United States Department of Energy

Savannah River Site

Record of Decision
Remedial Alternative Selection for the
R-Area Operable Unit (RAOU) (U)

CERCLIS Number: 95

SRNS-RP-2010-01062

Revision 1

December 2010

Prepared by:
Savannah River Nuclear Solutions, LLC
Savannah River Site
Aiken, SC 29808

Prepared for U.S. Department of Energy under Contract No. DE-AC09-08SR22470

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Prepared for
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and
Savannah River Nuclear Solutions, LLC
Aiken, South Carolina

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DECLARATION FOR THE RECORD OF DECISION

Unit Name and Location

R-Area Operable Unit (RAOU)

Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Identification Number: OU- 95

Savannah River Site

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Identification Number: SC1 890 008 989

Aiken, South Carolina

United States Department of Energy

The RAOU is listed as a Resource Conservation and Recovery Act (RCRA) 3004(u) Solid Waste Management Unit /CERCLA unit in Appendix C of the Federal Facility Agreement (FFA) for the Savannah River Site (SRS). This Record of Decision (ROD) document addresses the RAOU that is comprised of multiple subunits, some of which were previously selected for non-time critical (NTC) removal actions.

The FFA is a legally binding agreement between regulatory agencies (United States Environmental Protection Agency [USEPA] and South Carolina Department of Health and Environmental Control [SCDHEC]) and regulated entities (United States Department of Energy [USDOE]) that establishes the responsibilities and schedules for the comprehensive remediation of SRS.

The media associated with the subunits discussed in this document include surface soil, rail bed materials, metal components, concrete, sediment, and groundwater.

Statement of Basis and Purpose

This decision document presents the selected remedial action for the RAOU subunits located at the SRS near Aiken, South Carolina. The RAOU is comprised of the following subunits and Potential Source Areas (PSA):

- R-Reactor Building (105-R) Complex:
  - R-Reactor Building (105-R), including the Engine Houses (108-1R and 108-2R)
    - R-Reactor Vessel
    - R-Reactor Disassembly Basin
    - R-Reactor Emergency Basin
  - Area on the North Side of Building 105-R, Laydown Area North of 105-R, Release from the Decontamination of R-Area Reactor Disassembly Basin (NBN) Subunit
  - Combined Spills North of Building 105-R (NBN) Subunit
  - Potential Release from the R-Area Disassembly Basin (105-R) Subunit
- R-Area Process Sewer Line (PSL) Combined Subunit:
  - R-Area PSLs as Abandoned (NBN) Subunit
  - Process Water Storage Tank (106-R) PSA
  - Cooling Water Effluent Sump (107-R) Subunit
  - Purge Water Storage Basin (109-R) Subunit
- R-Area Reactor Area Cask Car Railroad Tracks as Abandoned (NBN) Subunit
- R-Area Ash Basin (188-R) Subunit
- R-Area Groundwater (NBN) Subunit
- R-Area Isolated Contamination Area (NBN) PSA
- Process Storage Building (122-R) Subunit
- Potential Release of $NaOH/H_2SO_4$ from 183-2R Subunit
- Power House (184-R) PSA
- Cooling Tower (185-R) PSA
- Former Coal Pile (NBN) PSA
- Administrative and Maintenance Building (704-R) PSA
- Maintenance Material Storage Building (711-R) PSA
- Eastern Volatile Organic Compound (VOC)/Tritium Groundwater Plume PSA

Within the RAOU area are the following Deactivation and Decommissioning (D&D) No further Action (NFA) Facilities, and Site Evaluation (SE) NFA Area:

- Primary Substation (151-1R)
- Primary Substation (151-2R)
- Cooling Water Clarification Plant (183-1R)
- Filter and Softener Plant (183-2R)
- Cooling Water Reservoir (186-R)
- Cooling Water Pump House (190-R)
- Potential Release from R-Area Concrete Lakes (183-1R/186-R)

The remedy was chosen in accordance with CERCLA, as amended by the Superfund Amendments Reauthorization Act, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan. This decision is based on the information contained in the Administrative Record File for this site.

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

Assessment of the Site

Regulatory decisions were previously made at selected RAOU subunits. The Early Action ROD for the C-, K-, L-, and R-Reactor Complexes (SRNS 2009c) was approved in December 2009, and documents the selected remedy for the R-Reactor Complex as *in situ* decommissioning (ISD) with land use controls (LUCs). NTC removal actions are documented in five Removal Site Evaluation Reports (RSER)/Engineering Evaluation/Cost Analyses (EE/CAs) and include the following subunits:

- R-Reactor Building (105-R) Complex (RBC); which includes the R-Reactor Building (105-R), the Engine Houses (108-1R and 108-2R), the R-Reactor Vessel, the R-Reactor Disassembly Basin, the R-Reactor Emergency Basin, the Area on the North Side of Building 105-R, Laydown Area North of 105-R, Release from the Decontamination of R-Area Reactor Disassembly Basin (NBN), Combined Spills

North of Building 105-R (NBN), and the Potential Release from the R-Area Disassembly Basin (105-R) (SRNS 2009c and SRNS 2009d);

- R-Reactor Disassembly Basin (USDOE 2002);
- R-Area PSL Combined Subunit; including the R-Area PSLs as Abandoned (NBN), Process Water Storage Tank PSA (106-R), Purge Water Storage Basin (109-R), Cooling Water Effluent Sump (107-R) Subunit, Septic Tank (607-1R), outfalls, manholes, miscellaneous weirs and boxes; sumps, etc. (SRNS 2009f);
- R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit (SRNS 2009b); and
- R-Area Ash Basin (188-R) Subunit (SRNS 2009e).

The remaining subunits not selected for a NTC removal action were presented in the *RCRA Facility Investigation/Remedial Investigation with Baseline Risk Assessment and Corrective Measures Study/Feasibility Study* (RFI/RI/BRA/CMS/FS) report (SRNS 2009a). This report determined that the R-Area Groundwater (RAGW) Subunit and the R-Area Isolated Contamination Area (ICA) PSA have an unacceptable exposure risk to human health and will require LUCs as part of the selected remedy. The remaining RAOU subunits and RAOU PSAs presented in the RFI/RI/BRA/CMS/FS, were determined to pose no impact to human health or the environment based on an industrial worker scenario (SRNS 2009a), but will require LUCs to prevent unrestricted land use. The D&D NFA Facilities and a SE NFA Area were also determined to pose no risk to human health or the environment based on unrestricted land use; however, these facilities will be included with the LUCs selected for the RAOU because of their location within the R Area fence line.

Hazardous and radioactive substances at the RAOU have been released into the environment. Subsequent to the completion of the NTC removal actions, hazardous and radioactive wastes will remain in place at some of the subunits. Therefore, the response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous and radioactive substances into the environment.

Description of the Selected Remedy

The current land use for the RAOU is industrial with USDOE maintaining control of the land as long as necessary to keep the selected remedy fully protective of human health and the environment. The selected remedy for the RAOU is Alternative RAOU-2 – LUCs and Monitoring Natural Attenuation (MNA). LUCs will be implemented for the entire RAOU to maintain industrial land use with additional LUCs implemented as needed to prevent unacceptable exposure to industrial workers. Under this remedy, MNA will be implemented for the RAOU RAGW Subunit. This remedy was selected because it meets the remedial action objectives and the threshold criteria, provides overall protection of human health and the environment, and complies with Applicable or Relevant and Appropriate Requirements. The remedy effectively balances short-term effectiveness, implementation, and cost criteria, while providing a high level of long term protection to radioactive and hazardous contaminants that remain.

The following LUC objectives are necessary to ensure protectiveness of the selected remedy:

- Restrict unauthorized worker access and prevent contact, removal or excavation of contaminated waste, pipelines, equipment, and buildings;
- Prohibit industrial use of the R-Area ICA PSA;
- Prohibit the development and use of property for residential housing, elementary and secondary schools, child care facilities and playgrounds;
- Maintain the integrity of any current or future remedial or monitoring systems, such as soil covers, or groundwater monitoring wells;
- Prevent access or use of contaminated groundwater until cleanup levels are met; and
- Prevent construction of inhabitable buildings without an evaluation of indoor air quality to address vapor intrusion.

As previously stated, NTC removal actions were selected for some RAOU subunits, which are documented in five RSER/EE/CAs. The Early Action ROD for the C-, K-, L-, and R-Reactor Complexes (SRNS 2009c) documents the selected remedy for the R-Reactor Complex as ISD

with LUCs. The remaining subunits not selected for a NTC removal action were presented in the RFI/RI/BRA/CMS/FS report.

Following successful completion of the NTC removal actions, residual hazardous substances will remain at the RAOU that pose a threat to human health. Therefore, LUCs are needed for the RAOU to prevent unrestricted land use. Implementation of this alternative would require both near- and long-term actions.

The RCRA permit will be revised to reflect selection of the final remedy using the procedures under 40 Code of Federal Regulations Part 270, and South Carolina Hazardous Waste Management Regulations R.61-79.264.101 and R.61-79.270.

Statutory Determinations

Regulatory decisions were made on select RAOU subunits as documented in five Action Memoranda for the NTC removal actions. The remaining subunits not selected for a NTC removal action were presented in the RFI/RI/BRA/CMS/FS report. Following successful completion of the NTC removal actions, residual hazardous substances will remain at the RAOU that pose a threat to human health and the environment. Therefore, Alternative RAOU-2 – LUCs and MNA has been selected as the remedy for the RAOU. The future land use of the RAOU will be industrial land use, with the exception of the R-Area ICA PSA where LUCs will also prevent industrial use.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after the initiation of remedial action to ensure that the remedy is and will continue to be protective of human health and the environment.

The selected remedy for the RAOU (Alternative RAOU-2 – LUCs and MNA) is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action (unless justified by a waiver) and is cost-effective. This remedy for the RAOU does not satisfy the statutory preference for treatment

as a principal element of the remedy because it does not reduce the toxicity, mobility, or volume of materials comprising principal threats through treatment.

In the long-term, if the property is ever transferred to nonfederal ownership, the United States Government will take those actions necessary pursuant to Section 120(h) of CERCLA. Those actions will include a deed notification disclosing former waste management and disposal activities as well as remedial actions taken on the site. The contract for sale and the deed will contain the notification required by CERCLA Section 120(h). The deed notification shall notify any potential purchaser that the property has been used for the management and disposal of waste. These requirements are also consistent with the intent of the RCRA deed notification requirements at final closure of a RCRA facility if contamination will remain at the unit.

The deed shall also include deed restrictions precluding residential use of the property. However, the need for these deed restrictions may be reevaluated at the time of transfer in the event that exposure assumptions differ and/or the residual contamination no longer poses an unacceptable risk under residential use. Any reevaluation of the need for the deed restrictions will be done through an amended ROD with USEPA and SCDHEC review and approval.

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

The selected remedy for the RAOU leaves hazardous substances in place that pose a potential future risk and will require land use restrictions for an indefinite period of time. As agreed on March 30, 2000, among the USDOE, USEPA, and SCDHEC, SRS is implementing a Land Use Control Assurance Plan (LUCAP) to ensure that the LUCs required by numerous remedial decisions at SRS are properly maintained and periodically verified. The unit-specific Land Use Control Implementation Plan (LUCIP) for the RAOU will provide details and specific measures required to implement and maintain the LUCs selected as part of this remedy. The USDOE is responsible for implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs selected under this ROD. Upon final approval, the RAOU LUCIP will be appended to the

LUCAP and is considered incorporated by reference into the ROD, establishing LUC implementation and maintenance requirements enforceable under CERCLA. The approved LUCIP will establish implementation, monitoring, maintenance, reporting, and enforcement requirements for the unit. The LUCIP will remain in effect unless and until modifications are approved by the USEPA and SCDHEC as needed to be protective of human health and the environment. LUCIP modification will only occur through another CERCLA document.

Data Certification Checklist

This ROD provides the following information:

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

2.9.11
Date

Karen Guevara
Assistant Manager for Closure Project
U. S. Department of Energy
Savannah River Operations Office

3/11/11
Date

Franklin E. Hill
Director
Superfund Division
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DECISION SUMMARY
REMEDIAL ALTERNATIVE SELECTION (U)

R-Area Operable Unit

CERCLIS Number: 95

SRNS-RP-2010-01062
Revision 1

December 2010

Savannah River Site
Aiken, South Carolina

Prepared By:

Savannah River Nuclear Solutions, LLC
for the
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Savannah River Operations Office
Aiken, South Carolina

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LIST OF ACRONYMS AND ABBREVIATIONS

ACRONYM	Meaning
amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
BRA	Baseline Risk Assessment
C	Centigrade
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulation
CM	contaminant migration
CMS	Corrective Measures Study
COC	constituent of concern
CSM	conceptual site model
+D	plus daughters
D&D	Deactivation and Decommissioning
DPFR	Decommissioning Project Final Report
EAROD	Early Action Record of Decision
EE/CA	Engineering Evaluation / Cost Analysis
EMP	Environmental Monitoring Plan
ESD	Explanation of Significant Difference
°F	degrees Fahrenheit
FDE	Facility Decommissioning Evaluation
FFA	Federal Facility Agreement
FS	Feasibility Study
ft	feet
ft^2	feet square
ft^3/s	cubic feet per second
H_2SO_4	sulfuric acid
Ha	hectare
HH	human health
HI	hazard index
hr	hour
IC	institutional controls
ICA	Isolated Contamination Area
IOU	Integrator Operable Unit
ISD	*In situ* decommissioning
LLC	Limited Liability Company
LUC	land use control
LUCAP	Land Use Control Assurance Plan
LUCIP	Land Use Control Implementation Plan
km	kilometer
km^2	kilometer square
L	liter
LAZ	Lower Aquifer Zone

LIST OF ACRONYMS AND ABBREVIATIONS (*continued*)

ACRONYM	Meaning
m	meter
m^2	meter square
m^3	cubic meter
m^3/s	cubic meter per second
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
µg/L	microgram/Liter
mi	mile
mi^2	mile square
mrem	millirem
NA	not applicable
NaOH	sodium hydroxide
NBN	no building number
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	No Further Action
NTC	Non-Time Critical
O&M	Operations and Maintenance
OU	operable unit
pCi/g	picocuries per gram
pCi/mL	picocuries per milliliter
PSA	potential source area
PSL	process sewer line
PTSM	principal threat source material
RAGW	R-Area Groundwater
RAO	remedial action objective
RAOU	R-Area Operable Unit
RBC	R-Reactor Building (105-R) Complex
RCOC	refined constituent of concern
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RG	remedial goal
RI	Remedial Investigation
ROD	Record of Decision
RSER	Removal Site Evaluation Reports
SB/PP	Statement of Basis/Proposed Plan
SCDHEC	South Carolina Department of Health and Environmental Control
SCHWMR	South Carolina Hazardous Waste Management Regulations
SE	Site Evaluation
SEA	Science & Engineering Associates
SRNS	Savannah River Nuclear Solutions, LLC
SRS	Savannah River Site
TCE	trichloroethylene
TZ	Transmissive Zone

LIST OF ACRONYMS AND ABBREVIATIONS (*continued*)

ACRONYM	Meaning
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
VOC	volatile organic compounds
WSRC	Washington Savannah River Company, LLC (Oct. 2005 - Aug. 2008)
WSRC	Westinghouse Savannah River Company LLC (before Oct. 2005)
yd^2	square yards
yd^3	cubic yards
yrs	years

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

Unit Name, Location, and Brief Description

R-Area Operable Unit

Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Identification Number: OU- 95

Savannah River Site

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Identification Number: SC1 890 008 989

Aiken, South Carolina

United States Department of Energy (USDOE)

Savannah River Site (SRS) occupies approximately 803 km^2 (310 mi^2) of land adjacent to the Savannah River, principally in Aiken and Barnwell counties of South Carolina (Figure 1). SRS is located approximately 40.2 km (25 mi) southeast of Augusta, Georgia, and 32.2 km (20 mi) south of Aiken, South Carolina.

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

The Federal Facility Agreement (FFA) (FFA 1993) for the SRS lists the R-Area Operable Unit (RAOU) as a Resource Conservation and Recovery Act (RCRA) 3004(u) Solid Waste Management Unit/CERCLA unit in Appendix C of the FFA for the SRS.

The RAOU was evaluated through an investigation process that integrates and combines the RCRA corrective action process with the CERCLA remedial process to determine the actual or potential impact of releases of hazardous and radiological substances to human health and the environment.

II. SITE AND OPERABLE UNIT COMPLIANCE HISTORY

SRS Operational and Compliance History

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

Hazardous waste materials handled at SRS are managed under RCRA, a comprehensive law requiring responsible management of hazardous waste. Certain SRS activities require South Carolina Department of Health and Environmental Control (SCDHEC) operating or post-closure permits under RCRA. SRS received a RCRA hazardous waste permit from the SCDHEC, which was most recently renewed on September 30, 2003 (SC1 890 008 989). Module VIII of the Hazardous and Solid Waste Amendments portion of the RCRA permit mandates corrective action requirements for non-regulated solid waste management units subject to RCRA 3004(u).

On December 21, 1989, SRS was included on the National Priorities List. The inclusion created a need to integrate the established RCRA facility investigation (RFI) program with CERCLA requirements to provide for a focused environmental program. In accordance with Section 120 of CERCLA 42 United States Code Section 9620, USDOE has negotiated a FFA (FFA 1993) with United States Environmental Protection Agency (USEPA) and SCDHEC to coordinate remedial activities at SRS into one comprehensive strategy which fulfills these dual regulatory requirements. USDOE functions as the lead agency for remedial activities at SRS, with concurrence by the USEPA - Region 4 and the SCDHEC.

Operable Unit Operational and Compliance History

The RAOU is located in east-central SRS approximately 5.0 km (3.1 mi) east of the geographical center of SRS and about 7.0 km (4.3 mi) west of the nearest site boundary (Figure 1). RAOU is approximately 70.8 hectare (175 acre) (including the R-Area Ash Basin, R-Area Groundwater (RAGW), and R-Area Isolated Contamination Area (ICA) PSA) and is located primarily in the Lower Three Runs watershed. The north-western portion of the RAOU lies within the Upper Three Runs Watershed. The RAOU has a flat to gently rolling topography, and is approximately 88.4 m (290 ft) above mean sea level (amsl).

The RAOU is predominantly an industrialized area and does not provide significant ecological habitats in the immediate vicinity (within the fenced area) of the reactor. Outside the fence, a wetland area located south of the area has a significant ecological habitat. An ecological checklist for the RAOU was provided in the Remedial Investigation (RI) Work Plan (WSRC 2006a). Detailed descriptions of the floral and faunal species, biotic diversity, and hydrology of these watersheds are included in the Lower Three Runs Integrator Operable Unit (IOU) RI Work Plan (WSRC 2002) and the Upper Three Runs IOU RI Work Plan (WSRC 2003a).

The soils in all the areas cleared of trees in R Area are classified as Udorthent (USDA 1990). Udorthent is a generic term that indicates that the natural soil weathering horizon has been disturbed or removed, usually by construction activity or erosion. Soil may be classified as Udorthent when either the top soil or disturbed soil is used for fill during grading for parking lots or to create level areas.

Additional information pertaining to RAOU soils can be found in the RI Work Plan for the R Area Operable Unit (WSRC 2006a), and the Lower Three Runs and Upper Three Runs IOU RI Work Plans (WSRC 2002 and WSRC 2003a, respectively) which summarize the pedological assemblages and the distribution of various soil types specific to R Area.

There is no surface water body associated with the RAOU. However, during R-Reactor operation, large quantities of cooling water (11.3 m^3/s [400 ft^3/s]) were heated up to 57 °C (137 °F) in heat exchangers and discharged to either Joyce Branch or PAR Pond via the R-Area Discharge Canal. The combination of the heated water and high flow volume caused extreme scouring and sterilization within Joyce Branch. Joyce Branch began receiving thermal effluents from R-Reactor Area in 1953, and flow rates in Joyce Branch were largely influenced by these effluent releases. In 1958, effluents from R-Reactor were diverted to PAR Pond via discharge canals and Ponds A, B, and C (Figure 2). To date, natural flow exists within Joyce Branch and natural vegetation has repopulated the banks and stream bed.

R Area is higher in elevation (>88 m [290 ft] amsl) than the surrounding land (interfluvial zone). Surface drainage in the north-western portion of the RAOU is toward Mill Creek (Figure 2). The headwaters of Mill Creek, which originate north-west of the R-Reactor, sit at an elevation of 82 m (269 ft) amsl. Mill Creek drains into Tinker Creek, which in turn drains into Upper Three Runs. Surface drainage on the west and south side of the Reactor Area drains to unnamed tributaries that drain to Ponds 2 and 4, which drain into PAR Pond. Surface drainage on the east side of the Reactor Area drains to Joyce Branch that drains into Pond C, which drains into PAR Pond.

Generally, groundwater flow direction in both the upper and the lower Upper Three Runs Aquifer diverge at R Area with flows toward Mill Creek to the northwest, R-Reactor Discharge Canal to the northeast, Joyce Branch to the east, and PAR Pond to the southeast (Figure 2). In the Gordon Aquifer, groundwater flows to the southwest toward Meyers Branch. In area monitor wells, the depth to the water in the upper Upper Three Runs Aquifer is approximately 3 m (10 ft). Groundwater flow in the immediate vicinity of the R-Reactor Building (105-R) Complex (RBC) and associated building slabs is towards the east in the Transmissive Zone (TZ) of the upper part of the Upper Three Runs Aquifer (UTRA). The TZ is the primary unit responsible for horizontal transport of contaminants in the UTRA. The water table in R Area is the unconfined, upper part of the Upper Three Runs Aquifer.

In December 1953, R-Reactor began operations, and was placed in shutdown status in 1964 due to decreased demand for nuclear materials. The primary sources of radioactive contamination in R Area are activation products, fission products, and tritium, the majority of which were the consequence of R-Reactor operations. Currently, R-Reactor Building (105-R) and other facilities within R Area are undergoing deactivation in preparation for *in situ* decommissioning (ISD) (SRNS 2009c and SRNS 2009d).

RAOU consists of the following subunits and Potential Source Areas (PSAs) (Figure 3: Table 1):

- R-Area Process Sewer Line (PSL) Combined Subunit:
  - R-Area PSLs as Abandoned (NBN) Subunit
  - Process Water Storage Tank (106-R) PSA
  - Cooling Water Effluent Sump (107-R) Subunit
  - Purge Water Storage Basin (109-R) Subunit
- R-Reactor Building (105-R) Complex:
  - R-Reactor Building (105-R), including the Engine Houses (108-1R and 108-2R) Subunits
    - R-Reactor Vessel
    - R-Reactor Disassembly Basin
    - R-Reactor Emergency Basin
  - Area on the North Side of Building 105-R, Laydown Area North of 105-R, Release from the Decontamination of R-Area Reactor Disassembly Basin (NBN) Subunits
  - Combined Spills North of Building 105-R (NBN) Subunit
  - Potential Release from the R-Area Disassembly Basin (105-R) Subunit
- R-Area Reactor Area Cask Car Railroad Tracks as Abandoned (No Building Number [NBN]) Subunit
- R-Area Ash Basin (188-R) Subunit
- R-Area Groundwater (RAGW) (NBN) Subunit
- R-Area Isolated Contamination Area (ICA) PSA

- Process Storage Building (122-R) Subunit
- Potential Release of NaOH/ H_2SO_4 from 183-2R Subunit
- Power House (184-R) PSA
- Cooling Tower (185-R) PSA
- Former Coal Pile (NBN) PSA
- Administrative and Maintenance Building (704-R) PSA
- Maintenance Material Storage Building (711-R) PSA
- Eastern Volatile Organic Compound (VOC)/Tritium Groundwater Plume PSA

Within the RAOU area are the following Deactivation and Decommissioning (D&D) NFA Facilities and Site Evaluation (SE) NFA Area:

- Primary Substation (151-1R)
- Primary Substation (151-2R)
- Cooling Water Clarification Plant (183-1R)
- Filter and Softener Plant (183-2R)
- Cooling Water Reservoir (186-R)
- Cooling Water Pump House (190-R)
- Potential Release from R-Area Concrete Lakes (183-1R/186-R)

Summary of Previous Regulatory Decisions

Previous regulatory decisions were made on select RAOU subunits. These decisions included an Early Action Record of Decision (EAROD) for ISD of the R-Reactor Building (105-R) Complex (SRNS 2009c), and non-time critical (NTC) removal actions documented in five Removal Site Evaluation Reports (RSER)/ Engineering Evaluation / Cost Analysis (EE/CA) (USDOE 2002, SRNS 2009b, SRNS 2009d, SRNS 2009e, SRNS 2009f). The remaining RAOU subunits and PSAs not selected for a NTC removal action were presented in the *RFI/RI with Baseline Risk Assessment (BRA) and Corrective Measures Study (CMS)/Feasibility Study (FS) for the RAOU* (SRNS 2009a). The D&D Facilities and SE Area are addressed in Decommissioning Project Final Reports (DPFR)

(WSRC 2005a, WSRC 2005b, WSRC 2006b, WSRC 2006b, WSRC 2006c, WSRC 2006d, and WSRC 2006e) and in a SE report (WSRC 1994). Figure 3 and Table 1 present this information for each of the subunits.

