 inspectors ($45/hr) for 15 days/10 hr days (Big ponds assume 3 days each, other Eas 1 day each)
Path Maintenance /Vegetation Removal for Access	1	ea	$13,500	$13,500	Assume 2 workers for 15 days/10 hr days (Big ponds assume 3 days each, other Eas 1 day each)
Sign Maintenance / Repairs (1 per year) Allowance	1	ea	$13,500	$13,500	Assume 2 workers to accompany inspectors for 15 days/10 hr days
Remedy Review	1	ea	$100,000	$100,000	Standard remedy review cost of $20,000 multiplied by 5 to account for large number of EA s and review of MNR data
Subtotal Five Year O&M Costs				$140,500	
Present Worth Annual Costs (0.7% Discount Rate)				**$6,632,276**	
MNR Costs (every 5 years for 50 years)	10				
Review/revise Monitoring Plan	1	ea	$25,000	$25,000	Engineering review/revision of monitoring plan - assume slightly more than half of development cost ($40k)
Sediment sampling & analyses	36	ea	$1,000	$36,000	Costs are estimated for sediment sampling, however gamma overflight data may be used in lieu of sampling.
Fish Sampling and Analyses	12	ea	$1,000	$12,000	Sampling costs include transportation to site, sample collection, sample analyses, boat costs, radcon support
Deposition measurements	20	ea	$500	$10,000	Deposition measurements can be collected during sediment and fish sampling
Data evaluation & Reporting	1	ea	$45,000	$45,000	Reporting assumed to be in addition to 5-yr remedy review
				$128,000	
Present Worth Five Year Costs				$1,280,000	
Total Present Worth Direct O&M Cost				**$8,749,986**	
Indirect O&M Costs					
Project/Admin Management	25%	of direct O&M		$2,187,496	0.05 FTE/YEAR $75 PER HR 2500 HR/YR $2,718,750 Approximate
Health & Safety	20%	of direct O&M		$1,749,997	0.05 FTE/YEAR $45 PER HR 2500 HR/YR $1,631,250 Approximate
Overhead	30%	of direct O&M		$2,624,996	
Contingency	15%	of direct O&M		$1,312,498	
Total Estimated Present Worth Indirect O&M Cost				**$7,874,987**	
Total Estimated Present Worth O&M Cost				**$16,624,973**	
TOTAL ESTIMATED COST				**$17,321,141**	

1. Interest rate from OMB Cirular No A-94 (December 12, 2016)

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Lower Three Runs — Integrator Operable Unit - Upper Section
A-5: Excavation, Treatment and Disposal of PTSM Sediments
EA-1 Pond A — Including R Discharge Canal