RAOU Subunits Requiring LUCs

The following discussion pertains to the RAOU subunits and PSAs that will require further actions (Figure 4, Table 1):

R-Reactor Building (105-R) Complex (RBC)

The RBC, in its entirety, is subdivided into components based on total curie inventory, risk, and future remedial action(s). For clarification, the RBC, as a whole, contains all components which were integral to reactor operations (Figure 5). The components of the RBC are as follows:

- R-Reactor Building (105-R) including the Engine Houses [108-1R/ 108-2R]) Subunits
  - Reactor Vessel
  - Disassembly Basin
  - Emergency Basin
- Area on the North Side of Building 105-R, Laydown Area North of 105-R, Release from the Decontamination of R-Area Reactor Disassembly Basin (NBN) Subunits
- Combined Spills North of Building 105-R (NBN) Subunit
- Potential Release from the R-Area Disassembly Basin (105-R) Subunit

Additional information pertaining to components of the RBC, the sampling results, and the curie estimates can be found in the RFI/RI/BRA/CMS/FS for the RAOU (SRNS 2009a) and the RSER/EE/CA for the RBC (SRNS 2009d). The risks associated with the RBC are shown in Table 2.

The action memorandum, dated February 2, 2010, documents the selected NTC removal action for the RBC. Alternative R-2A (ISD with the Reactor Vessel grouted in place) was the selected removal alternative for the R-Reactor Building (105-R) Complex

(Figure 6). It is anticipated this removal action will be completed by 2011. This alternative includes grouting the below grade portions of the Process, the Purification, and the Assembly Areas of the RBC, and grouting the reactor vessel in place and placing a concrete cover over the vessel. The below-grade contents of the Disassembly Basin will be grouted to stabilize the contaminants. The above-grade structure of the Disassembly Basin will be demolished to grade-level, and the below grade basins will be grouted to ground surface. A sloped concrete cover will then be placed over the grouted Disassembly Basin. The Disassembly Basin concrete cover will also cover contaminated soil, asphalt, and concrete contaminated with cesium-137 (+D) greater than 10 pCi/g within the Area on the North Side of Building 105-R Subunit. The remaining contaminated equipment in the above-grade structure of the RBC will be left in place, though access inside the RBC will be prevented by sealing the entrances.

Following the removal action, radioactive contaminants will be left in place. LUCs will be required to prevent exposure to contaminants located within the RBC for as long as necessary to keep the selected remedy fully protective of human health and the environment.

R-Area Process Sewer Lines Combined Subunit

There are about 6.4 km (4 mi) of buried process piping in R-Area, which is collectively referred to as the R-Area Process Sewer Lines (PSLs) as Abandoned (NBN) Subunit.

The R-Area PSLs as Abandoned (NBN) Subunit has been combined with the Process Water Storage Tank PSA (106-R), the Cooling Water Effluent Sump (107-R) Subunit, and the Purge Water Storage Basin (109-R) Subunit since they are interconnected and have similar process histories (Figure 7). This combined subunit will hereafter be referred to as the R-Area PSL Combined Subunit. No contamination was found in the soils exterior to the R-Area PSL Combined Subunit during the RAOU characterization (SRNS 2009a), or the SE characterization (WSRC 1997).

In addition, based on process knowledge and data obtained inside the process sewer lines during limited investigations conducted at C- and R-Reactor (SEA 1999), there is a

potential for cesium-137 (+D) and cobalt-60 to be present at principal threat source material (PTSM) levels (industrial worker risk > 1E-03) fixed within the pipeline walls. A qualitative PTSM evaluation was performed on the R-Area PSL Combined Subunit, because the R-Area PSLs are assumed to contain PTSM based on the 109-R fixed contamination data (WSRC 2006e). In a Core Team meeting held in May 2009, representatives from the USDOE, USEPA, and SCDHEC agreed that there is a potential for PTSM to be present within the matrix (pore spaces of the concrete or trapped in the rust and scale) of the sewer lines. Therefore, there is a potential for receptor exposure from the R-Area PSLs if the lines are accessed or if they are mechanically breached and brought to the surface.

The RSER/EE/CA for the R-Area PSL Combined Subunit (SRNS 2009f) public comment period was in February 2010. A range of alternatives were evaluated in the RSER/EE/CA, and the problems warranting action associated with this subunit are being addressed as a removal action. The action memorandum, dated April 7, 2010, documents the selected NTC removal action for the R-Area PSL Combined Subunit. The removal action will be Alternative P-2 (Isolation Plugging of R-Area PSLs and Drainage System; Grouting of Manholes, Diversion Boxes, and Process Tanks; Select Removal of Process Equipment External to the Reactor Building [105-R]; Sealing/Plugging of Outfalls, and LUCs) (Table 1). It is anticipated this removal action will be completed in 2011. This removal action will be conducted to eliminate exposure to access points in the lines, and prevent possible contamination from the Process Water Storage Tank (106-R) PSA into the groundwater at concentrations exceeding regulatory limits (maximum contaminant levels [MCLs]). Currently there is no CM risk from the Process Water Storage Tank (106-R) PSA, however if tank integrity fails within the near future it would result in groundwater contamination. Following the removal action, radioactive contaminants will be grouted in place to prevent CM risk. LUCs will be required to prevent exposure to pipelines or structures should they become mechanically breached and exposed at the surface.

R-Area Reactor Area Cask Car Railroad Tracks As Abandoned Subunit

The R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit were used during the operation of R Reactor from 1953 to 1964 for the transportation of railroad cars that contained casks of radiological materials. The R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit begins at the cask car loading area outside the Disassembly Basin of the R-Reactor Building (105-R), and extends to the R-Area perimeter fence (Figure 8). There is approximately 1,524 m (5,000 ft) of existing and former track lines within the R-Area perimeter fence.

Leaks from the cask cars (water contaminated with radionuclides – mostly cesium-137 [+D]) occurred, which resulted in two areas of radioactive contamination along the railroad tracks to the west and south of the R-Reactor Building (105-R) (Figure 8). Total cumulative carcinogenic risk to an industrial worker is 1.3E-01 (Table 2).

A range of alternatives were evaluated in the RSER/EE/CA (SRNS 2009b), and the problems warranting action associated with this subunit were addressed by a removal action. The selected removal action plan consisted of excavating soil/gravel equal to or exceeding 10 pCi/g cesium-137, and back-filling with clean fill material. The action memorandum, dated May 28, 2009, documents the selected removal action for the cesium-137 (+D) associated with the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit. The removal action was completed in February 2010, and achieved the removal all cesium-137 contaminated media greater than 1 pCi/g. The R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use of the area.

R-Area Ash Basin (188-R) Subunit

Each reactor at SRS utilized a coal-fired powerhouse to generate steam and electricity, with coal ash produced as a result of boiler operations. In R-Area, this ash was disposed of within the R-Area Ash Basin (188-R) Subunit. The basin operated from 1953 to 1964. The ash basin is located to the south of R-Area. The R-Area Ash Basin is an earthen containment basin that is approximately 49,776 m^2/4.98 hectare (59,532 yd^2/12.3 acre) in

size. Ash thickness in the basin tapers from 4.9 m (16 ft) at the point the coal ash was sluiced into the basin in the north to 0.15 m (0.5 ft) at the lowest point of the basin at the southern end (Figure 9). No ash is observed on or outside of the berms. Due to the lack of operations and maintenance actions, the ash basin has naturally re-vegetated and supports a thriving, diverse ecology of grasses, shrubs, and trees.

A range of alternatives were evaluated in the RSER/EE/CA (SRNS 2009e), and the problems warranting action associated with this subunit are being addressed as a removal action. An action memorandum for the P Area Ash Basin (Including Outfall P-007) (188-P) and the R-Area Ash Basin (188-R) Subunit was issued in March 2010, which documents the selected removal action (Alternative R-3: Soil Cover; LUCs). It is anticipated that this removal action will be completed by 2011. Following the removal action, radioactive and hazardous contaminants will be left in place beneath the soil cover. LUCs will be required to prevent disturbance of the cover and potential exposure to the contaminants.

R-Area Reactor Groundwater (NBN) Subunit

The plumes comprising the RAGW Subunit have a combined area of approximately 22.3 hectare (55 acre) (Figure 10). These groundwater plumes have been grouped into the RAGW Subunit.

There are three distinct tritium plumes in R-Area: a northern tritium plume originating from the R-Area Seepage Basins and trending to the north and northwest toward Mill Creek; a tritium plume originating from the east end of the R-Reactor Building (105-R) and trending to the east and northeast toward Joyce Branch; and a tritium plume originating from the west end of R-Reactor Building (105-R) and trending to the south. There is also a VOC plume originating from the northeast area of R-Reactor Building (105-R) and trending to the east and northeast toward Joyce Branch.

The RAGW Subunit has tritium and VOCs exceeding their respective MCLs/MCLG as problems warranting action (Table 2). No Action and MNA with LUCs were the alternatives evaluated for this subunit (SRNS 2009a) (Table 1).

R-Area Isolated Contamination Area (ICA) PSA

The RAOU R-Area ICA PSA is a cypress wetland area, approximately 3.44 hectare (8.5 acre), and is located to the south of R Area (Figure 11).

The R-Area ICA PSA was identified in the 1991 and 1998 aerial gamma surveys of SRS and in 2004 by a gamma field survey, as a cesium-137 contamination area. The R-Area ICA PSA is not identified as a subunit in the FFA, but could present a surface exposure risk due to known cesium-137 contamination. The RAOU Core Team agreed to incorporate this area into the RAOU.

Human health (HH) RCOCs for a future industrial worker at the R-Area ICA PSA have an 8.1E-04 cumulative risk (Table 2). Cesium-137 (+D) is the HH risk-driver in the R-Area ICA PSA. However, it has a relatively short half-life (30 yrs) so there is an order of magnitude decrease in the cesium-137 HH risk every 100 yrs. There are no ecological RCOCs, and no CM constituents of concern (COCs) for the R-Area ICA PSA.

The alternatives evaluated for the R-Area ICA PSA were No Action and LUCs. The Core Team agreed that any remedial activity that involved excavation to remove the cesium-137 (+D) contamination from surface soil would result in unacceptable damage to the sensitive ecology of the wetland. Therefore, the alternatives evaluated for the R-Area ICA PSA included No Action and LUCs; excavation technology was not considered as an alternative. LUCs are consistent with USEPA Green Remediation guidance document (USEPA 2008) for sensitive wetland areas, and LUCs would restrict access to, and excavation of, contaminated soil at surface and at depth. LUCs prevent future residential use and limit exposure to the industrial worker. The wetland area is not a favorable location for the development of future industrial processes. Dense vegetative growth is prominent and the exposure to cesium-137 (+D) in surface soil is likely only possible with extended earth moving activities. LUCs, including signage and administrative controls, would prohibit industrial use, and the R-Area ICA PSA footprint would remain undisturbed. Because of the nature of the wetland setting, fencing of the R-Area ICA PSA footprint would not be necessary or practicable.

Process Storage Building (122-R) Subunit

The Process Storage Building (122-R) Subunit was used to store the heavy water for the reactor primary cooling water circuit (Figure 4). A FDE was completed for the Process Storage Building (122-R) in February 2005, and a DPFR was issued in January 2006. The building was demolished in the 1990s and only the 441.2 m^2 (4,750 ft^2) floor slab remains. The heavy water was contained in stainless steel drums and would have been contaminated with fission products and tritium. Any leakage would have contaminated the floor slab, and one contaminated spot on the slab was known. The floor was scabbled to remove the contamination. The floor slab does not appear to have been constructed with floor drains; however, there is visual evidence that a sump existed on the south side of the slab, which appears to have been filled in with concrete at some time in the past. There is no documented evidence that this sump is connected to the area sewer system.

Based on the results of the human health risk assessment (SRNS 2009a), there are no human health refined constituents of concern (RCOCs) in the concrete slab or soils for a future industrial worker at the Process Storage Building (122-R) Subunit. The Process Storage Building (122-R) Subunit will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use of this facility.

Potential Release of NaOH/ H_2SO_4 from 183-2R

The R-Area Filter and Softener Plant (183-2R) was constructed in 1953 and served as a chemical treatment facility for water from PAR Pond and the Savannah River prior to its transfer to the R-Reactor Building (105-R). The R-Area Filter and Softener Plant (183-2R), operations included filtration, water treatment with chlorine and polyphosphates, and laboratory analysis of water quality. Although no documented spills have been identified, sodium hydroxide (NaOH) and sulfuric acid (H_2SO_4) are suspected to have been released during operation of this facility. This subunit consists of the ground immediately surrounding the R-Area Filter and Softener Plant (183-2R), which is approximately 474 m^2 (5,100 ft^2) (Figure 4). In February 1994, part of the Filter and Softener Plant (183-2R) was removed. Final decommissioning of the R-Area Filter and Softener Plant (183-2R) occurred in 2005 as a Simple Model with approval by SCDHEC

and the USEPA in July 2005. The DPFR for the Filter and Softener Plant (183-2R) was completed in November 2005 (WSRC 2005b).

Based on the results of the human health risk assessment (SRNS 2009a), there are no human health RCOCs in the surface soils for a future industrial worker at the Potential Release of $NaOH/H_2SO_4$ from 183-2R Subunit. The Potential Release of NaOH/H2SO4 from 183-2R Subunit will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use of this area (Table 1).

Power House (184-R) PSA

No historical information has been identified for the Power House (184-R) PSA. An FDE has not been performed for the Power House (184-R) PSA, and it is not listed on Appendix K of the FFA. This facility was demolished prior to the current Site D&D program and FDE process. The current state of the Power House (184-R) PSA is a clean concrete slab with an area of approximately 1,725 m^2 (18,568 ft^2). This facility was evaluated for final disposition as part of RAOU closure process (Figure 4).

Based on the results of the human health risk assessment (SRNS 2009a), there are no human health RCOCs in the surface soils for a future industrial worker at the Power House (184-R) PSA. The Power House (184-R) PSA will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use of this facility (Table 1).

Cooling Tower (185-R) PSA

No historical information has been identified for the Cooling Tower (185-R) PSA. An FDE has not been performed for the Cooling Tower (185-R) PSA facility, and it is not listed on Appendix K of the FFA. This facility was demolished prior to the current Site D&D program and FDE process. The current state of the facility is a 706 m^2 (7,600 ft^2) concrete basin approximately 1.5 m (5 ft) above ground surface. This facility was evaluated for final disposition as part of RAOU closure process (Figure 4).

Based on the results of the human health risk assessment (SRNS 2009a), there are no human health RCOCs in the surface soils for a future industrial worker at the Cooling

Tower (185-R) PSA. The Cooling Tower (185-R) PSA will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use of this facility (Table 1).

Former Coal Pile (NBN) PSA

A coal pile was formerly located inside the northwestern corner of the R-Area boundary fence (Figure 4). Coal was used at the R-Area Power House (184-R) PSA during the years of reactor operations (1953-1964). The coal has been removed from the site although a trace amount remains scattered across the ground surface. The Former Coal Pile (NBN) PSA covers approximately 1.4 hectare (3.5 acre).

Based on the results of the human health risk assessment (SRNS 2009a), there are no human health RCOCs in the surface soils for a future industrial worker at the Former Coal Pile (NBN) PSA. The Former Coal Pile (NBN) PSA will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use of this facility (Table 1).

Administrative and Maintenance Building (704-R) PSA

The Administrative and Maintenance Building (704-R) PSA served as the area's primary administrative building providing offices, a cafeteria, medical, and a maintenance shop (Figure 4). The building was abandoned in the mid-1960's when the reactor was placed in standby. In the early 1980's, the building was opened for receipt and storage of 55-gallon drums of depleted uranium oxide powder. The drums were relocated to the Drum Storage Facility (221-22F) in 1994. A radiological survey after the removal identified six distinct areas of contamination on the slab floor. The affected sections of concrete were removed. A verification radiological survey performed in December of 2006 confirmed that no radiological contamination was present. The current state of the facility is a concrete slab. An FDE has not been performed for the Administrative and Maintenance Building (704-R) PSA, and it is not listed on Appendix K of the FFA. This facility is a PSA within the RAOU, and was evaluated for final disposition as part of RAOU.

Based on the results of the human health risk assessment (SRNS 2009a), there are no human health RCOCs in the surface soils or the concrete slab for a future industrial

worker at the Administrative and Maintenance Building (704-R) PSA. The Administrative and Maintenance Building (704-R) PSA will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use of this facility (Table 1).

Maintenance Material Storage Building (711-R) PSA

The Maintenance Material Storage Building (711-R) PSA was a small 65.0 m^2 (700 ft^2) building located to the south of the Administrative and Maintenance Building (704-R) PSA slab and was used to store raw materials for the maintenance shop (Figure 4). The building was demolished at the same time as the Administrative and Maintenance Building (704-R) PSA.

This facility was officially demolished before the current site D&D program was established. The current state of the facility is a concrete slab. An FDE has not been performed for the Maintenance Material Storage Building (711-R) PSA. The Maintenance Material Storage Building (711-R) PSA is not listed on Appendix K of the FFA. This facility is a PSA within the RAOU, and was evaluated for final disposition as part of RAOU.

Based on the results of the human health risk assessment (SRNS 2009a), there are no human health RCOCs in the surface soils or concrete slab for a future industrial worker at the Maintenance Material Storage Building (711-R) PSA. The Maintenance Material Storage Building (711-R) PSA will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use of this facility (Table 1).

Eastern VOC/Tritium Groundwater Plume PSA

The goal of the Eastern VOC/Tritium Groundwater Plume PSA investigation was to locate the vadose zone source(s) of the tritium and VOC groundwater plumes to the east of R-Reactor Building (105-R). This PSA is specific to the vadose zone soils source areas, while groundwater is addressed under the RAGW subunit.

RAOU groundwater samples indicate the VOC source historically emanated from the soil surrounding a storm sewer manhole sump on the northeast corner of R-Reactor Building

(105-R). The tritium source historically originated from the southeast corner of the R-Reactor Building (105-R), probably associated with Purification Area operations, processes, or spill/leaks. Both historic vadose zone PSAs (tritium & VOCs) were found to be depleted sources. The contamination is primarily within the Transmissive Zone (TZ) of the Upper Three Runs Aquifer. The residual sources (tritium and VOCs) are located in sediments below the water table and will be addressed within the scope of the RAGW Subunit. The Eastern VOC/Tritium Groundwater Plume PSA will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use of this area (Table 1).

D&D Facilities and SE Area Requiring No Further Action

Within the RAOU boundary are six D&D facilities and one SE Area that were determined to require No Further Action (NFA). These facilities and area pose no impact to human health or the environment based on an unrestricted land use scenario. The six D&D facilities have been moved to FFA Appendix K.2 – *D&D No Further Evaluation* and the SE Area has been moved to FFA Appendix G.2 – *Areas Determined to Require No Further Response Action* (Figure 3; Table 1). Although land use controls (LUCs) are not required for these subunits, as discussed in further detail below, these facilities will be included with the LUCs selected for the RAOU because of their location within the R Area fence line.

Primary Substation (151-1R)

The Primary Substation (151-1R) Facility Decommissioning Evaluation (FDE) was submitted to the USEPA and SCDHEC on February 27, 2008. In March 2008, both agencies concurred that the Simple Model for decommissioning of non-contaminated facilities was appropriate for this facility. The Primary Substation (151-1R) was deactivated, and the above grade part of building demolished. The lower part of building, mostly below grade, was filled with the crushed rubble and gravel. All process equipment (e.g. 13.8 KV switchgear internal components and cabinets, relay and control panels, conduits, lighting switches, disconnects, etc.) were removed. Also, mechanical equipment (air compressor units, sump pumps, piping, valves, actuators etc.) were removed. Sump

discharge piping that connects to the storm water system was cut and plugged. The exterior equipment pit was filled with gravel and/or concrete. All decommissioning activities have been completed, including waste disposal in accordance with Federal and State regulations.

The remaining structure is free of hazards, both chemical and physical. The DPFR for the Primary Substation (151-1R) was completed in April 2009 (SRNS 2009g), and no further investigation/evaluation of this facility was warranted. The facility was moved to FFA Appendix K.2.

Primary Substation (151-2R)

The Primary Substation (151-2R) has been decommissioned as a Simple Model by Site D&D with approval by SCDHEC in February 2005, and approval from the USEPA in April 2005. The Primary Substation (151-2R) decommissioning is complete. The above-grade portion of the structure has been demolished, and equipment and components have been removed from the below-grade spaces. The remaining below-grade structure and pads are free of physical, chemical and radiological hazards. All building interfaces have been isolated, disconnected, ad plugged; and below-grade spaces have been filled with concrete rubble and stone to achieve a uniform surface. The above-grade surface was graded, and topped with approximately two feet of gravel and stone to account for settling. All exterior equipment has been removed, and metal protrusions extending greater than 2 inches in length have been cut-off to less than 2 inches of the foundation. All decommissioning activities have been completed, including waste disposal in accordance with Federal and State regulations.

The remaining below-grade structure and pads are free of physical, chemical and radiological hazards; therefore, warrant no further action. Since this facility poses no threat to human health or the environment, no long-term stewardship activities were identified for the remaining structure. The DPFR for the Primary Substation (151-2R) was completed in April 2006 (WSRC 2006b), and no additional investigation/evaluation was required for this facility. The facility was moved to FFA Appendix K.2.

Cooling Water Clarification Plant (183-1R)

The Cooling Water Clarification Plant (183-1R) has been decommissioned as a Simple Model by Site D&D with approval by SCDHEC in February 2005, and approval from the USEPA in April 2005. The Cooling Water Clarification Plant (183-1R) has been drained and partially demolished (in-situ disposal). The exterior and four interior basin walls were breached, and a vehicle ramp (through the exterior wall) remains in place. All process equipment (e.g. valves, piping, pumps, motors, paddles, conduit, etc.) has been removed. Access to walkways and the top of walls, along with handrails, grating, and lighting, have also been removed. Exterior pits have been filled with gravel or dirt, and concrete rubble has been used as interior structural fill. The drain lines at the north end of each basin (approximately three feet above the bottom of the basin) were left open to minimize the collection of rainwater. All decommissioning activities have been completed, including waste disposal in accordance with Federal and State regulations.

The remaining structure is free of hazards, both chemical and accessible physical; and therefore, warrants no further action. Since this facility poses no threat to human health or the environment, no long-term stewardship activities were identified for the structure. The DPFR for the Cooling Water Clarification Plant (183-1R) was completed in November 2005 (WSRC 2005a), and no additional investigation/evaluation was required for this facility. The facility was moved to FFA Appendix K.2.

Filter and Softener Plant (183-2R)

The Filter and Softener Plant (183-2R) has been decommissioned as a Simple Model by Site D&D with approval by SCDHEC and the USEPA in July 2005. The Filter and Softener Plant (183-2R) has been partially demolished (in-situ disposal), i.e. the basin roof was broken in, but the basin floor and walls remain. All equipment and components (e.g. valves, piping, pumps, motors, conduit, etc.) have been removed. Access stairs to the top of the concrete structure have also been removed. The underground basin and exterior pits have been filled with gravel or dirt, and concrete rubble has been used as interior structural fill. All decommissioning activities have been completed, including waste disposal in accordance with Federal and State regulations.

The remaining structure is free of hazards, both physical and chemical and therefore, warrants no further action. No long-term stewardship activities were identified for the structure, because it poses no threat to human health or the environment. The DPFR for the Filter and Softener Plant (183-2R) was completed in November 2005 (WSRC 2005b), and no additional investigation/evaluation is required for this facility. The facility was moved to FFA Appendix K.2.

Cooling Water Reservoir (186-R)

The Cooling Water Reservoir (186-R) has been decommissioned as a Simple Model by Site D&D with approval by SCDHEC and the USEPA in April 2005. The Cooling Water Reservoir (186-R) has been drained and partially demolished (in-situ disposal). The exterior and two interior basin walls were breached, and a vehicle ramp (through the exterior wall) remains in place. All process equipment (e.g. valves, piping, pumps, motors, paddles, conduit, etc.) has been removed. Access to walkways and the top of walls, along with handrails, grating, and lighting, have also been removed. Exterior pits have been filled with gravel or dirt, and concrete rubble has been used as interior structural fill. The drain lines at the south end of each basin have been left open to minimize the collection of rainwater. All decommissioning activities have been completed, including waste disposal in accordance with Federal and State regulations.

The remaining structure is free of hazards, both chemical and accessible physical; and therefore, warrants no further action. Since this facility poses no threat to human health or the environment, no long-term stewardship activities were identified for the structure. The DPFR for the Cooling Water Reservoir (186-R) was completed in May 2006 (WSRC 2006d), and no additional investigation/evaluation was required for this facility. The facility was moved to FFA Appendix K.2.

Cooling Water Pump House (190-R)

The Cooling Water Pump House (190-R) has been decommissioned as a Simple Model by Site D&D with approval by SCDHEC in March 2005, and approval from the USEPA in April 2005. The Cooling Water Pump House (190-R) has been partially demolished

(in-situ disposal). The roof and upper portions of walls were removed. The exterior wall on east side was breached. A vehicle ramp through the exterior wall has been installed to provide access for equipment and people. All process equipment and appurtenances have been removed and the basement was filled with the clean structural material. The wall between the pump suction well and the 186-R basin has been removed, and the suction well has been filled with concrete rubble. All equipment and appurtenances were removed from the electrical switchgear room and west access opening to the stairwell has been blocked with rock/gravel. All decommissioning activities have been completed, including waste disposal in accordance with Federal and State regulations.

The remaining structure is free of hazards, both chemical and accessible physical; and therefore, warrants no further action. Since this facility poses no threat to human health or the environment, no long-term stewardship activities have been identified for the structure. The DPFR for the Cooling Water Pump House (190-R) was completed in March 2006 (WSRC 2006c), and no additional investigation/evaluation is required for this facility. The facility was moved to FFA Appendix K.2.

Potential Release from R-Area Concrete Lakes (183-1R/186-R)

SRS requested approval for NFA for the Potential Release from the R-Area Concrete Lakes (183-1R/186-R), based on the results of recent D&D characterization, and previous SE characterization (WSRC 1994). The water inside the reservoirs has been drained to the R-Area discharge canal. These reservoirs will not be re-used, and do not require long-term stewardship or maintenance. This site does not pose a threat to human health or the environment, therefore no further action was required for this site. Both SCDHEC and USEPA approved the NFA request for this unit in October 2006, and no additional characterization was warranted for this SE Area. This SE Area was moved to FFA Appendix G.2.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Both RCRA and CERCLA require the public to be given an opportunity to review and comment on the draft permit modification and proposed remedial alternative. Public participation requirements are listed in South Carolina Hazardous Waste Management Regulation (SCHWMR) R.61-79.124 and Sections 113 and 117 of CERCLA (42 United States Code Sections 9613 and 9617). These requirements include establishment of an Administrative Record File that documents the investigation and selection of the remedial alternatives for addressing the RAOU. The Administrative Record File must be established at or near the facility at issue.

The *SRS FFA Community Involvement Plan* (WSRC 1996) is designed to facilitate public involvement in the decision-making process for permitting, closure, and the selection of remedial alternatives. The SRS FFA Community Involvement Plan addresses the requirements of RCRA, CERCLA, and the National Environmental Policy Act, 1969. SCHWMR R.61-79.124 and Section 117(a) of CERCLA, as amended, require the advertisement of the draft permit modification and notice of any proposed remedial action and provide the public an opportunity to participate in the selection of the remedial action. The *Statement of Basis/Proposed Plan for the R-Area Operable Unit (RAOU)* (SB/PP) (SRNS 2010a), a part of the Administrative Record File, highlights key aspects of the investigation and identifies the preferred actions for addressing the RAOU.

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

US Department of Energy
Public Reading Room
Gregg-Graniteville Library
University of South Carolina – Aiken
171 University Parkway
Aiken, South Carolina 29801
(803) 641-3465

Thomas Cooper Library
Government Documents Department
University of South Carolina
Columbia, South Carolina 29208
(803) 777-4866

The RCRA Administrative Record File for SCDHEC is available for review by the public at the following locations:

The South Carolina Department of Health and Environmental Control
Bureau of Land and Waste Management
8911 Farrow Road
Columbia, South Carolina 29203
(803) 896-4000

The South Carolina Department of Health and Environmental Control – Region 5
Aiken Environmental Quality Control Office
206 Beaufort Street, Northeast
Aiken, South Carolina 29801
(803) 641-7670

The SB/PP for the RAOU 45-day public comment period began on July 14, 2010 and ended on August 28, 2010.

The Early Action ROD for the C-, K-, L-, and R-Reactor Complexes (SRNS 2009c) was approved in December 2009, and documents the selected remedy for the C-, K-, L-, and R-Reactor Complexes as ISD with LUCs. The EAROD for the C-, K-, L-,and R-Reactor Complexes 45-day public comment period began on June 18, 2009 and end on August 3, 2009. A public workshop was held in North Augusta, SC on July 28, 2009. The comments and responses are published in the appendices of the EAROD for the C-, K-, L-, and R-Reactor Complexes (SRNS 2009c). The public notice for the EAROD was issued on December 8, 2009.

The RSER/EE/CA for the R-Reactor Building (105-R) Complex (SRNS 2009d) public comment period began December 17, 2009, ended on January 16, 2010, and no comments were received from the public during that period. However, comments were received on the Environmental Bulletin that announced the public comment period for the RSER/EE/CA. The Action Memorandum for the RBC RSER/EE/CA addressed the public comments in the responsiveness summary.

The RSER/EE/CA for the Grouting of the R-Reactor Disassembly Basin (USDOE 2002) public comment period began June 10, 2002, ended on July 10, 2002, and no comments were received from the public during that period.

The RSER/EE/CA for the R-Area PSL Combined Subunit (SRNS 2009f) public comment period began February 24, 2010, ended on March 26, 2010, and no comments were received from the public during that period.

The RSER/EE/CA for the P-Area Ash Basin (Including Outfall P-007) (188-P) and the R-Area Ash Basin (188-R) Subunit (SRNS 2009e) public comment period began January 27, 2010, ended on February 26, 2010, and no comments were received from the public during that period.

The RSER/EE/CA for the R-Reactor Area Cask Car Railroad Tracks as Abandoned (NBN) Subunit (SRNS 2009b) public comment period began April 14, 2010, ended on May 14, 2010, and no comments were received from the public during that period.

IV. SCOPE AND ROLE OF THE OPERABLE UNIT

The USDOE developed a new completion strategy in 2003 for environmental restoration at SRS including an area-by-area remediation strategy. Through the coordinated sequencing of environmental restoration and decommissioning activities, environmental cleanup can be completed for the entire areas of SRS. In addressing whole areas, individual units will be consolidated to form an Area OU to take advantage of characterization data, risk assessments, decommissioning documents and integrated remedy strategies to affect economies of scale and reduce administrative requirements. In 2005, the Core Team (representatives from USDOE, USEPA and SCDHEC) convened and agreed that using the Area OU strategy to manage the facilities in the former R-Area industrial area (including the R-Area Ash Basin [188-R]) as a single Area OU was appropriate. The current land use for the RAOU is industrial with USDOE maintaining control of the land as long as necessary to keep the selected remedy fully protective of human health and the environment. The future land use of the RAOU is expected to remain industrial.

In 2009, the USDOE decided to proceed with removal actions to support accelerated remediation of several subunits of the RAOU under the American Recovery and Reinvestment Act of 2009. These removal actions included the details of the ISD for the

RBC, as described in the NTC removal action for the RBC (SRNS 2009d), the NTC removal action for the R-Area PSL Combined Subunit (SRNS 2009f), the NTC removal action for the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit, and the NTC Removal action for the R-Area Ash Basin (188-R) Subunit (SRNS 2009e). This strategy resulted in an acceleration of the completed remedial actions of about three years.

Following successful completion of the NTC removal actions, residual hazardous substances will remain at the RAOU, and will require LUCs to prevent unrestricted use. The scope that will be addressed by the selected remedial action, after completion of the NTC removal actions, for the RAOU include:

- LUCs for the R-Area PSL Combined Subunit;
- LUCs for the R-Area Ash Basin (188-R) Subunit to meet remedial goals (RGs);
- LUCs for the R-Reactor Building (105-R) Complex;
- LUCs for the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit;
- LUCs and MNA for the RAGW Subunit;
- LUCs specific to the R-Area ICA PSA, which prohibit industrial use as well as residential; and
- LUCs for the entire RAOU will include the subunits designated in Table 1 that were not included in the NTC removal actions decisions but are located within the R-Area fence line.

V. OPERABLE UNIT CHARACTERISTICS

This section presents the conceptual site model (CSM), provides an overview of the characterization activities, and presents the characterization results and COCs.

Conceptual Site Model for the RAOU

The CSM identified and evaluated suspected sources of contamination, contaminant release mechanisms, potentially affected media (secondary sources of contamination), potential exposure pathways, and potential human and ecological receptors.

The primary sources of contamination at the RAOU are due to the R-Reactor facility and other R-Area operations. Spills, leaks, accidental releases, or simply the operation itself resulted in releases of hazardous and/or radioactive substances. If the primary source were to contact other media, secondary sources of contamination could be created through several release mechanisms. Typically, the potential secondary release mechanisms include release of volatile constituents from the soil (volatilization), generation of contaminated fugitive dust by wind or other surface soil disturbance, biotic uptake, radiation emissions, bioturbation between surface and subsurface soils, and infiltration/percolation/leaching to groundwater. Contact with contaminated environmental media created potential pathways for both human and ecological receptors.

The future industrial worker was chosen as the baseline risk assessment exposure scenario for quantitative evaluation of human receptors at this site. Detailed CSMs for each of the RAOU subunits are presented in the RFI/RI/BRA/CMS/FS (SRNS 2009a). Although a quantitative evaluation of the future resident scenario was not performed for RAOU subunits, rather it was qualitatively assessed by recognizing that residential use of the area will be restricted by implementing land use restrictions to ensure long-term protectiveness.

The exposure pathways for evaluation relative to the future industrial worker included:

- Exposure to surface (0 to 0.3 m [0 to 1 ft]) soil, ash, or gravel via incidental ingestion, dermal contact, inhalation of windblown dust, inhalation of VOCs, and external exposure to radionuclides. In addition, sediment media was evaluated using the same pathways as soil media.

- Exposure to concrete surface media via the incidental ingestion and external radiation pathways. In addition, metal media was evaluated using the same pathways as concrete media.
- Exposure to groundwater through ingestion of drinking water from contaminated sources.

The majority of the RAOU subunits were determined not to require a quantitative ecological risk evaluation due to lack of habitat (industrial setting) and/or conceptual model considerations (e.g., contamination at depth). However, the risk potential for ecological receptors was evaluated for the subunits outside the R-Area fence line (i.e., R-Area Ash Basin and R-Area ICA PSA) in the surface (0 to 0.3 m [0 to 1 ft]) and subsurface (0.3 to 1.2 m [1 to 4 ft]) soil intervals via the incidental ingestion, dermal contact, inhalation of windblown dust (surface only), biotic uptake, and external exposure to radionuclides pathways. The ecological risk assessment considered an evaluation of terrestrial receptors which included soil invertebrates, herbivorous mammals, insectivorous mammals, omnivorous mammals, insectivorous birds and carnivorous birds.

Surface soil and building features, as well as subsurface soils and building features (i.e., sumps, trenches, pipelines, etc.), that are below grade (i.e., > 0.3 m [1 ft]) of concrete slab, gravel, or soil offer a potential exposure pathway for a future industrial worker under an excavation scenario. This pathway was evaluated in the PTSM analysis.

Leaching of contaminants from the contaminated media (concrete, pipeline, soil) to groundwater constitutes a secondary contaminant release mechanism. The potential to leach to groundwater was evaluated in the contaminant migration analysis. Ingestion of groundwater offers a potentially complete pathway for human receptors.

Media Assessment

The RFI/RI/BRA/CMS/FS (SRNS 2009a) contains detailed information and analytical data for all the characterization investigations conducted and samples taken in the media

assessment of the RAOU. It is available in the Administrative Record File (see Section III of this document). Media assessment results are focused on RAOU characterization activities for those subunits that did not have an NTC removal action conducted.

Characterization Investigation

Soil, ash, groundwater, and gravel samples were collected, evaluated, and screened against appropriate regulatory thresholds and protocols to identify COCs that would warrant further remedial action at the RAOU.

Soil, ash, and gravel samples were evaluated against trigger levels of 20 and 50 pCi/g for gross alpha and nonvolatile beta, respectively. If a sample exceeded either of these trigger levels, the sample was analyzed for a range of radionuclides according to the appropriate analyses for that radionuclide indicator.

For the field investigation, radiological instruments were used as a precursor to determining a gross-level of radioactivity in RAOU surface units prior to the sampling events. This field activity included the use of sodium-iodide detectors, lanthanum-bromide detectors, and other radiological handheld surveying instruments. The detectors/instruments were used outside and inside of the R-Reactor Building (105-R), and within the R-Area ICA PSA.

Contaminant fate and transport analyses were performed to select CM COCs on the basis of leaching by infiltrating water and subsequent transport to groundwater. These analyses were also used to predict the rate of CM and to project contaminant concentration at receptor locations via various transport media. The overall objective of these analyses is to evaluate potential future impact to human health and the environment.

Groundwater Investigation

The Core Team convened in 2008, and agreed to include the RAGW Operable Unit as a subunit of the RAOU. Characterization activities included sampling existing wells, collecting samples from direct push penetrometer, and installing and sampling new groundwater wells. Groundwater samples were evaluated against trigger levels of 15 and

50 pCi/g for gross alpha and nonvolatile beta, respectively. If a sample exceeded either of these trigger levels, the sample was analyzed for a range of radionuclides according to the appropriate analyses for that radionuclide indicator.

Groundwater samples were collected throughout R Area, which delineated three groundwater plumes. In addition, groundwater samples were collected at all subunits to support conclusions concerning potential impact from the vadose zone into the groundwater system and direct future groundwater remediation efforts.

Media Assessment Results

In summary, the RAOU was investigated to determine the nature and extent of contamination, the risks to an industrial worker and the environment, the presence of PTSM, and if there is any CM concerns. Soil, ash, gravel, concrete, Disassembly Basin sludge and water, and groundwater samples were collected, evaluated, and screened against appropriate regulatory thresholds and protocols to identify COCs that would warrant further remedial action. For the RBC, the R-Area Cask Car Railroad Tracks, the R-Area PSL Combined Subunit, the R-Area Ash Basin (188-R) Subunit, R-Area ICA PSA, and RAGW Subunit data identified problems warranting action. For each of these subunits, with the exceptions of the R-Area ICA PSA and RAGW Subunit, a NTC removal action was conducted, and the summary of the media assessments and risk assessments for these NTC removal actions are presented in the appropriate regulatory document (SRNS 2009b, SRNS 2009d, SRNS 2009e, SRNS 2009f, USDOE 2002).

The following sections summarize the media sampling results for the RAOU subunits and PSAs that require LUCs, and the No Further Action D&D Facilities and SE Area.

RAOU Subunits and PSAs Requiring LUCs

The following discussions pertain to the RAOU subunits and PSAs that will require LUCs, which were not previously addressed by a NTC removal action.

R-Area Groundwater (RAGW) Subunit

There are three tritium plumes and one VOC plume that comprise the RAGW Subunit. These groundwater plumes are discussed in this section.

The RAGW Northern Tritium Plume covers about 8.9 hectare (22 acre) from the R-Reactor Seepage Basins toward the R-Reactor Discharge Canal and to Mill Creek (Figure 10). The historic maximum (since 1987) tritium concentration was 474 pCi/mL in 1989 near the seepage basin source area(s) in the shallow A/AA Horizons of the Upper Three Runs Aquifer, which exceeds the MCL (20 pCi/mL). By April 2009 the tritium concentration had decreased to 49.6 pCi/mL at that source area well. Wells down-gradient of the seepage basin source area(s) indicate the tritium has descended into the Transmissive Zone (TZ) of the Upper Three Runs Aquifer. The TZ provides the primary pathway for horizontal contaminant migration. The maximum tritium concentration for the TZ wells has decreased from 285 pCi/mL in 2000 to 66 pCi/mL in April 2009. At the eastern edge of the Northern Tritium Plume, one well has elevated tritium concentrations (3.6 pCi/mL) in the Upper Three Runs Lower Aquifer Zone (LAZ), though below the MCL (20 pCi/mL). The Mill Creek seepline was sampled at one location in 1997, and the maximum tritium result was 1.58 pCi/mL. In 2008 six seepline wells were installed, and the maximum tritium result for the Mill Creek seepline was 1.04 pCi/mL. The Mill Creek results indicate that dilution, dispersion, and decay attenuate the tritium plume below the drinking water standard MCL (20 pCi/mL) as it travels from the R-Reactor Seepage Basins.

The RAGW Western Tritium Plume covers a small area (< 0.4 hectare [< 1 acre]) west of the R-Reactor Building (105-R), trends to the southeast from this location, and descends from the A/AA Horizons into the TZ (Figure 10). The maximum tritium (since 1990) concentration in the RAGW Western Tritium Plume was 199 pCi/mL at well RDB-2D, which monitors A/AA Horizons, in September 1990. The tritium concentration decreased to 2.04 pCi/mL in February 2009 at RDB-2D. However, the tritium concentration for a nearby direct push sample from the A/AA Horizon was 193 pCi/mL in April 1997. This plume has no point of discharge to the surface water. Groundwater

data to the south east of the plume indicate that through dilution, dispersion, and decay this plume also attenuates below the MCL (20 pCi/mL) for tritium before reaching the R-Reactor perimeter fence.

The RAGW Eastern Tritium Plume covers 8.9 hectare (22 acre) originating near the eastern end of the R-Reactor Building (105-R), trending to the northeast, and discharging into Joyce Branch (Figure 10). The shallow A/AA Horizons, to the immediate east of the R-Reactor Purification Area, have tritium concentrations between 38.6 pCi/mL and 58.9 pCi/mL, and is the only other shallow aquifer area that currently exceeds the tritium MCL (20 pCi/mL). The plume descends into the TZ, where the maximum tritium concentration was 1,740 pCi/mL in March 2008 near the R-Reactor Purification Area. The RAGW Eastern Tritium Plume can be traced in the TZ to Joyce Branch where it discharges. The maximum tritium concentration at the point of discharge in the seepline along Joyce Branch is 16.9 pCi/mL. Through dilution, dispersion, and decay this plume also attenuates below the MCL (20 pCi/mL) at the point of discharge.

The RAGW Eastern VOC Plume covers 12.1 hectare (30 acre) and is almost all co-located with the Eastern Tritium Plume (Figure 10). The Eastern VOC Plume has a maximum trichloroethylene (TCE) concentration of 416 µg/L (MCL = 5 µg/L) and a maximum carbon tetrachloride concentration of 1,080 µg/L (MCL = 5 µg/L) immediately to the northeast of the R-Reactor (105-R) building. This VOC plume descends into the TZ as it reaches the R-Reactor (105-R) building, and travels east in the TZ to discharge at Joyce Branch. Degradation products of TCE (cis-1,2-dichloroethylene [MCL = 70 µg/L] and vinyl chloride [MCL = 2 µg/L]) and carbon tetrachloride (chloroform [MCLG = 70 µg/L]) are found exceeding their respective MCLs/MCLG at downgradient sample locations from the source area. Through dilution, dispersion, and biodegradation the VOCs attenuate to below their MCLs at the point of discharge in Joyce Branch. The maximum TCE concentration for the seepline samples is 1.64 µg/L, and all other VOCs were less than this value or below detection. No VOCs were detected in the surface water samples from Joyce Branch.

R-Area Isolated Contamination Area (ICA) PSA

Human health (HH) RCOCs for a future industrial worker at the R-Area ICA PSA have an 8.1E-04 cumulative risk (Table 2). Cesium-137 (+D) is the HH risk-driver in the R-Area ICA PSA with a maximum concentration of 156 pCi/g. However, it has a relatively short half-life (30 yrs) so there is an order of magnitude decrease in the cesium-137 (+D) HH risk every 100 yrs. There are no ecological RCOCs, and no CM constituents of concern (COCs) for the R-Area ICA PSA.

The wetland area is not a favorable location for the development of future industrial processes. Dense vegetative growth is prominent and the exposure to cesium-137 (+D) in surface soil is likely only possible with extended earth moving activities. Excavation to remove the cesium-137 (+D) contamination from surface soil would result in unacceptable damage to the sensitive ecology of the wetland. LUCs, including signage and administrative controls, would prohibit both residential and industrial use. Because of the nature of the wetland setting, fencing of the R-Area ICA PSA footprint would not be necessary or practicable. LUCs are consistent with USEPA Green Remediation guidance document (USEPA 2008) for sensitive wetland areas.

Process Storage Building (122-R) Subunit

Investigation of subsurface soil and groundwater around the Process Storage Building (122-R) Subunit determined the presence of inorganic and radionuclide constituents (SRNS 2009a), but at naturally-occurring levels, with the exception of tritium. However, the presence of tritium in the groundwater is not attributed to the Process Storage Building (122-R) Subunit, but rather to upgradient sources (R-Reactor Purification Area Distillation Towers). The groundwater has been included as part of the RAOU RAGW Subunit.

Potential Release of NaOH/ H_2SO_4 From 183-2R Subunit

Composite surface soil samples were collected from each side of the Filter and Softener Plant (183-2R) to discern any release of potential contamination (SRNS 2009a). Analysis of the data indicates that no human health RCOCs are in the soils based on a

future industrial worker scenario. No groundwater RCOCs were found for the Potential Release of NaOH/ H_2SO_4 From 183-2R Subunit.

Power House (184-R) PSA

Soil and groundwater sampling was conducted to discern the nature and extent of inorganic/metal, organic, and radionuclide constituents from potential contamination for the Power House (184-R) PSA (SRNS 2009a). Analysis of the data indicates that no human health RCOCs are in the soils based on a future industrial worker scenario. No groundwater RCOCs were found at the Power House (184-R) PSA.

Cooling Tower (185-R) PSA

Soil and groundwater sampling was conducted to discern the nature and extent of inorganic/metal, organic, and radionuclide constituents from potential contamination for the Cooling Tower (185-R) PSA (SRNS 2009a). Analysis of the data indicates that no human health RCOCs are in the soils based on a future industrial worker scenario. No groundwater RCOCs were found at the Cooling Tower (185-R) PSA.

Former Coal Pile (NBN) PSA

Soil and groundwater sampling was conducted to discern the nature and extent of inorganic/metal, organic, and radionuclide constituents from potential contamination for the Former Coal Pile (NBN) PSA (SRNS 2009a). Analysis of the data indicates that no human health RCOCs are in the soils based on a future industrial worker scenario. No groundwater RCOCs were found at the Former Coal Pile (NBN) PSA.

Administrative and Maintenance Building (704-R) PSA

Soil and groundwater sampling was conducted to discern the nature and extent of inorganic, organic, and radionuclide constituents from potential contamination for the Administrative and Maintenance Building (704-R) PSA (SRNS 2009a). Analysis of the data indicates that no human health RCOCs are in the soils based on a future industrial worker scenario. No groundwater RCOCs were found at the Administrative and Maintenance Building (704-R) PSA.