Item	Quantity	Units	Unit Cost	Total Cost	
Direct Capital Costs					
Regulatory Documents and Work Planning	1	ea	$50,000	$50,000	Develop RAIP, sampling plan, workpackages
Sampling to define extent of PTSM in R-Canal					
Sample Analysis	20	ea	$1,500	$30,000	Approximately 1 sample every 30 meters
Labor for sampling	4	days	$2,250	$9,000	2 samplers, 2 radcon, 1 health and safety for 10 hours per day = ($45/hr x 5 people x 10 hr /day) = $2250/day
Mobilization/Demobilization	1	ea	$3,500	$3,500	Includes bringing in mini excavator, two bobcats/backhoes, removing & disposal of silt curtain
Clearing for roll off pan laydown yard	0.5	acre	$4,197	$2,099	Unit cost for clearing and grubbining from 488-1D estimate
Site Prep for roll of pan laydown yard	0.5	acre	$14,000	$7,000	grade to provided containment berm, lay crusher run, etc… (crusher run volume = 202 cy - cost $6722
Access road improvements - widening	1750	ft	$34	$58,958	From GOSB estimate for access road improvments (cost includes canal prep for equipment access and temporary bridge for equipment)
Clear/stage/ship vegetation (rad waste)	108	ft^2			Removal of vegetation tree debris required prior to cap placement.
Mini - excavator with long reach & clam shell	1	week	$1,000	$1,000	assume that a mini excavator with long reach clamshell can operate from dry land
Labor - operator	30	hrs	$100	$3,000	Assume one operator for 30 hours per week. 1 day to mobilize & prejob brief, on day to remove vegetation, one day to decon & demobilize
General Laborer	60	hrs	$45	$2,700	Two laborers required to set up staging, dewatering for vegetation, place in roll off with burrito bags
Truck driver	5	hrs	$50	$250	Vegetation is assumed to require 2 roll off pans with two trips to E-Area (3 hr round trip includes wait time)
Radcon	60	hrs	$75	$4,500	2 radcon assumed for support of vegetation removeal and burrito bag preparation for shipping
Equipment Cost- Sediment Excavation					
Excavator Rental	1	week	$1,500	$1,500	3 days to include mobilization, excavation and decontamination
Roll Off pan	2	ea	$400	$800	
truck contaminated sediments to E-Area	13	cy	$220	$2,860	20 mile round trip ((1.5 hrs x $45/hr)*1 turck + truck rental $500/day x 2 days) x 2 radcon@$45/hr x 20 hrs = $2868
Dewater roll offs - burrito wrap for transport	2	ea	$2,700	$5,400	Assume 2 radcon $45/hr and 2 laborers $45/hr all for 30 hours
Install silt curtain	25	ft	$17	$413	Per "The Balance" turbidity barrier material and installtion costs are 8.25/lf - double based on SRS factor and small area
Post excavation sampling/surveying	1	ea	$2,300	$2,300	Survey cost based on Seth's estimate for project 01293250
Subtotal - Direct Capital Cost				$185,279	
Mobilization/Demobilization	12%	of subtotal direct capital		$22,233	Includes badging, radworker training
Site Preparation/Site Restoration	10%	of subtotal direct capital		$18,528	Includes submittals, workpackage development, acceptance walkdowns
Total Direct Capital Cost		(sum of * items)		**$226,040**	
Indirect Capital Costs					
Engineering & Design	25%	of direct capital		$56,510	Estimating Guideline Range 14-26%. Includes engineering review and development of maintenance criteria
Project/Construction Management	25%	of direct capital		$56,510	Standard
Health & Safety	15%	of direct capital		$33,906	Health and safety review and sign off on procedures
Overhead	30%	of direct capital		$67,812	Standard
Contingency	20%	of direct capital		$45,208	Standard
Total Indirect Capital Cost				**$259,946**	
Total Estimated Capital Cost				**$485,986**	
Direct O&M Costs (over 290 years)					
Annual Costs (yearly costs over 290 years)	0.7%	discount rate for costs > 30 years duration[1]			
Subtotal - Annual Costs				$0	
Five Year Costs	10				
LUCs and remedy reviews are included in A-2		ea		$0	
Present Worth Five Year Costs				$0	
Total Present Worth Direct O&M Cost				**$0**	
Indirect O&M Costs					
Project/Admin Management	90%	of direct O&M	$0	$0	0.05 FTE/YEAR $75 PER HR 1250 HR/YR $46,875 Approximal doubled this due to huge dam construction project
Health & Safety	50%	of direct O&M	$0	$0	0.05 FTE/YEAR $45 PER HR 1250 HR/YR $28,125 Approximal doubled this due to huge dam construction project
Overhead	30%	of direct O&M		$0	
Contingency	15%	of direct O&M		$0	
Total Estimated Present Worth O&M Cost				**$0**	
TOTAL ESTIMATED COST				**$485,986**	

1. Interest rate from OMB Circular No. A-94 (December 12, 2016)
2. In addition to costs associated with this alternative, LUCs with MNR and five-year remedy reviews for the entire Upper subunit is estimated at ~$17 M (refer to details in Alternative A-2)

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Lower Three Runs — Integrator Operable Unit - Upper Section
A-6: Maintain Water in Ponds for EA-3 – Pond B