Maintenance Material Storage Building (711-R) PSA

Soil and groundwater sampling was conducted to discern the nature and extent of inorganic, organic, and radionuclide constituents from potential contamination for the Maintenance Material Storage Building (711-R) PSA (SRNS 2009a). Analysis of the data indicates that no human health RCOCs are in the soils based on a future industrial worker scenario. No groundwater RCOCs were found at the Maintenance Material Storage Building (711-R) PSA.

Eastern VOC/Tritium Groundwater Plume PSA

The goal of the Eastern VOC/Tritium Groundwater Plume PSA investigation was to locate the vadose zone source(s) of the tritium and VOC groundwater plumes to the east of R-Reactor Building (105-R).

RAOU groundwater samples indicate the VOC source historically emanated from the soil surrounding a storm sewer manhole sump on the northeast corner of R-Reactor Building (105-R). The tritium source historically originated from the southeast corner of the R-Reactor Building (105-R), probably associated with Purification Area operations, processes, or spill/leaks. However, both historic vadose zone PSAs (tritium and VOCs) were found to be depleted sources; these constituents were not detected above levels of concern for potential groundwater impact (SRNS 2009a).

The residual sources (tritium and VOCs) are located below the water table, and are addressed within the scope of the RAGW Subunit.

D&D Facilities and SE Area Requiring No further Action

The following D&D NFA Facilities and SE NFA Area were determined to pose no risk to human health or the environment based on unrestricted land use; however, these facilities will be included with the LUCs selected for the RAOU because of their location within the RAOU boundary.

Primary Substation (151-1R)

The Primary Substation (151-1R) has been deactivated, and the above grade part of building has been demolished. Prior to demolition, SRS removed brass components, circuit boards, and lead-acid batteries from the facility for reuse. Additionally, SRS removed equipment and components, including three transformers and a circuit breaker, for reuse as part of the D&D process. SRS also segregated steel (626 m^3 [819 yds^3]) from the concrete rubble for recycling during demolition. Characterization of the Primary Substation (151-1R) identified tritium in exit signs, mercury switches, non-friable asbestos material, PCBs in transformer oil and circuit breaker bushings, used oil, and clean structural rubble as wastes (SRNS 2009g). All wastes were removed and disposed of in accordance with State and Federal regulations. The remaining structure is free of hazards, both chemical and physical; and therefore, warrants no further action.

Primary Substation (151-2R)

The Primary Substation (151-2R) decommissioning is complete. Many of the components in this facility were removed for reuse elsewhere at the SRS before the decommissioning project began. Additionally, some electrical cabinets/switchgear, structural metal and components (118197 kg [260,580 lb]) associated with the decommissioning project were salvaged or reused. Characterization of the Primary Substation (151-2R) identified PCBs within light ballasts, lead seals, mercury switches, compressors, creosote posts, treated wood, and clean structural rubble as wastes (WSRC 2006b). All wastes were removed and disposed of in accordance with State and Federal regulations. The remaining below-grade structure and pads are free of physical, chemical and radiological hazards; therefore, warrants no further action.

Cooling Water Clarification Plant (183-1R)

All decommissioning activities have been completed for the Cooling Water Clarification Plant (183-1R). Many of the components in this facility were removed for use elsewhere at SRS before the decommissioning project began. No material or components were identified for reuse during the D&D process. Characterization of the Cooling Water Clarification Plant (183-1R) identified used gear box oil, gear boxes, motors, metal gears,

friable asbestos-containing material, light bulbs, and clean structural rubble as wastes (WSRC 2005a). All wastes were removed and disposed of in accordance with State and Federal regulations. The remaining structure is free of hazards, both chemical and accessible physical; and therefore, warrants no further action.

Filter and Softener Plant (183-2R)

The Filter and Softener Plant (183-2R) has been partially demolished (in-situ disposal), i.e. the basin roof was broken in, but the basin floor and walls remain. Approximately 11.5 m^3 (15 yds^3) of pipe and 0.08 m^3 (0.11 yds^3) of brass were segregated for salvage and recycling during the demolition process. Characterization of the Filter and Softener Plant (183-2R) identified light bulbs, lead seals, railroad ties, bollards, electric motors, metal tape, non-friable asbestos containing material, and clean structural rubble as wastes (WSRC 2005b). All wastes were removed and disposed of in accordance with State and Federal regulations. The remaining structure is free of hazards, both physical and chemical, and therefore warrants no further action.

Cooling Water Reservoir (186-R)

The Cooling Water Reservoir (186-R) has been drained and partially demolished (in-situ disposal). Many of the components in this facility were removed for use elsewhere at the SRS before the decommissioning project began. No material or components were salvaged or reused during the decommissioning project. Characterization identified used oil from traveling screens, incandescent and mercury vapor light bulbs, traveling screens, headers, structural components, and rubble as wastes (WSRC 2006d). All wastes were removed and disposed of in accordance with State and Federal regulations. The remaining structure is free of hazards, both chemical and accessible physical; and therefore, warrants no further action.

Cooling Water Pump House (190-R)

The Cooling Water Pump House (190-R) has been partially demolished (in-situ disposal), including the removal of the roof and upper portions of walls. Many of the components in this facility were removed for use elsewhere at the SRS before the decommissioning

project began. Approximately 4,776 kg (10,530 lb) of steel, structural components, electrical cabinets, and switchgear were salvaged or reused associated with the decommissioning project. Characterization identified PCB in light ballasts, steel and structural components, asbestos-containing material, used equipment oil, fluorescent and incandescent light bulbs, lead seals, lead flashing, and lead heads as wastes. All wastes were removed and disposed of in accordance with State and Federal regulations. The remaining structure is free of hazards, both chemical and accessible physical; and therefore, warrants no further action.

Potential Release from R-Area Concrete Lakes (183-1R/186-R)

The R-Area Concrete Lakes (183-1R/186-R) were used to store Savannah River water prior to sending it through the reactor cooling system. Cooling water was not returned to the basins, but was sent to the discharge canal. The 183-1R reservoir operated for only a couple of years and was shut down in the late 1950's, while the 186-R reservoir remained in operation until the reactor shut-down in 1964. Fourteen water samples were collected from both reservoirs for gross alpha, non-volatile beta, and target analyte list analyses. Twenty three soil samples were collected around the perimeter of both reservoirs for gross alpha, non-volatile beta, and target analyte list analyses. The water and soil samples did not identify any HH or ecological COCs (WSRC 1994). The water inside the reservoirs has been drained to the R-Area discharge canal. These reservoirs will not be re-used, and require no long-term stewardship or maintenance. This site does not pose a threat to human health or the environment, therefore no further action is required for this site.

VI. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

Land Uses

According to the *SRS Future Use Project Report, Stakeholder Preferred Recommendations for SRS Land Use Facilities* (USDOE 1996), residential uses of SRS land should be prohibited. The *Land Use Control Assurance Plan for the Savannah River Site* (WSRC 2009) designates the RAOU as being within an industrial area. The

future land use is reasonably anticipated to remain industrial with USDOE maintaining control of the land.

Groundwater Uses/Surface Water Uses

R Area shallow groundwater has been impacted by previous reactor operations in the area. Although there is no anticipated current or future use of the groundwater, SRS procedures and South Carolina regulations will prevent use of the groundwater without prior approval. These administrative controls will remain in effect until groundwater no longer exceeds regulatory limits.

VII. SUMMARY OF OPERABLE UNIT RISKS

Baseline Risk Assessment

As a component of the RFI/RI process, a BRA was performed to evaluate risks associated with the RAOU (SRNS 2009a). The BRA estimates what risks the site poses if no action is taken, and provides the basis for taking action through the identification of contaminants and exposure pathways that need to be addressed by the remedial action. The BRA includes human health and ecological risk assessments. Risks associated with the potential for contaminant migration to groundwater and PTSM are also summarized. This section of the ROD summarizes the results of the BRA for the RAOU subunits.

Summary of Human Health Risk Assessment

A summary of the risks for each subunit is provided below, including the expected residual risk after the removal actions are completed. An area is considered to pose adverse health effects if the cumulative risk from all COCs exceeds a carcinogenic risk threshold greater than 1E-06 or a noncarcinogenic Hazard Index (HI) greater than 1.

The results of the human health risk assessment for the RAOU subunits are shown in Table 2. Subunits for which RCOCs were determined for the human health risk assessment are: the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit, R-Reactor Building (105-R) Complex, R-Area Ash Basin (188-R) Subunit, and the R-Area ICA PSA. Additionally, COCs were qualitatively identified for the R-Area

PSL Combined Subunit based on the potential for fixed contamination within the lines. RAGW Subunit COCs were identified based on MCL/MCLG exceedances. The RAOU subunits that will be addressed by NTC removal actions are briefly discussed below. The R-Area ICA PSA and RAGW Subunit are also discussed below, but do not have NTC removal actions associated with them.

R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit

Due to human health risk at the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit (Table 2), an NTC removal action was conducted to eliminate exposure to radionuclide contaminants (total cumulative risk = 1.3E-01). The NTC removal action achieved soil removal down to 1 pCi/g cesium-137, and the R-Area Cask Car Railroad Tracks Subunit will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.

R-Reactor Building (105-R) Complex

Because of the below-grade contamination and the above-grade contaminated equipment remaining in place at the RBC, an NTC removal action will be conducted to eliminate exposure to radionuclide contaminants (total cumulative risk = 5.6E+01). The primary risks associated with the RBC is exposure to radionuclides in the R-Reactor Vessel, resulting in a future worker risk of 5.5E+01. Additionally, the R-Reactor Disassembly Basin and portions of the ground-level and below-grade portions of the R-Reactor Building contributed to the total cumulative number risk of 5.6E+01 for the RBC. Risks associated with the R-Reactor Disassembly Basin were also described in the EE/CA for the grouting of the 105-R Disassembly Basin (USDOE 2002), which is now scheduled to coincide with the NTC removal action for the RBC (SRNS 2009d). Following these removal actions, radioactive contaminants will be left in place. LUCs will be required to prevent exposure to contaminants present in the ground-level building structure and the above-grade contaminated equipment remaining in place at the RBC. Therefore, LUCs will be required for as long as necessary to keep the selected remedy fully protective of human health and the environment.

R-Area Ash Basin (188-R) Subunit

Based on radioactive and hazardous contaminants within the R-Area Ash Basin (188-R) Subunit, a removal action will be conducted to install a soil cover to prevent potential exposure to the contaminants (total cumulative risk = 3.8E-04). Following the removal action, LUCs will be required to prevent disturbance of the cover and potential exposure to the contaminants.

R-Area PSL Combined Subunit

Based on the likelihood for human health risks to exceed 1E-03 in the R-Area PSL Combined Subunit, a removal action will be conducted to eliminate exposure to access points in the lines and prevent water flow through the lines. Following the removal action, radioactive contaminants will be left in place. LUCs will be required to prevent exposure if the PSLs are physically breached and exposed at the surface.

R-Area ICA PSA

The human health cumulative risk for the R-Area ICA PSA is 8.1E-04. Cesium-137 (+D) is the HH risk-driver in the R-Area ICA PSA. There are no ecological RCOCs, and no CM COCs for the R-Area ICA PSA. LUCs that exclude both residential and industrial use for the R-Area ICA PSA are consistent with USEPA Green Remediation guidance document (USEPA 2008) for sensitive wetland areas. LUCs will restrict access to, and excavation of, contaminated surface soil at surface and at depth. The Core Team agreed that any remedial activity that involved excavation to remove the cesium-137 (+D) contamination from surface soil would result in unacceptable damage to the sensitive ecology of the wetland.

RAGW Subunit

Previous sampling results for the RAGW Subunit has tritium (maximum tritium = 1,740 pCi/mL) and VOCs (maximum TCE = 416 µg/L, and carbon tetrachloride = 1,080 µg/L) exceeding their MCLs (20 pCi/mL, 5 µg/L, and 5 µg/L respectively). Sampling results describing the maximum concentrations for the fiscal year 2010 monitoring well data for

the COCs in each of the four plumes is shown below. However, groundwater discharging to surface water is below MCLs/MCLG. MNA is the alternative selected for this subunit (SRNS 2010a). The RAGW Subunit will also be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.

Maximum 2010 Monitoring Well Data for Each of the RAGW Plumes Compared to MCLs

Constituent	MCL	N Tritium Plume (pCi/mL)	W Tritium Plume (pCi/mL)	E Tritium Plume (pCi/mL)	E VOC Plume (ug/L)
Tritium	20 pCi/ml	64.4	50.6	1530	NA
TCE	5 ug/L	NA	NA	NA	22.5
Vinyl Chloride	2 ug/L	NA	NA	NA	4.9
Carbon Tetrachloride	5 ug/L	NA	NA	NA	ND
Cis-DCE	70 ug/L	NA	NA	NA	29.8
Chloroform	70 ug/L	NA	NA	NA	ND

NA = Not Applicable
ND = Not-Detected

The remaining RAOU subunits and PSAs do not have contaminants exceeding a 1.0E-06 risk for a future industrial worker scenario, but will be subject to LUCs preventing unrestricted use since an unrestricted use scenario (i.e. residential) was not evaluated for these subunits.

Process Storage Building (122-R) Subunit

As determined in the RFI/RI/BRA/CMS/FS (SRNS 2009a), the Process Storage Building (122-R) Subunit was determined to have no HH RCOCs under the industrial land use scenario (Tables 1 and 2). However, the Process Storage Building (122-R) Subunit will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.

Potential Release of NaOH/ H_2SO_4 from 183-2R Subunit

As discussed in the RFI/RI/BRA/CMS/FS, the Potential Release of NaOH/ H_2SO_4 from 183-2R Subunit was determined to have no HH RCOCs under the industrial land use scenario (SRNS 2009a) (Tables 1 and 2). However, the Potential Release of NaOH/

H_2SO_4 from 183-2R Subunit will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.

Power House (184-R) PSA

As discussed in the RFI/RI/BRA/CMS/FS, the Power House (184-R) PSA was determined to have no HH RCOCs under the industrial land use scenario (SRNS 2009a) (Tables 1 and 2). However, the Power House (184-R) PSA will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.

Cooling Tower (185-R) PSA

As discussed in the RFI/RI/BRA/CMS/FS, the Cooling Tower (185-R) PSA was determined to have no HH RCOCs under the industrial land use scenario (SRNS 2009a) (Tables 1 and 2). However, the Cooling Tower (185-R) PSA will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.

Former Coal Pile (NBN) PSA

As discussed in the RFI/RI/BRA/CMS/FS (SRNS 2009a), the Former Coal Pile (NBN) PSA was determined to have no HH RCOCs under the industrial land use scenario (Tables 1 and 2). However, the Former Coal Pile (NBN) PSA Subunit will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.

Administrative and Maintenance Building (704-R) PSA

As discussed in the RFI/RI/BRA/CMS/FS, the Administrative and Maintenance Building (704-R) PSA was determined to have no HH RCOCs under the industrial land use scenario (SRNS 2009a) (Tables 1 and 2). However, the Administrative and Maintenance Building (704-R) PSA will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.

Maintenance Material Storage Building (711-R) PSA

As discussed in the RFI/RI/BRA/CMS/FS, the Maintenance Material Storage Building (711-R) PSA was determined to have no HH RCOCs under the industrial land use scenario (SRNS 2009a) (Tables 1 and 2). However, the Maintenance Material Storage Building (711-R) PSA will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.

Eastern VOC/Tritium Groundwater Plume PSA

As discussed in the RFI/RI/BRA/CMS/FS, the Eastern VOC/Tritium Groundwater Plume PSA was determined to have no HH RCOCs under the industrial land use scenario (SRNS 2009a) (Tables 1 and 2). However, the Eastern VOC/Tritium Groundwater Plume PSA will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.

Summary of Ecological Risk Assessment

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

An ecological risk assessment was conducted on the R-Area Ash Basin (188-R) Subunit and the R-Area ICA PSA. The remaining RAOU subunits were determined not to require a quantitative ecological risk evaluation due to lack of habitat (industrial setting) and/or conceptual model considerations (e.g., contamination at depth).

The results of the ecological risk assessment for the RAOU subunits are shown in Table 2. There were no ecological COCs identified for any of the RAOU subunits.

Summary of the Contaminant Fate and Transport Analysis

A contaminant migration analysis was performed to identify CM COCs. The constituents are identified as a CM COC if leachability modeling predicts the constituent will leach to the groundwater and exceed MCLs or preliminary remedial goals within 1000 years.

The results of the CM evaluation for the RAOU subunits are shown in Table 2. The only subunit for which COCs were determined for the CM evaluation is the R-Reactor Building (105-R) Complex. A removal action has been developed (SRNS 2009d) that will address the CM COCs to the extent practicable in this subunit.

Discussion of Principal Threat Source Material (PTSM)

Source materials are those materials that include or contain hazardous substances, pollutants, or contaminants that act as a reservoir for migration to groundwater, surface water, or air, or that act as a source for direct exposure. PTSM is defined as those source materials that have a high toxicity or mobility and cannot be reliable contained or present a significant risk to human health or the environment (USEPA 1991). Treatment alternatives should be considered for source materials with a toxicity of 1E-03 or greater for carcinogens or cumulative HI of 10 or greater for noncarcinogens.

At SRS, source material is considered to be PTSM if the cumulative risk exceeds one of the following threshold criteria:

- Carcinogens – greater than 1E-03 industrial worker risk; or
- Non-carcinogens – industrial worker HI greater than 10.

The results of the PTSM evaluation for the RAOU subunits are shown in Table 2. Subunits for which RCOCs were determined for the PTSM evaluation are: the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit, R-Area PSL Combined Subunit, and R-Reactor Building (105-R) Complex. Removal actions have been developed (SRNS 2009b, SRNS 2009d, SRNS 2009f) that will address the PTSM in these subunits.

Conclusions

Following successful completion of the ongoing removal actions to meet industrial level RGs, residual contamination will remain at the RAOU that may present a risk to human health and the environment. LUCs for the entire RAOU are needed to prevent unrestricted use.

A conceptual site model that identifies how the final remedial action will eliminate the primary exposure pathway(s) for the contaminants and media of concern for each RAOU subunit is presented in Figure 12.

VIII. REMEDIAL ACTION OBJECTIVES AND REMEDIAL GOALS

The goals of remedial actions are to protect human health and the environment and to mitigate the effects of contamination. Remedial action objectives (RAOs) are media- or OU-specific objectives for protecting human health and ecological receptors from exposure to unit-related contamination. RGs represent media-specific cleanup goals and serve as a standard by which to measure whether a selected remedial action has met its RAO.

USEPA has established a structured process to identify and evaluate technologies for remedial applications. This process involves developing and screening a range of appropriate remedial options and selecting the most suitable approach(es) for corrective measures and remedial actions.

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) specifies six criteria for developing this range of remedial technologies [40 Code of Federal Regulation (CFR) Part 300.430 (a)(1)(iii)(A)-(F)]:

- Whenever practical, use treatment to address principal threats posed by the unit;
- Use engineering controls for waste that poses a relatively low long-term risk or when treatment is impractical;

- Combine methods (for example, treatment plus engineering controls) to protect human health and the environment;
- Supplement engineering controls with institutional controls to prevent or limit exposure;
- Whenever practical, use innovative technologies; and
- Return usable groundwater to beneficial uses or prevent further degradation.

Remedial Action Objectives

RAOs usually specify potential receptors and exposure pathways, and are identified during scoping once the CSM is understood. RAOs describe what the cleanup must accomplish and are used as a framework for developing remedial alternative. The RAOs are based on the nature and extent of contamination, threatened resources, and the potential for human and environmental exposure. The following RAOs are identified for the RAOU subunits warranting final action and are protective of the industrial worker:

- Eliminate or control all routes of exposure to residual radioactive or chemical contamination posing risks exceeding 1E-06 to the industrial worker or the resident in media or structures associated with the RBC, the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit, the R-Area PSL Combined Subunit, the R-Area ICA PSA, the R-Area Ash Basin (188-P) Subunit, and the RAGW Subunit;
- Prevent the migration of contaminants from residual water in the Process Water Storage Tank (106-R) PSA to groundwater at concentrations exceeding regulatory standards (MCLs);
- Prevent human exposure to tritium and VOCs in groundwater that exceed regulatory limits (MCLs or MCLG), and restore contaminated groundwater to below regulatory limits (MCLs or MCLG) for the RAGW Subunit; and
- Prevent exposure of potential contamination in media or structures to a residential receptor associated with the following subunits:
    - Process Storage Building (122-R) Subunit

- Potential Release of NaOH/ H_2SO_4 from 183-2R Subunit
- Power House (184-R) PSA
- Cooling Tower (185-R) PSA
- Former Coal Pile (NBN) PSA
- Administrative and Maintenance Building (704-R) PSA
- Maintenance Material Storage Building (711-R) PSA
- Eastern VOC/Tritium Groundwater Plume PSA

Remedial Goals

RGs can be qualitative statements or numerical values often expressed as concentrations in soils and groundwater, or actions (installation of engineered barriers, placement of caps and covers, etc.) that achieve the RAO. Final RGs will be monitored to determine when the remedial action is complete.

The RGs identified in the RFI/RI/BRA/CMS/FS and removal action decision documents (SRNS 2009a, SRNS 2009b, SRNS 2009d, SRNS 2009e, and SRNS 2009f) will be met as the actions are completed. With the exception of the final action for RAGW Subunit, specific RGs are not developed for the final action since the preferred alternative (LUCs) will break the exposure pathway to any contamination left in place following completion of the removal actions.

The RGs for the RAGW Subunit are based on the chemical-specific ARARs (MCLs or MCLG) from the South Carolina and Federal regulations:

- Tritium MCL = 20 pCi/mL
- TCE MCL = 5 µg/L;
- cis-1,2-Dichloroethylene MCL = 70 µg/L;
- Vinyl Chloride MCL = 2 µg/L ;

- Carbon Tetrachloride MCL = 5 µg/L ; and

- Chloroform MCLG = 70 µg/L.

Applicable or Relevant and Appropriate Requirements

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 law 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 were defined 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. The NCP requires the development of health-based, site-specific levels for chemicals where such limits do not exist and where there is a concern with their potential health or environmental effects.

ARARs for the NTC removal actions were previously identified in the RSER/EE/CA documents. The chemical- and action-specific ARARs identified for Alternative RAOU-2 are shown in Table 3. There are no location-specific ARARs for this alternative, as the RAOU is not located in an area that, based on its location, would trigger any ARARs.

IX. DESCRIPTION OF ALTERNATIVES

This section presents and summarizes the remedial alternatives for the final remedy for RAOU. Under CERCLA, it is desirable when practical to offer a range of diverse alternatives to compare during the detailed analysis to arrive at the most effective cost-efficient remedial action. The range of alternatives includes options that (1) immobilize chemicals, (2) reduce the contaminant volume, or (3) reduce the need for long-term, onsite management. For RAOU, these alternatives were previously evaluated in the removal action decision documents (SRNS 2009b, SRNS 2009d, SRNS 2009e, SRNS 2009f, USDOE 2002). For the final action at RAOU, the LUC alternative and MNA alternative was developed that involves no treatment yet provides protection to human health and the environment by preventing or controlling exposure to the contaminants through LUCs while allowing groundwater contaminants to attenuate below RGs. As required by the NCP, the No Action alternative is provided as a baseline for comparison.

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

For each of the alternatives below, a discount rate of 2.7% was used to estimate the present-worth. The present-worth costs include the five-year remedy reviews, if included as part of the alternative. Detailed breakdowns of these cost summaries are included in Tables 4 and 5. Present-worth costs for these items are based on an estimated time frame of 200 years. ARARs for the RAOU subunits are provided in Section X.

Two remedial alternatives were developed for the RAOU and are discussed below. These alternatives are based on the site conditions that remain following successful completion of the removal/remedial actions to meet RGs.

Alternative RAOU-1 – No Action

Total Present Worth Cost *$0*

The No Action alternative is required by the NCP to serve as a baseline for comparison with other remediation alternatives. Under this alternative, no efforts would be made to control access, limit exposure, or reduce contaminant toxicity, mobility, or volume at the

RAOU. This alternative would leave the RAOU in its current condition with no additional controls. This alternative does not include five-year remedy reviews.

Alternative RAOU-2: Land Use Controls with MNA for Groundwater

Total Present Worth Cost *$5,591,169*

Under this alternative, LUCs will be implemented after completion of the removal/remedial actions for the entire RAOU. Engineering controls such as physical barriers (i.e., signs) and institutional controls (i.e., excavation permit restrictions and deed restrictions) will be used to restrict access or activities that can be performed at the impacted areas. The RAOU LUC boundary is depicted in Figure 13. MNA will be implemented for the RAOU RAGW Subunit, until it is determined to be no longer required. No additional active remedial action is needed after completion of the removal actions. Implementation of this alternative would require both near- and long-term actions.

For the near-term, signs would be posted to indicate that the area was used for disposal of waste material. Placement of signs is expected to be completed by the end of 2011. The language used on the signs will be detailed in the Land Use Control Implementation Plan (LUCIP). In addition, existing SRS access controls would be used to maintain the use of the RAOU consistent with its intended use. A perimeter fence will not be maintained or constructed around the RAOU because removal actions, remoteness of the area, and land use restrictions are sufficient to prevent human exposure to the contaminants. Surface soils will not pose a potential threat to a current on-unit worker at the RAOU once removal actions have been completed to meet RGs. The one exception is the R-Area ICA PSA. At this subunit, LUCs will prevent both residential and industrial uses of this area that would result in long-term daily exposure to residual cesium-137 (+D) levels in surface soils.

Periodic inspections would be conducted and maintenance would be performed to help ensure that the removal/remedial actions are in satisfactory condition. Maintenance, as needed, would consist primarily of mowing, cap and roof repair, subsidence repairs, etc.

Minor drainage modification may be conducted as needed to prevent ponding and to promote surface water runoff. The RAGW Subunit of the RAOU will require groundwater monitoring for tritium and VOCs to confirm that contaminant concentrations continue to decline, and are not impacting surface water above MCLs/MCLG. Periodic (every five years) groundwater monitoring will also be conducted at the RBC to confirm that contaminants associated with the RBC are not reaching the groundwater.

X. COMPARATIVE ANALYSIS OF ALTERNATIVES

The NCP [40 CFR 300.430(e)(9)] requires that potential remedial alternatives undergo detailed analysis using relevant evaluation criteria that will be used by decision makers to select a final remedy. The results of the detailed analysis are then examined to compare alternatives and identify key tradeoffs among alternatives. Potential alternatives that address the RAOU are individually evaluated in detail against CERCLA requirements. A comparative analysis is then conducted for the corrective measure/remedial alternatives.

In this section, the alternatives formulated and retained are evaluated in detail against CERCLA requirements. The statutory requirements that guide the evaluation of remedial alternatives in a CERCLA FS state that a remedial action must:

- Be protective of human health and the environment;
- Attain ARARs or define criteria for invoking a waiver;
- Be cost effective; and
- Use permanent solutions to the maximum extent.

USEPA has established nine evaluation criteria to address these statutory requirements under CERCLA. The criteria fall into the categories of threshold criteria, primary balancing criteria, and modifying criteria. Evaluation criteria categories and the nine evaluation criteria are listed and explained below.

Threshold Criteria

Threshold criteria are requirements that each alternative must achieve to be eligible for selection as a permanent remedy under CERCLA. The threshold criteria are:

- Overall protection of human health and the environment; and
- Compliance with ARARs.

Primary Balancing Criteria

Primary balancing criteria are factors that identify key tradeoffs among alternatives. The primary balancing criteria are:

- Long-term effectiveness and permanence;
- Reduction of mobility, toxicity, or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

Modifying Criteria

Modifying criteria (i.e., state or support agency acceptance, community acceptance) are also considered during remedy selection. Community acceptance is formally assessed after the public review and comment period on the SB/PP. The modifying criteria are:

- State or support agency acceptance; and
- Community acceptance.

Comparative Analysis of the R-Area Operable Unit Alternatives

A comparative analysis summary and ranking of the RAOU alternatives is shown in Table 6. The following two alternatives were developed for consideration:

- Alternative RAOU-1 - No Action; and
- Alternative RAOU-2 - Land Use Controls with MNA for Groundwater.

1. Overall Protection of Human Health and the Environment - Alternative RAOU-2 is protective of human health (industrial workers and residents) by preventing the exposure to contaminated soils/structures and contaminated groundwater through LUCs and MNA; Alternative RAOU-1 is not protective of human health since no controls are in place to prevent the potential exposure to contaminated soils and structures. Alternative RAOU-2 would achieve RAOs.

2. Compliance with ARARs – ARARs are associated with this proposed action (Table 3). Alternative RAOU-1 does not meet the chemical-specific ARARs since there are no controls in place to prevent the potential exposure to contaminated soils/structures or groundwater; RAOU-2 meets both chemical-specific and action-specific ARARs.

3. Long-Term Effectiveness and Permanence – The remedial alternatives are assessed based on their ability to maintain reliable protection of human health and the environment after implementation. Alternative RAOU-2 is protective and provides long-term effectiveness and permanence as long as LUCs and MNA criteria are met. It is expected that contaminant concentrations will remain below MCLs/MCLG in surface water, and that MCLs/MCLG will be achieved in all the groundwater plumes within 124 years from present. The RAOU Northern Tritium Plume is predicted to take the longest time to reach MCLs (124 years). This is a very conservative estimate using the original (1958) source term concentration (400,000 pCi/mL) discharged to the seepage basins, and only radioactive decay half-life for tritium (2010b). In contrast, the maximum observed groundwater concentration from monitoring wells (1987-2009) was 474 pCi/mL in 1989. The time for the VOC plumes to reach MCLs is 26 years from present, based on conservative biodegradation rates (SRNS 2010b). Alternative RAOU-1 does not provide long-term effectiveness and permanence since there are no controls in place to prevent the potential exposure to contaminated soils/structures or contaminated groundwater.

4. Reduction of Toxicity, Mobility, or Volume through Treatment – Neither Alternatives RAOU-1 and RAOU-2 provides an active reduction in the toxicity, mobility, or volume of contaminants. Alternative RAOU-2 does provide limited reduction of the groundwater contaminant volume through the application of MNA. This criteria was addressed by the

removal actions for the specific subunits, as described in the RSER/EE/CA for the R-Reactor Building (105-R) Complex (SRNS 2009d), the RSER/EE/CA for the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit (SRNS 2009b), the RSER/EE/CA for the R-Area PSL Combined Subunit (SRNS 2009f), and the RSER/EE/CA for the R-Area Ash Basin (188-R) Subunit (SRNS 2009e).

*5. **Short-Term Effectiveness*** – The remedial alternatives are assessed considering factors relevant to implementation of the remedial action, including risks to the community during implementation, impacts on workers, potential environmental impacts and the time until protection is achieved. Alternative RAOU-2 achieves RAOs in a short period of time with essentially no risk to workers and the public. Alternative RAOU-1 does not provide short-term effectiveness since there are no controls in place to prevent the potential exposure to contaminated soils/structures or contaminated groundwater.

*6. **Implementability*** – The remedial alternatives are assessed by considering the difficulty of implementing the alternative, including technical feasibility, constructability, reliability of technology, ease of undertaking additional remedial actions (if required), monitoring considerations, administrative feasibility (regulatory requirements), and availability of services and materials. Both Alternative RAOU-1 and RAOU-2 are easily implementable.

*7. **Cost*** – Alternative RAOU-1 is less expensive ($0) than Alternative RAOU-2 ($5,591,169). Detailed alternative costs are provided in Tables 4 and 5. Five-year remedy reviews for 200 years are included for Alternative RAOU-2. At 200 years, greater than 99.5% of the total cost is captured based on the current discount rate used.

*8. **State Acceptance*** – State acceptance criteria were evaluated based on scoping meetings held between USDOE, USEPA, and SCDHEC, and based on comments received on the final SB/PP. Alternative RAOU-2 is the preferred remedy for SCDHEC.

*9. **Community Acceptance*** – The community acceptance of the preferred alternative is assessed by giving the public an opportunity to comment on the remedy selection

process. A public comment period was held from July 14, 2010 through August 28, 2010. No comments were received from the public indicating that the preferred remedy is acceptable.

XI. THE SELECTED REMEDY

Detailed Description of the Selected Remedy

The preferred alternative for the RAOU is described below.

R-Area Operable Unit

The preferred remedial action for the RAOU is Alternative RAOU-2 - Land Use Controls with MNA for Groundwater. This remedy meets the RAOs and the threshold criteria, provides overall protection of human health and the environment, and complies with ARARs. The remedy is effective in the long-term based on preventing human exposure to radioactive and hazardous contaminants that remain. Present worth cost estimates for Alternative RAOU-2 is $5,591,169.

The LUC and MNA objectives necessary to ensure the protectiveness of the selected remedy for the RAOU are:

- Restrict unauthorized worker access and prevent contact, removal, or excavation of contaminated waste, pipelines, equipment, and buildings;
- Prohibit the development and use of property for residential housing, elementary and secondary schools, child care facilities and playgrounds;
- Prohibit industrial use of the R-Area ICA PSA;
- Maintain the integrity of any current or future remedial or monitoring system, such as soil covers, or groundwater monitoring wells;
- Prevent access or use of contaminated groundwater until cleanup levels are met; and
- Prevent construction of inhabitable buildings without an evaluation of indoor air quality to address vapor intrusion.

Under Alternative RAOU-2, LUCs and MNA would be implemented after successful completion of the removal/remedial actions.

The long-term remedial action objective for the groundwater portion of the operable unit is to restore contaminated groundwater in the Upper Three Runs aquifer to below regulatory limits. This aquifer is not currently used on-site or off-site as a source of drinking water. MNA will be used to restore the aquifer to its future beneficial use as a potential source of drinking water within 125 years. Although this time-frame is longer than that expected if more active groundwater treatment was implemented, it is considered a reasonable time-frame given that (1) the same aquifer in R-Area is predicted to also remain contaminated with strontium-90 for over 200 years as agreed to in a previous ROD for the R-Reactor Seepage Basins (WSRC 2003b), and (2) there is no anticipated drinking water use for the aquifer in this area, which will be controlled by the long-term LUCs associated with the overall RAOU remedy. Further, recent monitoring indicates that the groundwater contaminant concentrations are declining, and no exceedances of the RGs have been observed in surface water where the groundwater plumes are discharging. Based on these factors, EPA and DHEC have agreed that contingency measures are currently not needed as part of the remedy selected in this ROD for the groundwater.

The MNA portion of the remedy will include the establishment of a monitoring plan that will includes both groundwater and surface water sampling in order to evaluated the remedy performance. In addition to identifying key source zone monitoring wells to be used to verify the sources are depleting or contained, the following data quality objectives will be used for MNA:

- Perform monitoring to demonstrate that the plume contaminants (VOCs and tritium) are trending to lower concentration over the time frame estimated (SRNS 2010b);
- Perform monitoring to verify the extent of each of the four plumes is captured within the LUC boundary;
- Perform monitoring to verify the plumes are not migrating to deeper aquifers (LAZ);

- Perform monitoring to verify no constituents exceed MCLs in surface water.

Details identifying the wells to be monitored, frequency of monitoring, and reporting will be presented in the Effectiveness Monitoring Plan (EMP) that will be prepared. The EMP provides the remedial design requirements for the R Area Operable Unit groundwater remedy and meets the intent of a Corrective Measures Implementation/Remedial Action Implementation Plan. The EMP also provides information on how the effectiveness of the remedy will be monitored. Effectiveness Monitoring Reports will be prepared that present and assess the monitoring data to verify that the groundwater plumes continue to attenuate and surface water concentrations remain below MCLs.

LUCs for the RAOU will include both near-term and long-term actions that are presented in Table 7 and identified below:

- Institutional controls (i.e., administrative measures) and use restrictions for on-site workers via the Site Use/Site Clearance Program. Other administrative controls to ensure worker safety include work controls, worker training, and worker briefing of health and safety requirements.
- Engineering controls consisting of signage located at the RAOU LUC boundaries to discourage unauthorized entry and uses, as shown in Figure 13.
- SRS access controls to prevent exposure to trespassers, as described in the 2000 RCRA Part B 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."

For the near-term, signs would be posted to identify the area that is subject to LUCs. The date for installation of the signs will be stated in the unit-specific LUCIP referenced in this ROD. The language used on the signs will be detailed in the LUCIP. In addition, existing SRS administrative controls would be used to limit uses of the RAOU in order to prevent unacceptable exposure. The Site Use / Site Clearance Program will restrict

excavation in appropriate areas (e.g., process sewer lines). A perimeter fence will not be constructed around the RAOU because removal/remedial actions and land use controls are sufficient to isolate the contaminants from human exposure. Surface soils will not pose a potential threat to a current on-unit worker at the RAOU once removal actions have been completed to meet RGs. The one exception is the R-Area ICA PSA. At this subunit, LUCs will also prevent any industrial use of this area preventing long-term daily exposure to residual cesium-137 (+D) levels in surface soils, and protecting the cypress wetland.

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

In addition, if the property or any portion thereof, is ever transferred by deed, the U.S. Government will also satisfy the requirements of CERCLA 120(h)(3). The requirements include a description of the remedial action taken, a covenant, and an access clause. These requirements are also consistent with the intent of the RCRA deed notification requirements at final closure of a RCRA facility if contamination will remain at the unit.

These property transfer LUCs will be implemented through the following:

- The contract, the deed, or other transfer document shall also include restrictions precluding residential use of the property. However, the need for these deed restrictions may be reevaluated at the time of transfer in the event that exposure assumptions differ and/or the residual contamination no longer poses an unacceptable risk under residential use. Any reevaluation of the need for the deed restrictions will be done through an amended ROD with USEPA and SCDHEC review and approval.

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

In the event of a property leas or interagency agreement, the equivalent restrictions will be implemented as required by CERCLA Section 120(h)(1) and (3).

The selected remedy for the RAOU leaves hazardous substances in place that pose a potential future risk and will require land use restrictions as long as necessary to keep the selected remedy fully protective of human health and the environment. As agreed on March 30, 2000, among the USDOE, the USEPA, and the SCDHEC, SRS is implementing a land use control assurance plan (LUCAP) to ensure that LUCs required by numerous remedial decisions at SRS are properly maintained and periodically verified. The unit-specific LUCIP referenced in this ROD will provide details and specific measures to implement and maintain the LUCs selected as part of this remedy. The USDOE is responsible for implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs selected under this ROD. The LUCIP, developed as part of this action, will be submitted for review and approval by USEPA and SCDHEC. Upon final approval, the LUCIP will be appended to the LUCAP and is considered incorporated by reference into the ROD, establishing LUC implementation and maintenance requirements enforceable under CERCLA and the SRS Federal Facility Agreement (FFA 1993). The approved LUCIP will establish implementation, monitoring, maintenance, reporting, and enforcement requirements for the RAOU. The LUCIP will remain in effect unless and until modifications are approved as needed to be protective of human health and the environment. The deed shall expressly prohibit activities inconsistent with the remedial goals and objectives in this ROD upon any and all transfers. The LUCs shall be maintained until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use. Approval by USEPA and SCDHEC is required for any modification or termination of the LUCs.

USDOE has recommended that residential use of SRS land be controlled; therefore, future residential use and potential drinking water usage will be restricted to ensure long-

term protectiveness. LUCs will restrict the RAOU to future industrial use and will prohibit residential use of the area. Unauthorized excavation will also be prohibited and the applicable portions of RAOU will remain undisturbed. LUCs selected as part of this action will be maintained for as long as necessary to keep the selected remedy fully protective of human health and the environment and termination of any LUCs will be subject to CERCLA requirements for documenting changes in remedial actions.

Periodic inspections will be conducted and maintenance will be performed to help ensure that the removal actions are in satisfactory condition. Maintenance, as needed, would consist primarily of mowing, cap and roof repair, subsidence repairs, etc. Minor drainage modification may be conducted as needed to prevent ponding and to promote surface water runoff. In addition to MNA for the R-Area groundwater subunit, periodic (every five years) groundwater monitoring would be conducted to confirm that contaminants associated with the RBC are not reaching the groundwater.

The final remedial action will consist of LUCs and MNA, and traditional design or construction activities will not occur.

Cost Estimate for the Selected Remedy

The detailed cost estimate for Alternative RAOU-2 – LUCs and MNA is presented in Table 5. Capital costs including posting of warning signs, preparing the LUCIP, and developing deed restrictions should property transfer occur. Direct Operations & Maintenance (O&M) costs are considered for 200 years and include annual inspections and maintenance, well monitoring, and five year remedy reviews.

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

R-Area Operable Unit

Summary of Costs

Total Estimated Capital Cost:	$ 124,740
Total Present-Worth Direct O&M Cost:	$1,987,792
Total Present-Worth Indirect O&M Cost:	$3,478,637

Estimated costs associated with the selected remedy on the 2.7% discount rate over a 200-year period are summarized above.

Estimated Outcomes of Selected Remedy

LUCs and MNA will be maintained for protection of human health and the environment at the RAOU by restricting the land use to industrial use only, except at the R-Area ICA PSA where industrial use will also be prohibited. It is expected that portions of the RAOU will be available for industrial use by 2012. The use of groundwater will continue to be restricted until RGs are met.

The selected remedy for the RAOU will meet RAOs through the following means:

- Eliminating or controlling all routes of exposure to residual radioactive or chemical contamination posing risks exceeding 1E-06 to the industrial worker or the resident in media or structures associated with the RBC, the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit, the R-Area PSL Combined Subunit, the R-Area Ash Basin (188-R) Subunit, the R-Area ICA PSA;
- Prevent the migration of contaminants from residual water in the Process Water Storage Tank (106-R) PSA to groundwater at concentrations exceeding regulatory standards (MCLs);
- Prevent human exposure to tritium and VOCs in groundwater that exceed regulatory limits (MCLs or MCLG), and restore contaminated groundwater to below regulatory limits (MCLs or MCLG) for the RAGW Subunit. The estimated time frames for MNA to restore contaminated groundwater to below regulatory limits are:
  - Northern Tritium Plume – 124 years;
  - Eastern Tritium Plume – 77 years;

- Western Tritium Plume – 37 years; and
- Eastern VOC Plume – 26 years; and

- Preventing exposure of potential contamination in media or structures to a residential receptor associated with the following subunits:
  - Process Storage Building (122-R) Subunit;
  - Former Coal Pile (NBN) PSA;
  - Power House (184-R) PSA;
  - Cooling Tower (185-R) PSA;
  - Administrative and Maintenance Building (704-R) PSA;
  - Maintenance Material Storage Building (711-R) PSA;
  - Eastern VOC/Tritium Groundwater Plume PSA; and
  - Potential Release of NaOH/ H_2SO_4 from 183-2R Subunit.

XII. STATUTORY DETERMINATIONS

Regulatory decisions were made on select RAOU subunits. These decisions included the NTC removal actions documented in five RSER/EE/CAs. The remaining subunits not selected for a NTC removal action were presented in the RFI/RI/BRA/CMS/FS report (SRNS 2009a). Following successful completion of the NTC removal actions, residual hazardous substances will remain at the RAOU that pose a threat to human health and the environment. Therefore, Alternative RAOU-2 – LUCs and MNA, has been selected as the final remedy for the RAOU. The future land use of the RAOU will be industrial, except at the R-Area ICA PSA, where LUCs will also prevent industrial use.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, and will continue to be, protective of human health and the environment. The selected remedy is protective of human health and the environment,

complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action (unless justified by a waiver) and is cost-effective. This remedy does not satisfy the statutory preference for treatment as a principal element of the remedy since the remedy does not reduce toxicity, mobility, or volume of materials comprising principal treats through treatment.

XIII. EXPLANATION OF SIGNIFICANT CHANGES

The remedy selected in this ROD for the RAOU contains one significant change from the preferred alternative presented in the SB/PP. The SB/PP used the preliminary remediation goal (PRG) as the RG for chloroform in groundwater; however, the MCLG for chloroform is used for the RG in this ROD. Chloroform does not specifically have an MCL, but is one of the four constituents that make up the Total Trihalomethane group. The Safe Drinking Water Act establishes a MCL of 80 µg/L for Total Trihalomethanes, and identifies an MCLG for each of the individual trihalomethanes, including the MCLG of 70 µg/L for chloroform (USEPA 2006). The more restrictive MCLG for chloroform is being used as the RG.

XIV. RESPONSIVENESS SUMMARY

The Responsiveness Summary is included as Appendix A of this document. All comments received and responses will be included in Appendix A.

XV. POST-ROD DOCUMENT SCHEDULE AND DESCRIPTION

A detailed schedule for the Post-ROD activities is shown in Figure 14. The forecast schedule for the post-ROD documentation is provided below:

- SRS submittal of the Revision 0 EMP and LUCIP is scheduled for September 22, 2010;
- USEPA and SCDHEC will receive 90 calendar days for review of the Revision 0 EMP and LUCIP;
- The SRS revision of the EMP and LUCIP will be completed 60 calendar days after receipt of all regulatory comments on the EMP and LUCIP;

- USEPA and SCDHEC will receive 30 calendar days for final review and approval of the EMP and LUCIP; and
- The projected Remedial Action start date is June 17, 2011.