Item	Quantity	Units	Unit Cost	Total Cost	
Direct Capital Costs					
No physical activites					
Establish Procedures MOU to concur with ROD requirements	1	ea	$10,000	$10,000	Establish formal internal documents to ensure dam maintenance complies with ROD
	1	ea	$0	$0	
Subtotal - Direct Capital Cost				$10,000	
Mobilization/Demobilization	0%	of subtotal direct capital		$0	
Site Preparation/Site Restoration	0%	of subtotal direct capital		$0	
Total Direct Capital Cost		(sum of * items)		**$10,000**	
Indirect Capital Costs					
Engineering & Design	15%	of direct capital		$1,500	Estimating Guideline Range 14-26%. Includes engineering review and development of maintenance criteria
Project/Construction Management	15%	of direct capital		$1,500	Standard
Health & Safety	5%	of direct capital		$500	Health and safety review and sign off on procedures
Overhead	30%	of direct capital		$3,000	Standard
Contingency	20%	of direct capital		$2,000	Standard
Total Indirect Capital Cost				**$8,500**	
Total Estimated Capital Cost				**$18,500**	
Direct O&M Costs (over 290 years)					
Annual Costs (yearly costs over 290 years)	0.7%	discount rate for costs > 30 years duration[1]			
	50	Years O&M			
Baseline Dam Program & Minor Maintainance Pond B	1	yr	$37,050	$37,050	Average of costs provided by SI for FY15-FY17 (SEE WORKSHEET FROM SI)
Assume one signifcant repair per year between both dams	1	yr	$62,000	$62,000	Average of costs provided by SI for FY15-FY17 (SEE WORKSHEET FROM SI)
Subtotal - Annual Costs				$99,050	
Present Worth Annual Costs (0.7% Discount Rate)				**$1,366,964**	
Five Year Costs					
Remedy Review (Included in A-2 LUCs and MNA)	0	ea	$0	$0	
Subtotal - Five Year O&M Costs				$0	
Present Worth Five Year Costs				$0	
Total Present Worth Direct O&M Cost				**$1,366,964**	
Indirect O&M Costs					
Project/Admin Management	4%	of direct O&M		$54,679	0.005 FTE/YR $75 PER HR 2500 HR/YR $46,875 Approximate
Health & Safety	2%	of direct O&M		$27,339	0.005 FTE/YR $45 PER HR 2500 HR/YR $28,125 Approximate
Overhead	30%	of direct O&M		$410,089	
Contingency	15%	of direct O&M		$205,045	
Total Estimated Present Worth Indirect O&M Cost				**$697,152**	
Total Estimated Present Worth O&M Cost				**$2,064,116**	
TOTAL ESTIMATED COST				**$2,082,616**	

1. Interest rate from OMB Circular No. A-94 (December 12, 2016)
2. In addition to costs associated with this alternative, LUCs with MNR and five-year remedy reviews for the entire Upper subunit is estimated at ~$17 M (refer to details in Alternative A-2)

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Lower Three Runs — Integrator Operable Unit - Upper Section
A-6: Maintain Water in Ponds for EA-6 PAR Pond

Item	Quantity	Units	Unit Cost	Total Cost	
Direct Capital Costs					
No physical activites					
Establish Procedures MOU to concur with ROD requirements	1	ea	$10,000	$10,000	Establish formal internal documents to ensure dam maintenance complies with ROI
	1	ea	$0	$0	
Subtotal - Direct Capital Cost				$10,000	
Mobilization/Demobilization	0%	of subtotal direct capital		$0	
Site Preparation/Site Restoration	0%	of subtotal direct capital		$0	
Total Direct Capital Cost		(sum of * items)		**$10,000**	
Indirect Capital Costs					
Engineering & Design	15%	of direct capital		$1,500	Estimating Guideline Range 14-26%. Includes engineering review and developmen
Project/Construction Management	15%	of direct capital		$1,500	Standard
Health & Safety	5%	of direct capital		$500	Health and safety review and sign off on procedures
Overhead	30%	of direct capital		$3,000	Standard
Contingency	20%	of direct capital		$2,000	Standard
Total Indirect Capital Cost				**$8,500**	
Total Estimated Capital Cost				**$18,500**	
Direct O&M Costs (over 290 years)					
Annual Costs (yearly costs over 290 years)	0.7%	discount rate for costs > 30 years duration[1]			
	50	Years O&M			
Baseline Dam Program & Minor Maintainance Pond PAR	1	yr	$74,100	$74,100	Average of for FY15-FY17
	1	yr	$62,000	$62,000	
Subtotal - Annual Costs				$136,100	
Present Worth Annual Costs (0.7% Discount Rate)				**$1,878,282**	
Five Year Costs					
Remedy Review (Included in A-2 LUCs and MNA)	0	ea	$0	$0	
Subtotal - Five Year O&M Costs				$0	
Present Worth Five Year Costs				$0	
Total Present Worth Direct O&M Cost				**$1,878,282**	
Indirect O&M Costs					
Project/Admin Management	3%	of direct O&M		$56,348	0.006 FTE/YR $75 PER HR 2500 HR/YR $56,250 Approximate
Health & Safety	2%	of direct O&M		$37,566	0.005 FTE/YR $45 PER HR 2500 HR/YR $28,125 Approximate
Overhead	30%	of direct O&M		$563,484	
Contingency	15%	of direct O&M		$281,742	
Total Estimated Present Worth Indirect O&M Cost				**$939,141**	
Total Estimated Present Worth O&M Cost				**$2,817,422**	
TOTAL ESTIMATED COST				**$2,835,922**	