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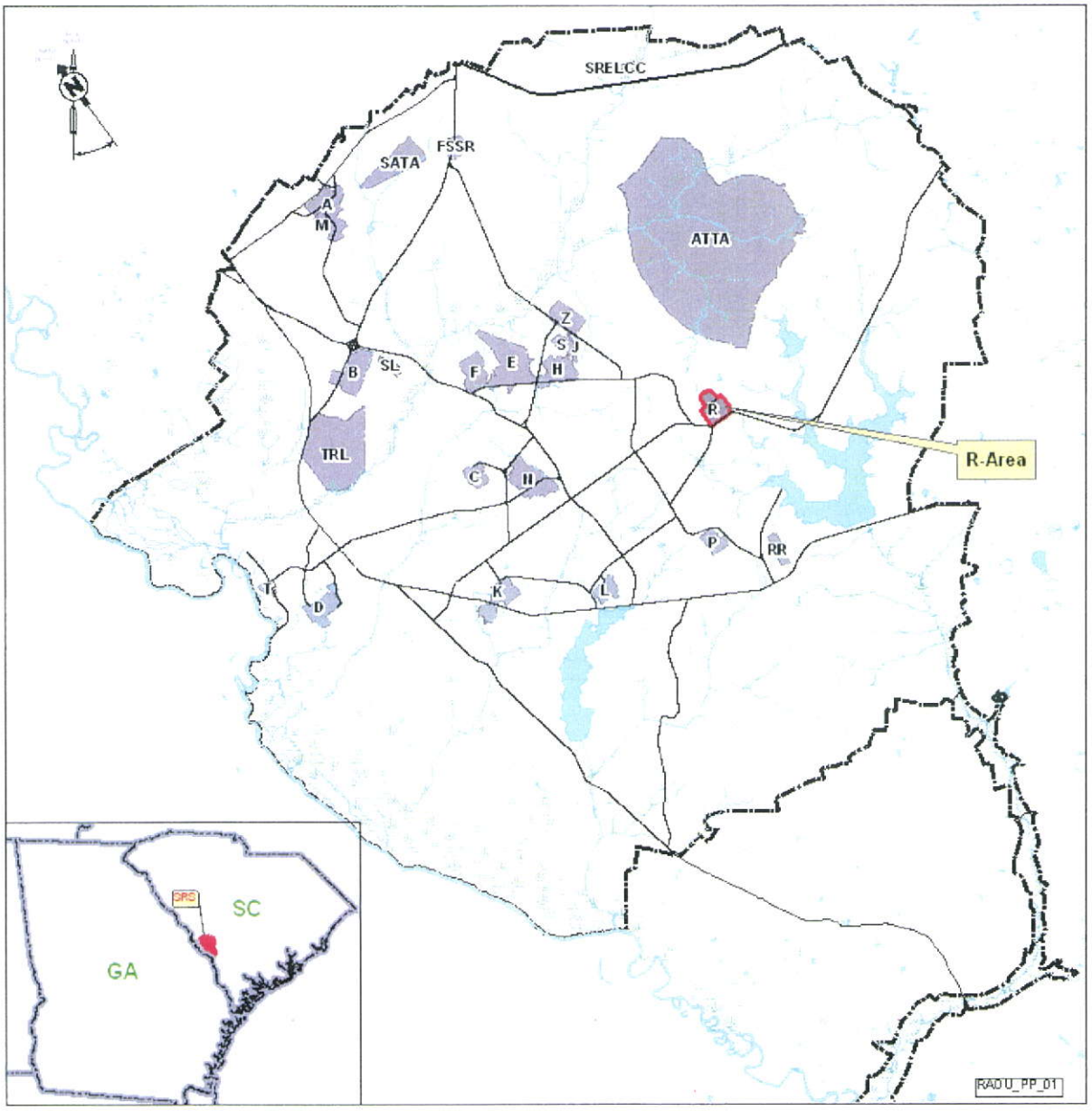

Location of the R-Area

Figure 1. Location of the R Area within the Savannah River Site

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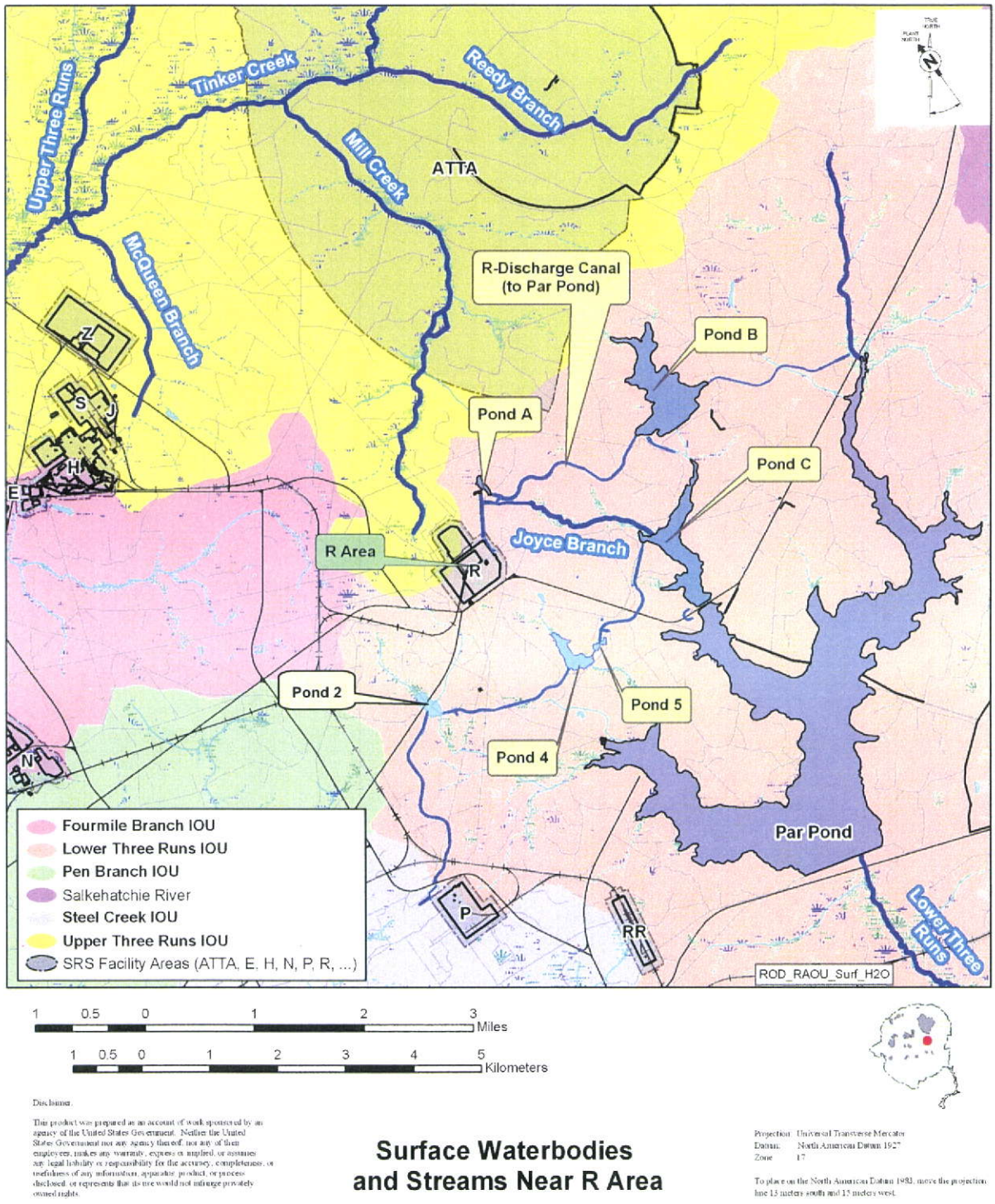

Figure 2. Surface Water near R Area at the Savannah River Site

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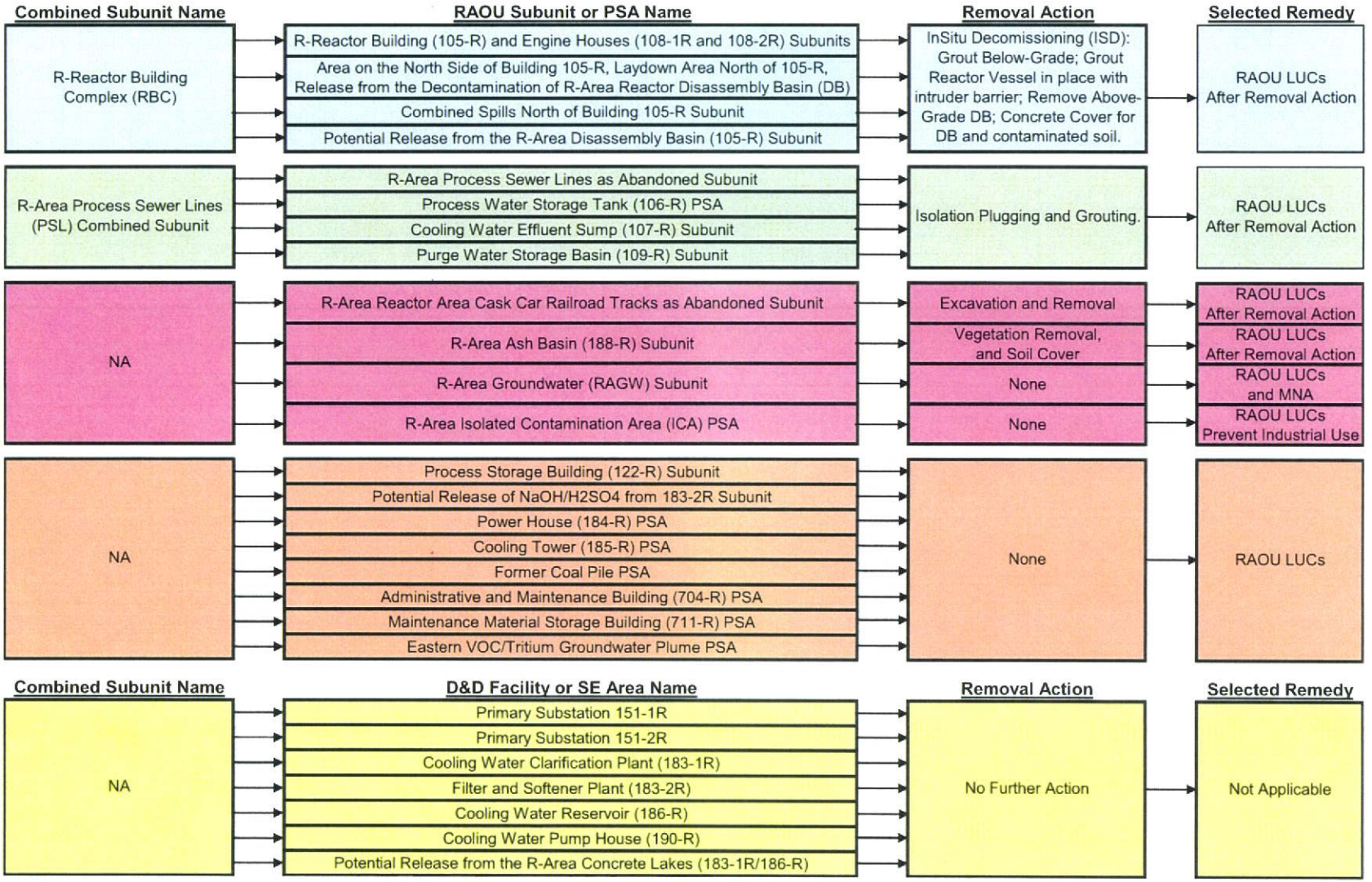

Figure 3. Administrative Paths for the RAOU Subunits and PSAs

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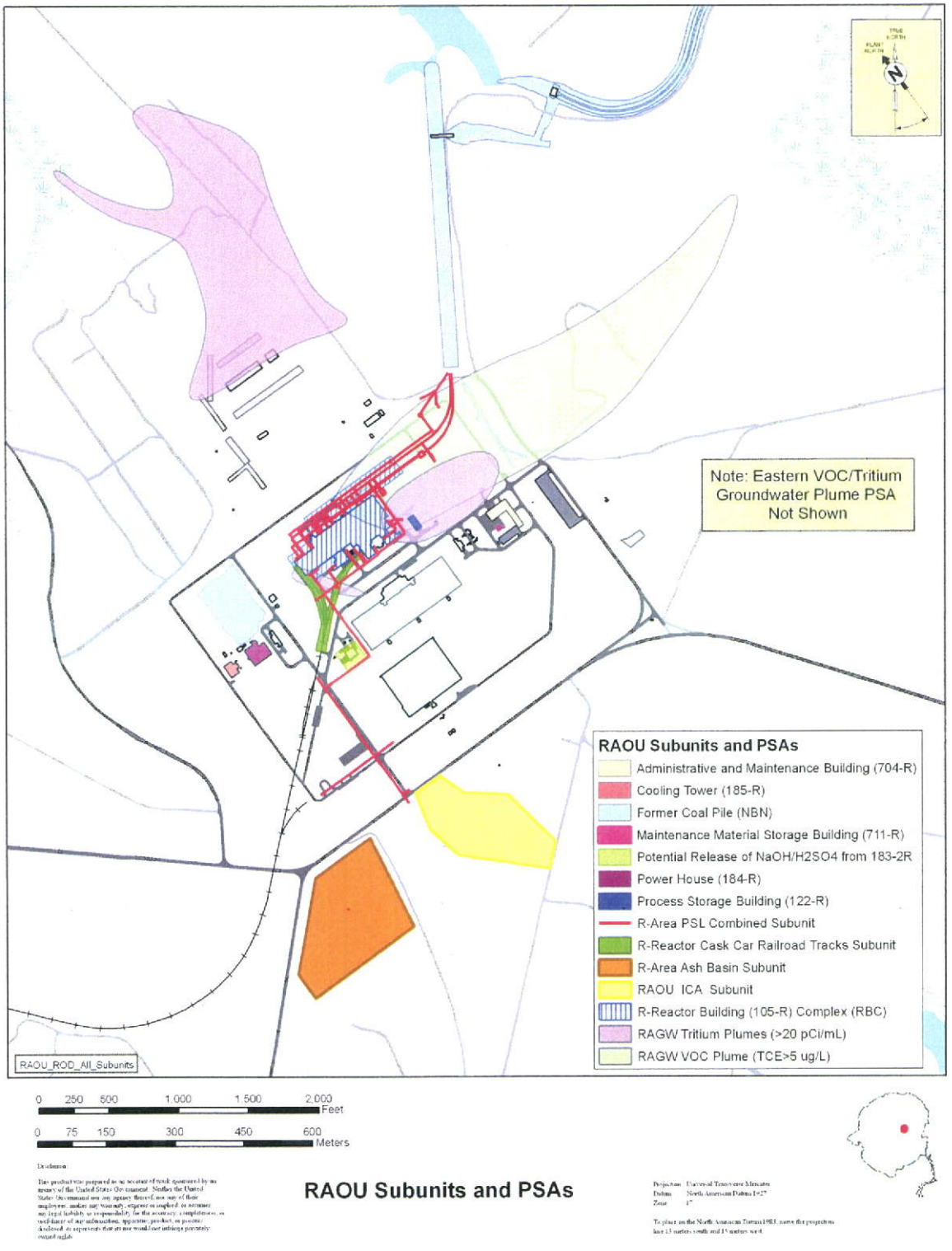

Figure 4. RAOU Subunits requiring LUCs.

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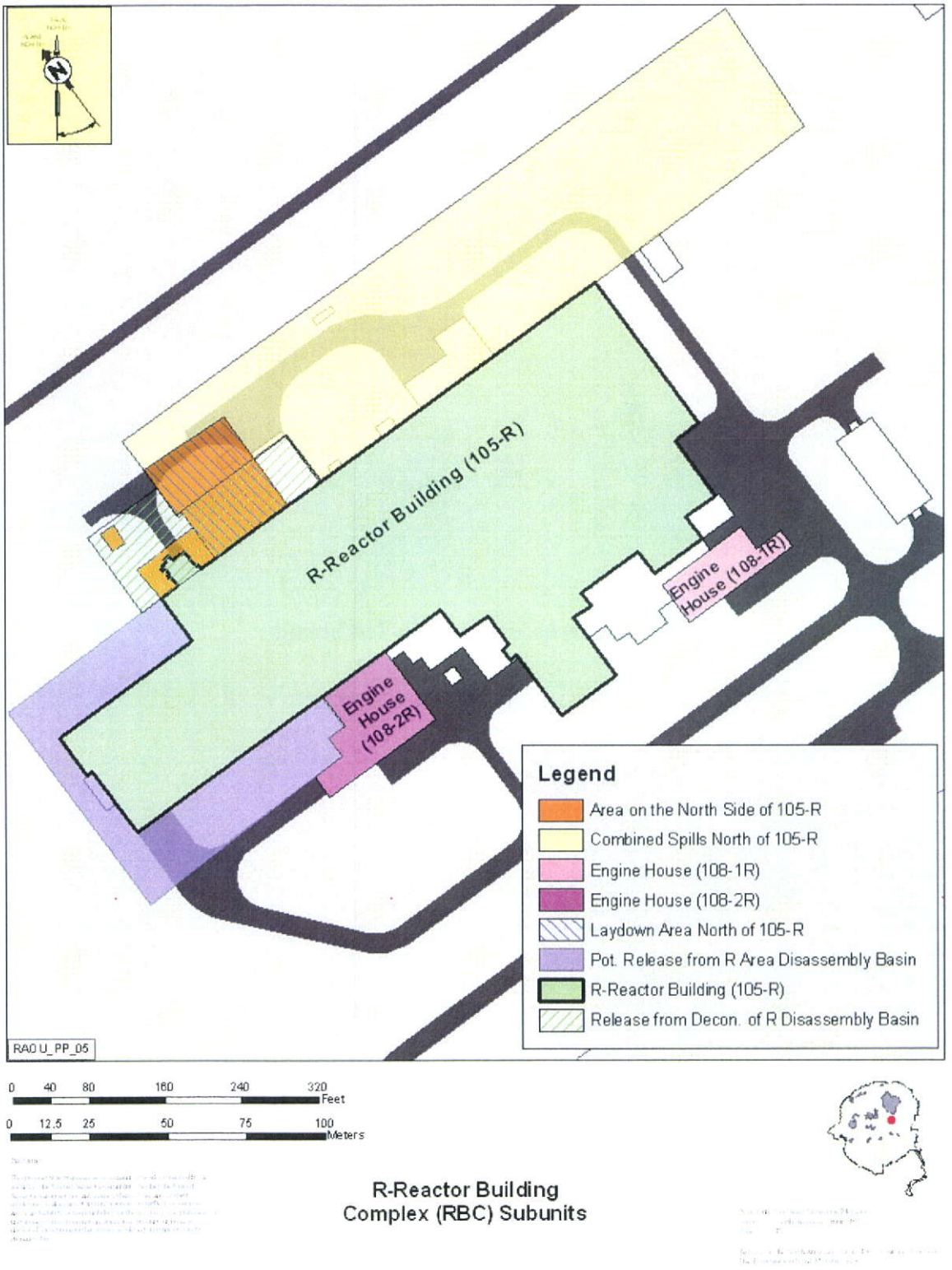

Figure 5. RAOU R-Reactor Building (105-R) Complex (RBC)

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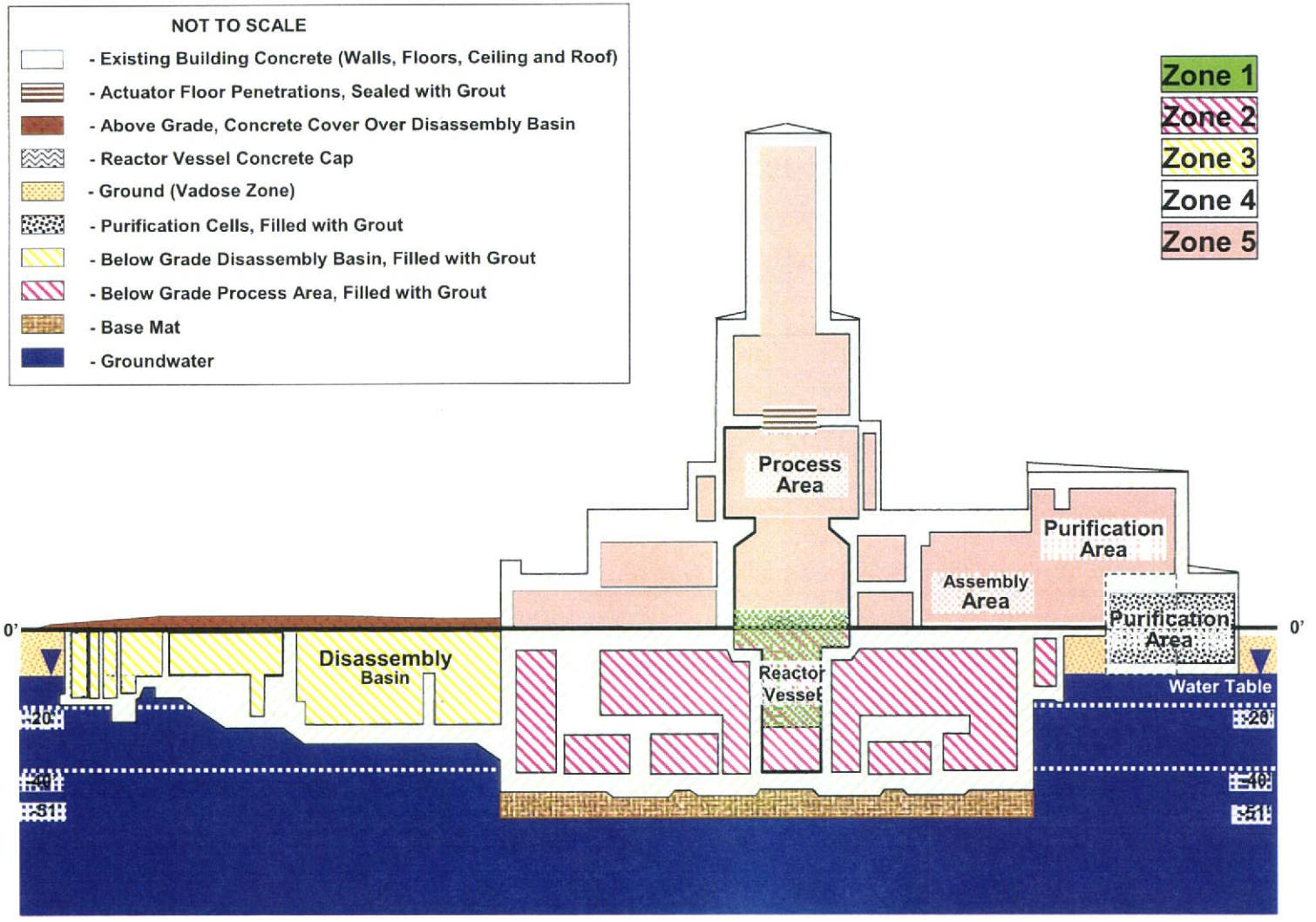

Figure 6. General Representation of the R-Reactor Building (105-R) depicting ISD with Reactor Vessel Grouted in Place

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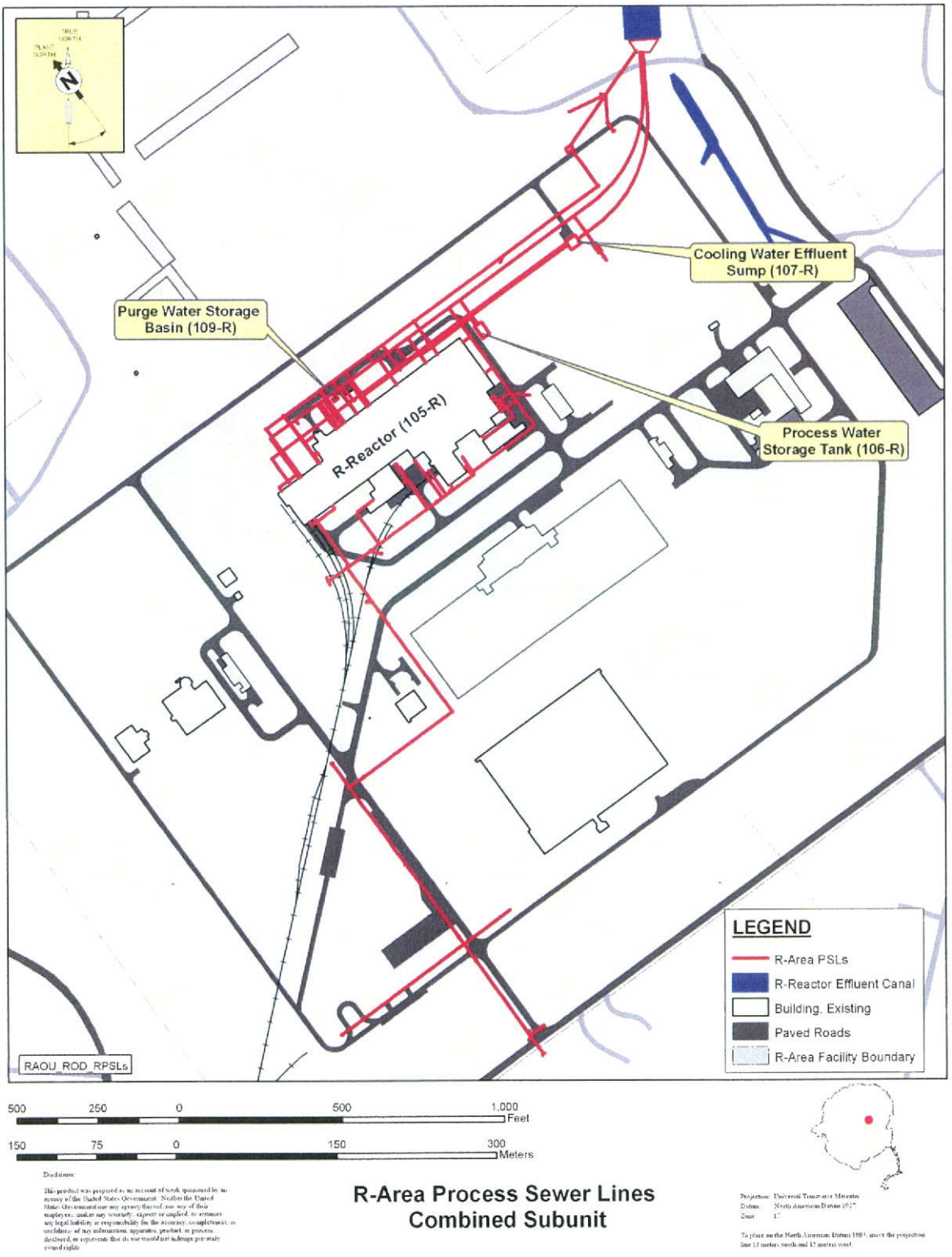

Figure 7. R-Area Process Sewer Lines Combined Subunit

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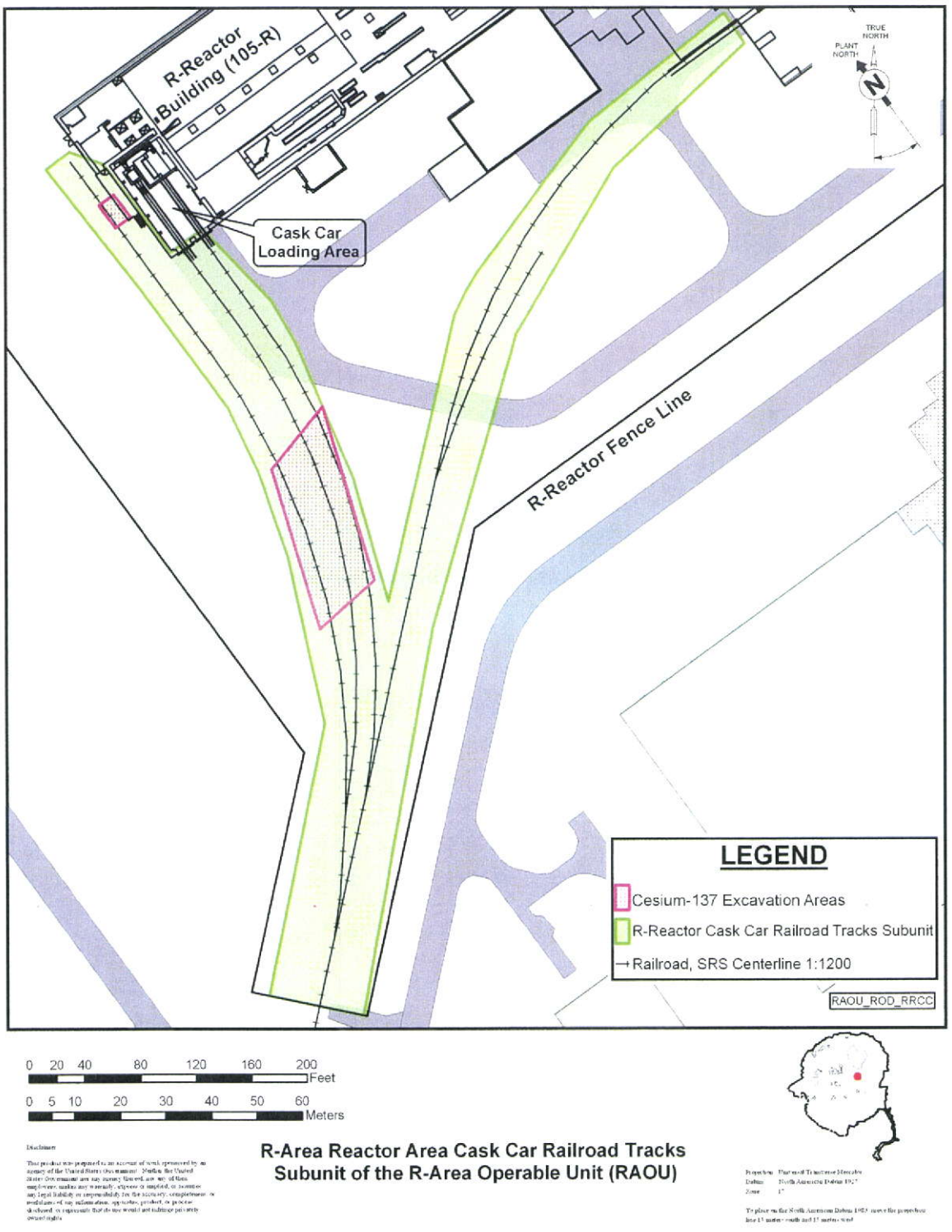

Figure 8. R-Area Reactor Area Cask Car Railroad Tracks Subunit

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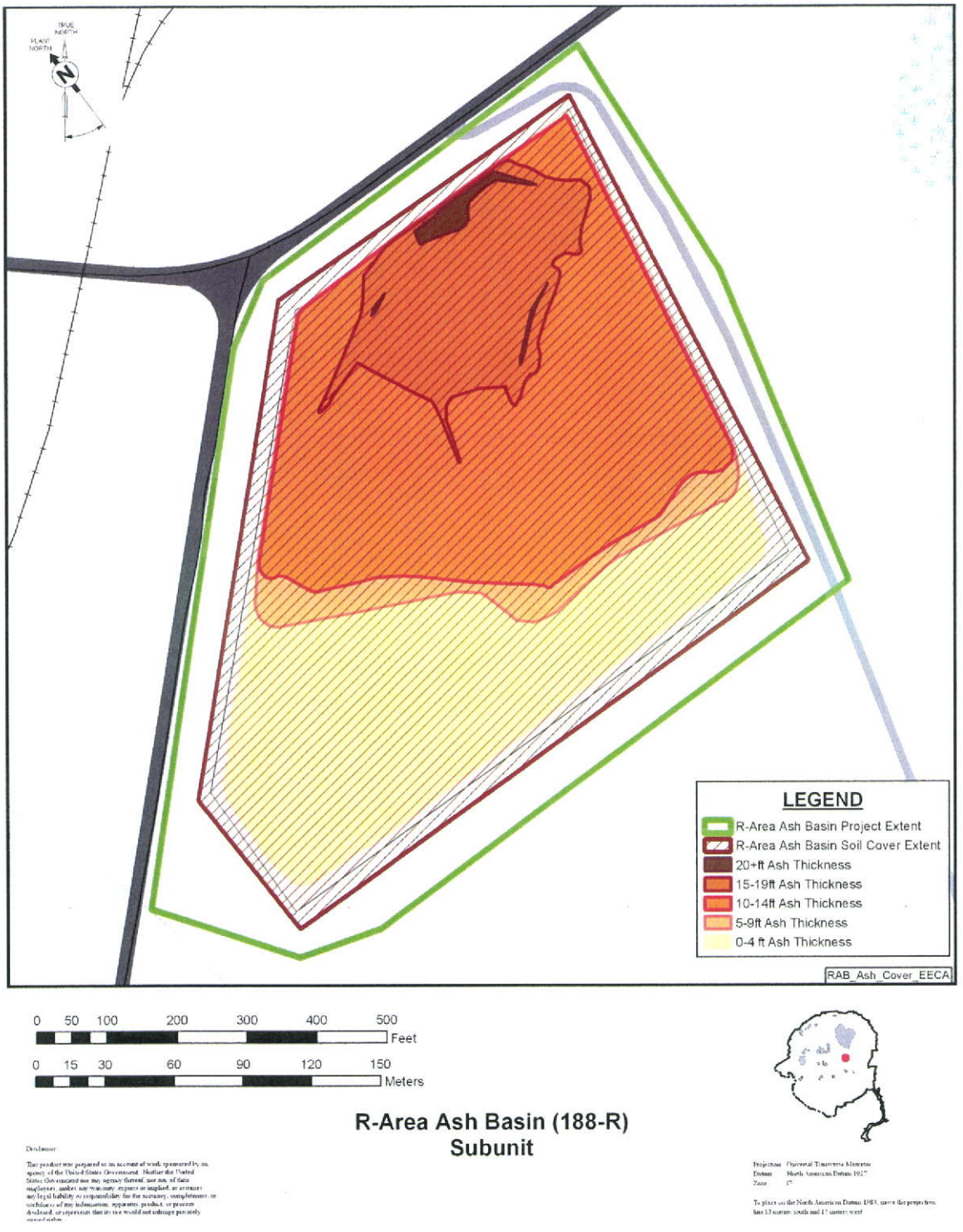

Figure 9. R-Area Ash Basin (188-R) Subunit

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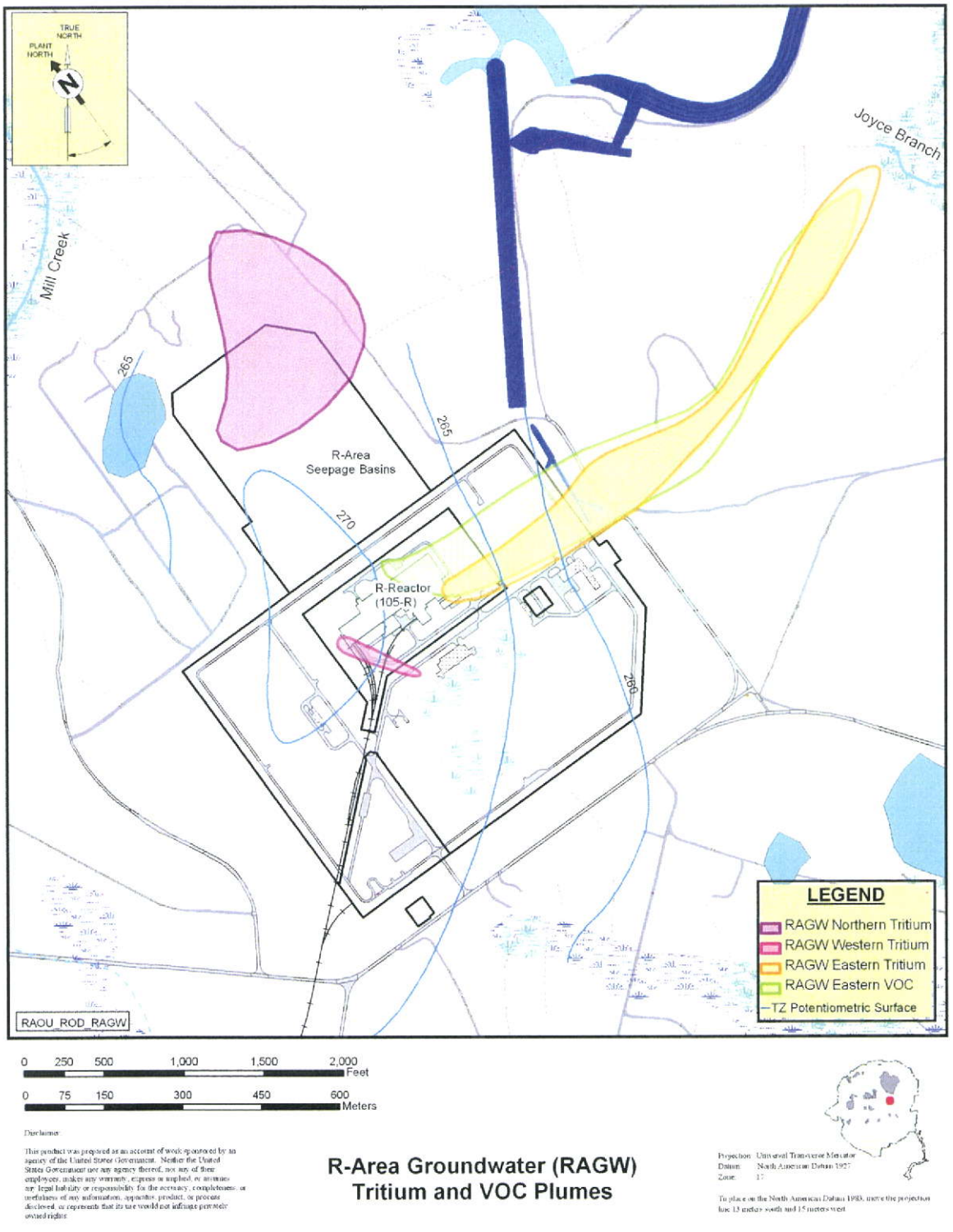

Figure 10. RAOU R-Area Groundwater (RAGW) Subunit

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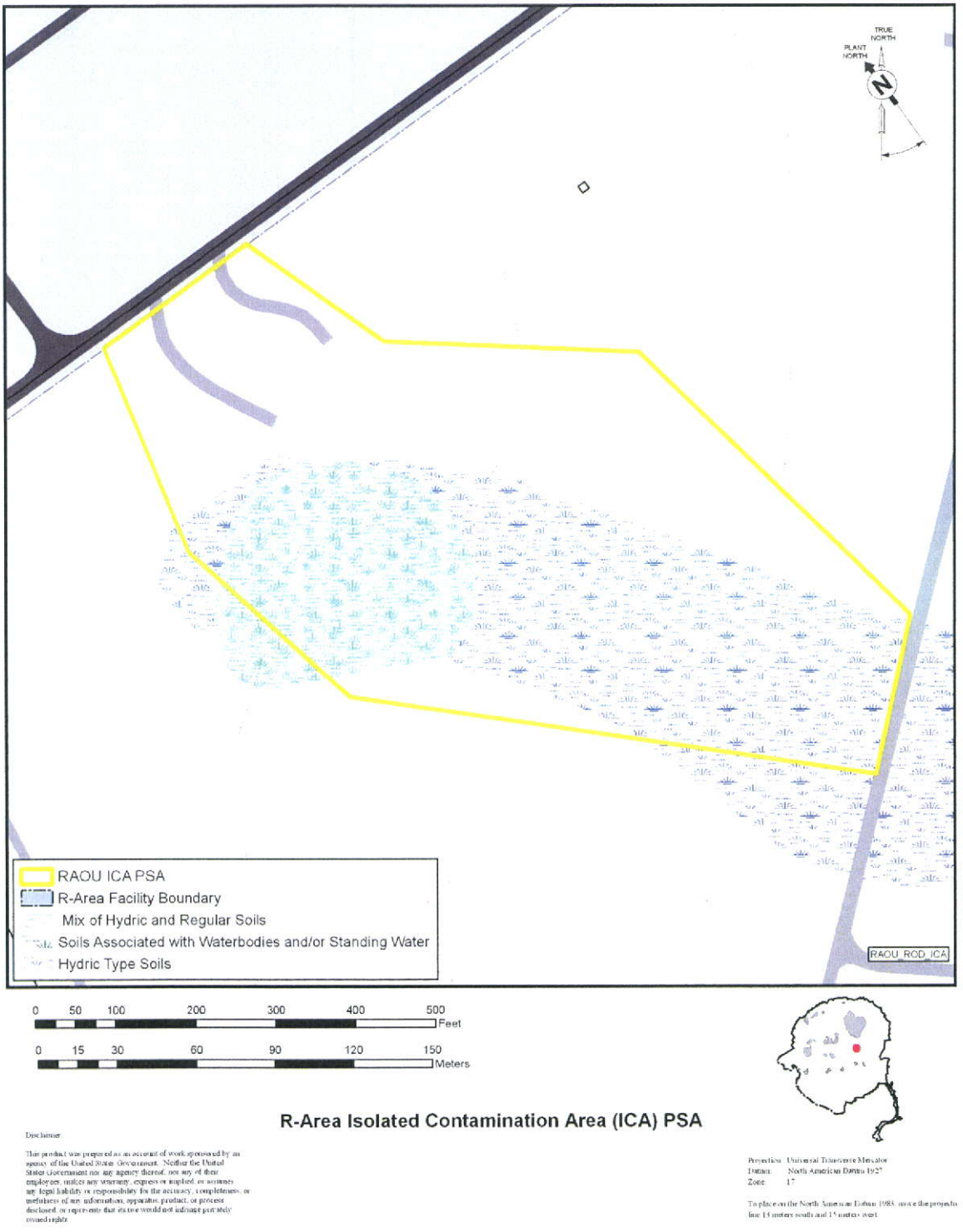

Figure 11. RAOU R-Area Isolated Contamination Area (ICA) PSA

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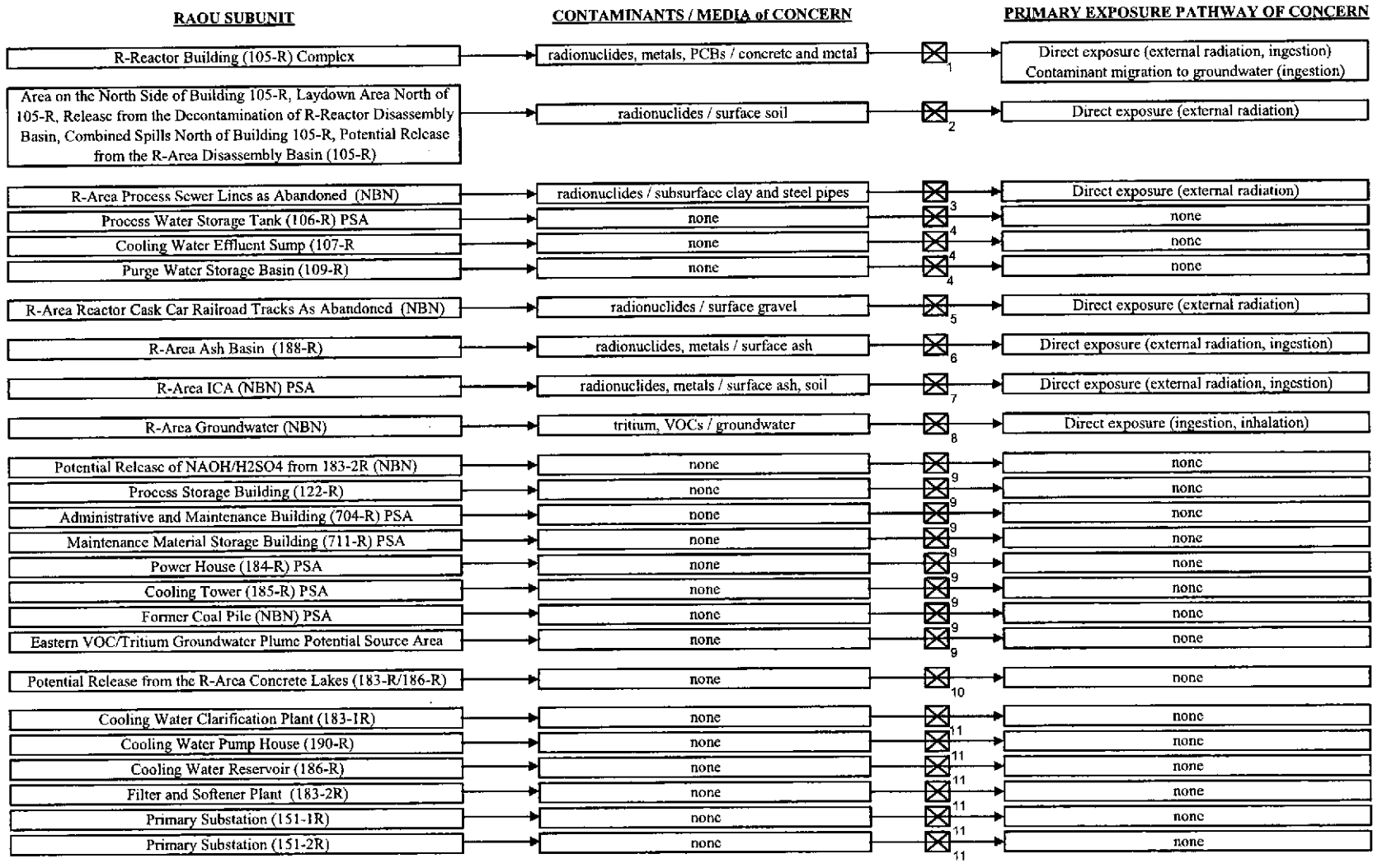

Figure 12. Generic Conceptual Site Model After Completion of Final Remedial Actions for the RAOU

LEGEND	
→ Complete exposure pathway.	→⊠ Incomplete exposure pathway due to final remedial action.
1 - In Situ Decommissioning with Reactor Vessel grouted in place (SRNS 2009d); RAOU Land Use Controls after completion of removal action .	7 - RAOU Land Use Controls.
2 - Concrete Cover (SRNS 2009d), RAOU Land Use Controls after completion of removal action.	8 - Monitored Natural Attenuation, R-Area Land Use Controls.
3 - Isolation, Plugging of RPSLs and Drainage System; Grouting of Manholes, Diversion Boxes, and Process Tanks; Select Removal of Process Equipment External to the Reactor Building; Sealing/ Plugging of Outfalls (SRNS 2009f), RAOU Land Use Controls after completion of removal action.	9 - No COCs based on an industrial land use scenario; RAOU Land Use Controls needed to prevent unrestricted land use.
4 - No COCs identified for these individual waste units- however they have been combined with the RPSLs because they are interconnected and have similar process histories (SRNS 2009f). RAOU Land Use Controls after completion of removal action.	10 - No COCs per evaluation performed in the Site Evaluation Program (FFA Appendix G.2). No Further Action (unrestricted land use).
5 - Excavate, Remove and Cover (SRNS 2009b), RAOU Land Use Controls after completion of removal action.	11 - No COCs per evaluation performed in the D&D Program (FFA Appendix K.2). No Further Action (unrestricted land use).
6 - Soil Cover (SRNS 2009e), RAOU Land Use Controls after completion of removal action.	

Figure 12. Generic Conceptual Site Model After Completion of Final Remedial Actions for the RAOU (Continued)