1. Interest rate from OMB Circular No. A-94 (December 12, 2016)
2. In addition to costs associated with this alternative, LUCs with MNR and five-year remedy reviews for the entire Upper subunit is estimated at ~$17 M (refer to details in Alternative A-2)

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Lower Three Runs — Integrator Operable Unit - Upper Section
A-6: Maintain Water in Ponds for EA-9 – Pond C

Item	Quantity	Units	Unit Cost	Total Cost	
Direct Capital Costs					
No physical activites					
Establish Procedures MOU to concur with ROD requirements	1	ea	$10,000	$10,000	Establish formal internal documents to ensure dam maintenance complies with ROD
	1	ea	$0	$0	
Subtotal - Direct Capital Cost				$10,000	
Mobilization/Demobilization	0%	of subtotal direct capital		$0	
Site Preparation/Site Restoration	0%	of subtotal direct capital		$0	
Total Direct Capital Cost		(sum of * items)		**$10,000**	
Indirect Capital Costs					
Engineering & Design	15%	of direct capital		$1,500	Estimating Guideline Range 14-26%. Includes engineering review and development of maintenan
Project/Construction Management	15%	of direct capital		$1,500	Standard
Health & Safety	5%	of direct capital		$500	Health and safety review and sign off on procedures
Overhead	30%	of direct capital		$3,000	Standard
Contingency	20%	of direct capital		$2,000	Standard
Total Indirect Capital Cost				**$8,500**	
Total Estimated Capital Cost				**$18,500**	
Direct O&M Costs (over 290 years)					
Annual Costs (yearly costs over 290 years)	0.7%	discount rate for costs > 30 years duration[1]			
	50	Years O&M			
Baseline Dam Program & Minor Maintainance Pond C	1	yr	$24,700	$24,700	Average of costs provided by SI for FY15-FY17 (SEE WORKSHEET FROM SI)
Subtotal - Annual Costs				$24,700	
Present Worth Annual Costs (0.7% Discount Rate)				**$340,878**	
Five Year Costs					
Remedy Review (Included in A-2 LUCs and MNA)	0	ea	$0	$0	
Subtotal - Five Year O&M Costs				$0	
Present Worth Five Year Costs					
Indirect O&M Costs					
Project/Admin Management	15%	of direct O&M		$51,132	0.005 FTE/YEAR $75 PER HR 2500 HR/YR $46,875 Approximate
Health & Safety	8%	of direct O&M		$27,270	0.005 FTE/YEAR $45 PER HR 2500 HR/YR $28,125 Approximate
Overhead	30%	of direct O&M		$102,264	
Contingency	15%	of direct O&M		$51,132	
Total Estimated Present Worth Indirect O&M Cost				**$231,797**	
Total Estimated Present Worth O&M Cost				$572,676	
TOTAL ESTIMATED COST				**$591,176**	

1. Interest rate from OMB Circular No. A-94 (December 12, 2016)
2. In addition to costs associated with this alternative, LUCs with MNR and five-year remedy reviews for the entire Upper subunit is estimated at ~$17 M (refer to details in Alternative A-2)

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