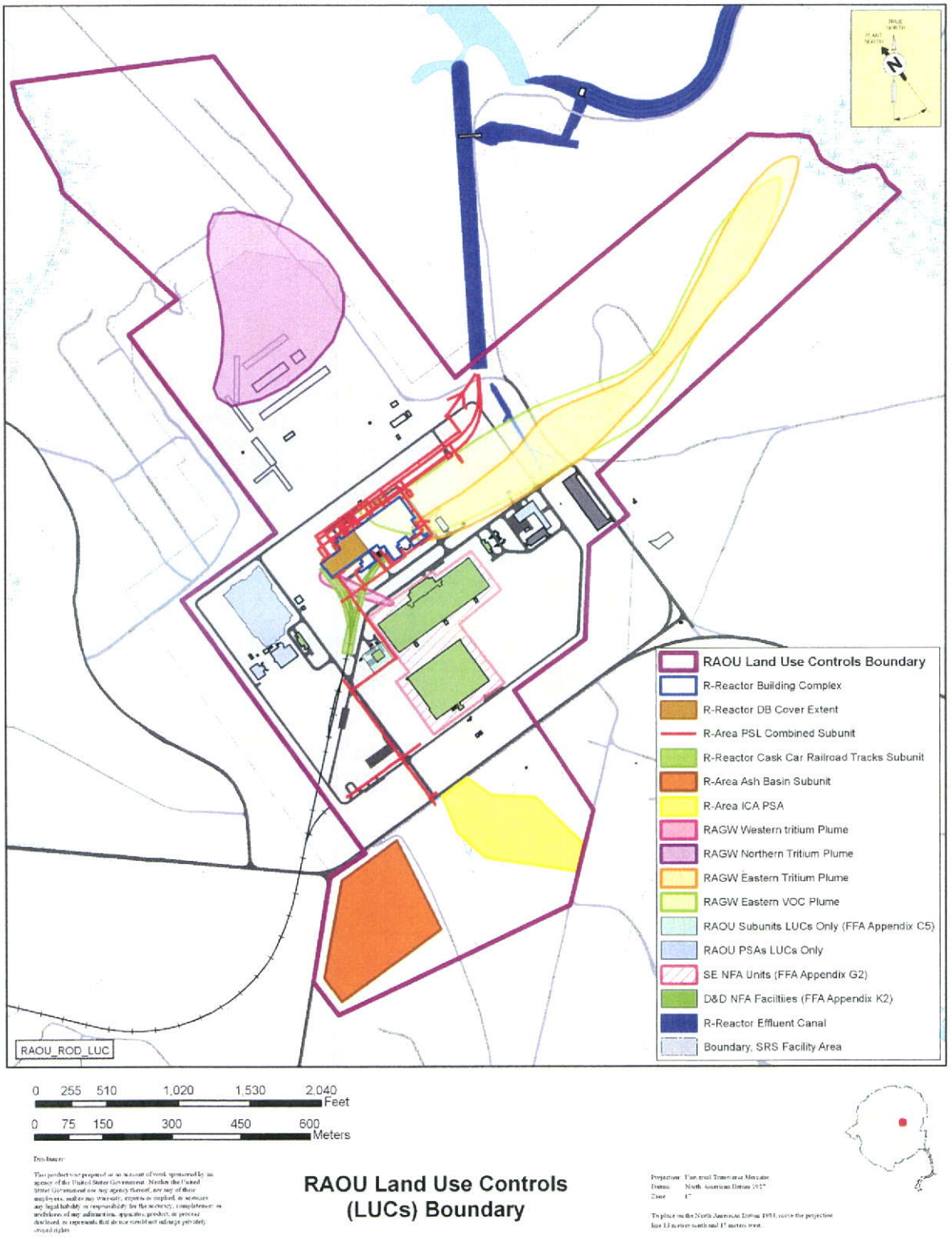

Figure 13. Land Use Control Boundary for the R-Area Operable Unit

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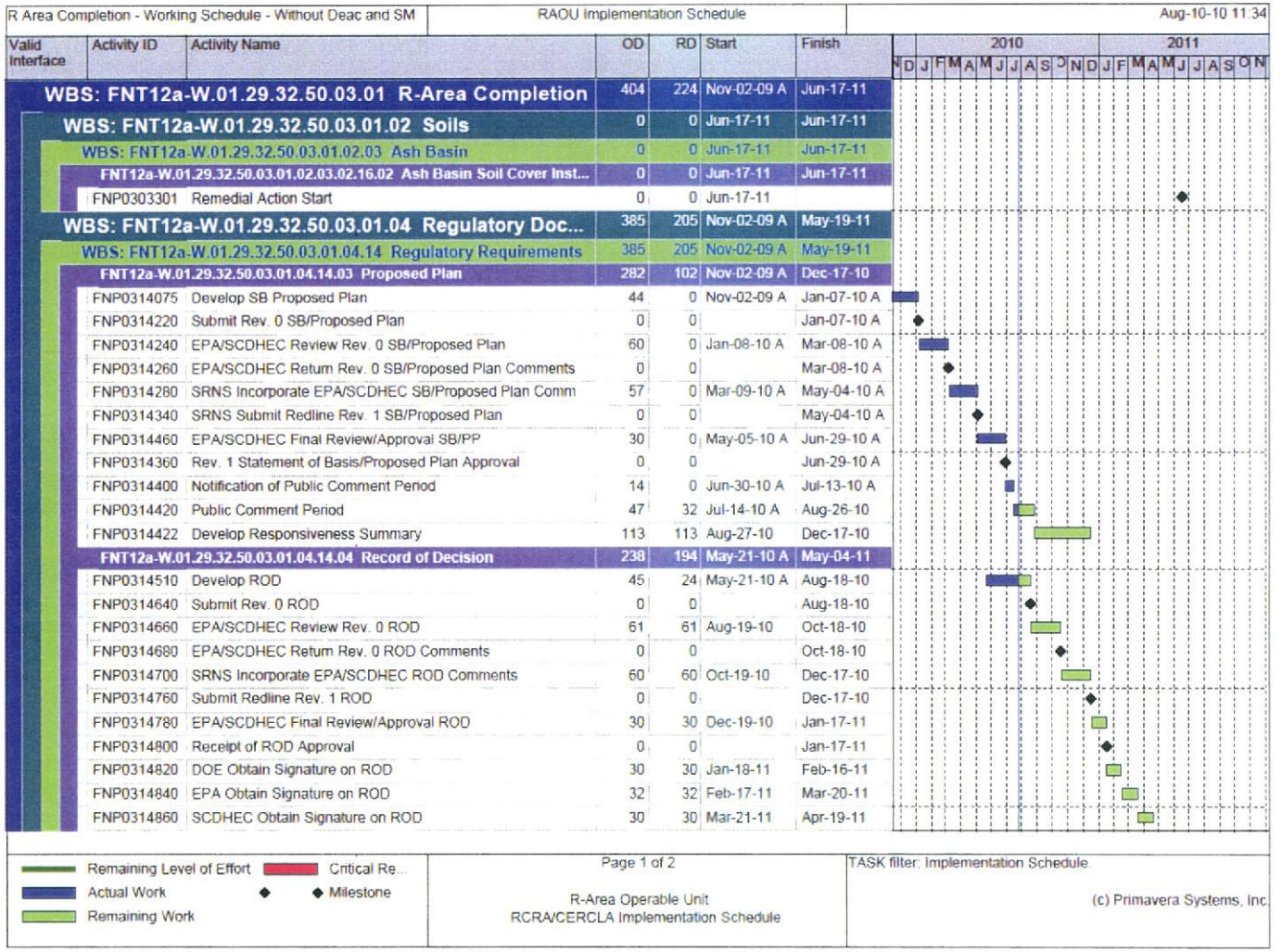
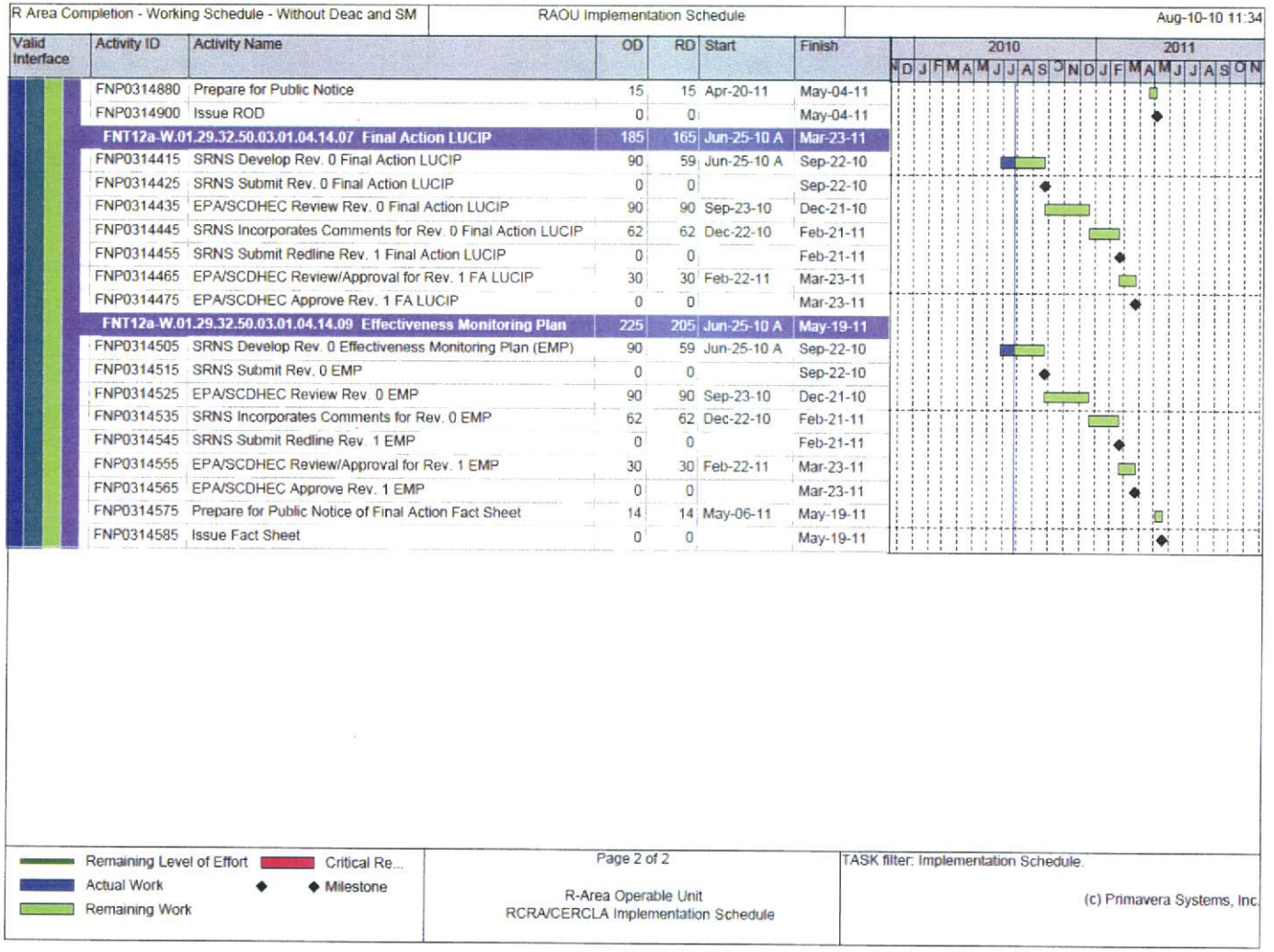


Figure 14. Post-ROD Schedule



R Area Completion - Working Schedule - Without Deac and SM | RAOU Implementation Schedule | Aug-10-10 11:34

Valid Interface	Activity ID	Activity Name	OD	RD	Start	Finish
	FNP0314880	Prepare for Public Notice	15	15	Apr-20-11	May-04-11
	FNP0314900	Issue ROD	0	0		May-04-11
	FNT12a-W.01.29.32.50.03.01.04.14.07	Final Action LUCIP	185	165	Jun-25-10 A	Mar-23-11
	FNP0314415	SRNS Develop Rev. 0 Final Action LUCIP	90	59	Jun-25-10 A	Sep-22-10
	FNP0314425	SRNS Submit Rev. 0 Final Action LUCIP	0	0		Sep-22-10
	FNP0314435	EPA/SCDHEC Review Rev. 0 Final Action LUCIP	90	90	Sep-23-10	Dec-21-10
	FNP0314445	SRNS Incorporates Comments for Rev. 0 Final Action LUCIP	62	62	Dec-22-10	Feb-21-11
	FNP0314455	SRNS Submit Redline Rev. 1 Final Action LUCIP	0	0		Feb-21-11
	FNP0314465	EPA/SCDHEC Review/Approval for Rev. 1 FA LUCIP	30	30	Feb-22-11	Mar-23-11
	FNP0314475	EPA/SCDHEC Approve Rev. 1 FA LUCIP	0	0		Mar-23-11
	FNT12a-W.01.29.32.50.03.01.04.14.09	Effectiveness Monitoring Plan	225	205	Jun-25-10 A	May-19-11
	FNP0314505	SRNS Develop Rev. 0 Effectiveness Monitoring Plan (EMP)	90	59	Jun-25-10 A	Sep-22-10
	FNP0314515	SRNS Submit Rev. 0 EMP	0	0		Sep-22-10
	FNP0314525	EPA/SCDHEC Review Rev. 0 EMP	90	90	Sep-23-10	Dec-21-10
	FNP0314535	SRNS Incorporates Comments for Rev. 0 EMP	62	62	Dec-22-10	Feb-21-11
	FNP0314545	SRNS Submit Redline Rev. 1 EMP	0	0		Feb-21-11
	FNP0314555	EPA/SCDHEC Review/Approval for Rev. 1 EMP	30	30	Feb-22-11	Mar-23-11
	FNP0314565	EPA/SCDHEC Approve Rev. 1 EMP	0	0		Mar-23-11
	FNP0314575	Prepare for Public Notice of Final Action Fact Sheet	14	14	May-06-11	May-19-11
	FNP0314585	Issue Fact Sheet	0	0		May-19-11

Figure 14. Post-ROD Schedule (continued)

Table 1. List and Status of Subunits at the RAOU

FFA Appendix	Combined Subunit Name	RAOU Subunit or PSA Name	Removal Action	Reference Documents	Final Selected Remedy
C.5 Area OU	R-Reactor Building (105-R) Complex	R-Reactor Building (105-R) and Engine Houses (108-1R and 108-2R) Subunits	Dewater Disassembly Basin (DB); Grout Below-Grade areas; Grout Reactor Vessel in place with intruder barrier; Remove Above-Grade DB to slit trenches; Concrete Cover for DB and contaminated soil; Prevent Rain Infiltration; and Prevent Intruders.	RSER/EE/CA for the R-Reactor Disassembly Basin (DOE/EE/CA-0001); EAROD Remedial Alternative Selection for the C-, K-, L-, and R-Reactor Complexes(SRNS-RP-2009-00707); RSER/EE/CA for the R-Reactor Building (105-R) Complex (SRNS-RP-2009-00801).	RAOU LUCs
C.5 Area OU		Area on the North Side of Building 105-R, Laydown Area North of 105-R, Release from the Decontamination of R-Area Reactor Disassembly Basin Subunits			
C.5 Area OU		Combined Spills North of Building 105-R Subunit			
C.5 Area OU		Potential Release from the R-Area Disassembly Basin (105-R) Subunit			
C.5 Area OU	RPSL Combined Subunit	R-Area Process Sewer Lines as Abandoned (NBN) Subunit	Isolation Plugging of R-Reactor RPSLs and Drainage System; Grouting of Manholes, Diversion Boxes, and Tanks; Plug Outfalls; and LUCs.	RSER/EE/CA for the R-Area Process Sewer Lines (SRNS-RP-2009-01341)	RAOU LUCs
Other PSA		Process Water Storage Tank (106-R) PSA			
C.5 Area OU		Cooling Water Effluent Sump (107-R) Subunit			
C.5 Area OU		Purge Water Storage Basin (109-R) Subunit			
C.5 Area OU	NA	R-Area Reactor Area Cask Car Railroad Tracks as Abandoned (NBN) Subunit	Removal & disposal Cesium-137 (+D) (>10pCi/g); and LUCs.	RSER/EE/CA for the R-Area Reactor Area Cask Car Railroad Tracks (SRNS-RP-2008-4090)	RAOU LUCs
C.5 Area OU	NA	R-Area Ash Basin (188-R) Subunit	Vegetation Removal; Soil Cover; LUCs	RSER/EE/CA for the R-Area Ash Basin (SRNS-RP-2009-01064)	RAOU LUCs
C.5 Area OU	NA	R-Area Groundwater (NBN) Subunit	None	RAOU RFI / RI / BRA / CMS / FS (SRNS-RP-2008-4035)	RAOU LUCs and MNA
Other PSA	NA	R-Area Isolated Contamination Area PSA	None	RAOU RFI / RI / BRA / CMS / FS (SRNS-RP-2008-4035)	RAOU LUCs (Prevent Industrial Land Use)
C.5 Area OU	NA	Process Storage Building (122-R) Subunit	None	RAOU RFI / RI / BRA / CMS / FS (SRNS-RP-2008-4035)	RAOU LUCs
C.5 Area OU	NA	Potential Release of NaOH/H2SO4 from 183-2R Subunit	None	RAOU RFI / RI / BRA / CMS / FS (SRNS-RP-2008-4035)	RAOU LUCs
Other PSA	NA	Power House (184-R) PSA	None	RAOU RFI / RI / BRA / CMS / FS (SRNS-RP-2008-4035)	RAOU LUCs
Other PSA	NA	Cooling Tower (185-R) PSA	None	RAOU RFI / RI / BRA / CMS / FS (SRNS-RP-2008-4035)	RAOU LUCs
Other PSA	NA	Former Coal Pile (NBN) PSA	None	RAOU RFI / RI / BRA / CMS / FS (SRNS-RP-2008-4035)	RAOU LUCs
Other PSA	NA	Administrative and Maintenance Building (704-R) PSA	None	RAOU RFI / RI / BRA / CMS / FS (SRNS-RP-2008-4035)	RAOU LUCs
Other PSA	NA	Maintenance Material Storage Building (711-R) PSA	None	RAOU RFI / RI / BRA / CMS / FS (SRNS-RP-2008-4035)	RAOU LUCs
Other PSA	NA	Eastern VOC/Tritium Groundwater Plume PSA	None	RAOU RFI / RI / BRA / CMS / FS (SRNS-RP-2008-4035)	RAOU LUCs

Table 1. List and Status of Subunits at the RAOU (Continued)

FFA Appendix	Combined Subunit Name	D&D Facility or SE Area Name	Removal Action	Reference Documents	Final Selected Remedy
K.2 D&D NFA	NA	Primary Substation 151-1R	No Further Action	V-PCOR-R-00016	Not Applicable
K.2 D&D NFA	NA	Primary Substation 151-2R	No Further Action	V-PCOR-R-00010	Not Applicable
K.2 D&D NFA	NA	Cooling Water Clarification Plant (183-1R)	No Further Action	V-PCOR-R-00001	Not Applicable
K.2 D&D NFA	NA	Filter and Softener Plant (183-2R)	No Further Action	V-PCOR-R-00004	Not Applicable
K.2 D&D NFA	NA	Cooling Water Reservoir (186-R)	No Further Action	V-PCOR-R-00007	Not Applicable
K.2 D&D NFA	NA	Cooling Water Pump House (190-R)	No Further Action	V-PCOR-R-00008	Not Applicable
G.2 SE NFA	NA	Potential Release from the R-Area Concrete Lakes (183-1R/186-R)	No Further Action	WSRC-RP-94-967	Not Applicable

Table 2. Summary of Risk Assessment Results (SRNS 2008b)

Subunit	RAOU Subunit or PSA		Human Health	Eco	PTSM	CM
R-Reactor Building Complex (RBC)	R Reactor Building (105-R) and Engine Houses (108-1R and 108-2R) Subunits		Ground Level: arsenic, aroclor 1254, americium-243 (+D), cesium-137 (+D), and strontium-90 (+D). **CR = 1.7E-02** Minus 20 Level: americium-243 (+D), cesium-137 (+D), and cobalt-60. **CR = 8.2E-05** Minus 40 Level: americium-241 (+D), aroclor 1254, cesium-137 (+D), cobalt-60, and strontium-90 (+D). **CR = 1.4E-02**	NA	cesium-137 (+D) and cobalt-60. **CR = 2.9E-02**	Aroclors and lead.
	R-Reactor Building Components	R-Area Disassembly Basin	cesium-137 (+D), cobalt-60, europium-154, and tritium. ****CR = 1.1E+00**	NA	cesium-137 (+D), cobalt-60, europium-154, and tritium. **CR = 1.1E+00**	None
		R-Reactor Emergency Basin	None	NA	None	iodine-129
		R-Reactor Vessel	barium-133, cesium-137, cobalt-60, europium-152, nickel-63, niobium-94, and silver-108m ****CR = 5.5E+01**	NA	barium-133, cesium-137, cobalt-60, europium-152, nickel-63, niobium-94, and silver-108m **CR = 5.5E+01**	carbon-14, chlorine-36, potassium-40, niobium-94, nickel-59, molybdenum-93, silver-108m, and lead.
	Area on the North Side of Building 105-R, Laydown Area North of 105-R, and Combined Spills North of Building 105-R (NBN), and Release from the Decontamination of R- Area Reactor Disassembly Basin (NBN), and Potential Release from the R-Area Disassembly Basin Subunits		cesium-137 (+D), **CR = 9.6E-05**	NA	NA	None
R-Area Process Sewer Lines Combined Subunit	R-Area Process Sewer Lines as Abandoned (NBN) Subunit		***Radiological Constituents	NA	***Radiological Constituents	None
	Process Water Storage Tank (106-R) PSA		None	NA	None	None
	Cooling Water Effluent Sump (107-R) Subunit		None	NA	None	None
	Purge Water Storage Basin (109-R) Subunit		None	NA	None	None

Table 2. Summary of Risk Assessment Results (SRNS 2008b) (Continued)

Subunit	RAOU Subunit or PSA	Human Health	Eco	PTSM	CM
NA	R-Area Reactor Area Cask Car Railroad Tracks as Abandoned (NBN) Subunit	cesium-137 (+D), uranium-235 (+D) **CR = 1.3E-01**	NA	cesium-137(+D) **CR = 1.3E-01**	None
NA	R-Area Ash Basin (188-R) Subunit	arsenic, potassium-40, radium-226 (+D), uranium-235 (+D), uranium-238 (+D) **CR = 3.8E-04**	None	None	None
NA	R-Area Reactor Groundwater Subunit	*TCE + degradation products, carbon tetrachloride + degradation products, and tritium	NA	NA	NA
NA	Potential Release of NaOH/H2SO4 from 183-2R (NBN) Subunit	None	NA	None	None
NA	Process Storage Building (122-R) Subunit	None	NA	None	None
NA	R-Area Isolated Contamination Area PSA	arsenic, potassium-40, radium-226 (+D), cobalt-60, and cesium-137 (+D) **CR = 8.1E-04**	None	None	None
NA	Administrative and Maintenance Building (704-R) PSA	None	NA	None	None
NA	Maintenance Material Storage Building (711-R) PSA	None	NA	None	None
NA	Power House (184-R) PSA	None	NA	None	None
NA	Cooling Tower (185-R) PSA	None	NA	None	None
NA	Former Coal Pile PSA	None	NA	None	None
NA	Eastern VOC/tritium Groundwater Plume PSA	None	NA	None	NA

FOOTNOTES:

* These are based on ARARs (MCLs/MCLG) rather than a HHRA evaluation. Only the constituents forming plumes are listed in Table 2.

** The HHRA and PTSM discussions identify several radiological and hazardous constituents as HH RCOCs or PTSM, but only the major risk drivers for the individual subunits are presented in this table.

*** Radiological constituents are qualitatively identified as HH and PTSM RCOCs based on process history and the potential for fixed residual contamination on the inside surfaces of the R-Area Process Sewer Lines as Abandoned (NBN).

NA = Not Applicable;
CR = Cumulative Risk.

Table 3. List of ARARs for the Selected Remedy at R-Area Operable Unit

Chemical-Specific			
Citation	**Status**	**Requirement Summary**	**Reason for Inclusion**
National Primary Drinking Water Regulations 40 CFR 141 SC R.61-58 State Primary Drinking Water Regulations o 40 CFR 141.16 Maximum contaminant levels for beta particle and photon radioactivity from man-made radionuclides in community water systems. o 40 CFR 141.66 Maximum contaminant levels for radionuclides. o SCDHEC R.61.58.5(H)(4) Maximum contaminant levels for beta particle and photon radioactivity o 40 CFR 141.53 Maximum contaminant level goals for disinfection byproducts o 40 CFR 141.61 Maximum contaminant levels for organic contaminants o SCDHEC R.61.58, Section 5 (N) Maximum Contaminant Levels for Volatile Synthetic Organic Chemicals	Applicable	MCLs established the highest level of a contaminant that is allowed in drinking water. Tritium=20,000 pCi/L (or 20 pCi/mL) Chloroform=0.07 mg/L (or 70 ug/mL) Vinyl chloride=0.002 mg/L (or 2ug/L) Carbon tetrachloride=0.005 mg/L (or 5 ug/L) cis-1,2-Dichloroethylene=0.07 mg/L (or 70 ug/mL) Trichloroethylene=0.005 mg/L (or 5 ug/L)	The state of South Carolina classifies all groundwater as potential sources of drinking water and mandates that groundwater meet MCLs established by the Safe Drinking water Act.
SC R. 61-68 Water Classification and Standards	Applicable	Establishes SC official classified water uses for all waters of the State, general rules and specific numeric and narrative criteria for protecting classified and existing water uses	This regulation classifies all groundwater in the state as a potential source of drinking water and mandates that groundwater meet MCLs

Table 3. List of ARARs for the R-Area Operable Unit (continued).

Chemical-Specific (Continued)			
Citation	**Status**	**Requirement Summary**	**Reason for Inclusion**
Radiation Protection of the Public and the Environment DOE Order 5400.5	To Be Considered	Establishes standards and requirements for operation of the USDOE and USDOE contractors with respect to protection of members of the public and the environment against undue risk from radiation.	R-Reactor facilities, R-Area PSL Combined Subunit, and R-Area ICA PSA contain radioactive contamination and radioactive material. As such, the requirements of the Order must be followed.
USEPA Office of Solid Waste and Emergency Response (OSWER) Directive 9200.4-18	To Be Considered	Cleanups of radioactive contamination outside the risk range (in general, exceeding 15 mrem/yr effective dose equivalent which equates to approximately 3E-04 increased lifetime risk) are not protective.	USEPA policy establishes protective range for radionuclide cleanups at CERCLA sites. Mandates use of CERCLA risk range rather than dose limits established under other regulations.
Action-Specific			
Citation	**Status**	**Requirement Summary**	**Reason for Inclusion**
SC R.61-107 Solid Waste Management Subarticle 19, Part IV (F)(1)(a)-(d) & Subarticle 19, Part IV (F)(2)(a)(1)	Relevant and Appropriate	A 2-ft thick final earth cover is required with a 3-5% slope, graded to promote positive drainage. Side slope not to exceed a 3:1 slope. Testing of cap closure by a SC certified professional engineer. Stormwater conveyance system designed to handle a 24-hr, 25-yr storm event. The finished surface to be seeded with suitable ground cover. Maintain 76% or greater vegetative ground cover.	Long-term maintenance of the R-Area Ash Basin earthen cover must be in compliance with South Carolina regulations.
SC R.61-71.H Monitoring Well Standards	Applicable	All wells shall be drilled, constructed, and abandoned by a South Carolina certified well driller per 40-23-10 et seq. All monitoring wells shall be drilled, constructed, maintained, operated, and/or abandoned to ensure that underground sources of drinking water are not contaminated. Specific grouting and casing requirements are established for permanently installed monitoring wells. Wells shall be labeled for identification.	Selected remedy includes Monitoring Natural Attenuation (MNA). This involves long-term ground water monitoring using monitoring wells installed, managed, and abandoned in accordance with the stated regulation.

Table 3. List of ARARs for the R-Area Operable Unit (continued).

Action-Specific (Continued)			
Citation	**Status**	**Requirement Summary**	**Reason for Inclusion**
SC R.61-79 Section 261.4(d) Transportation of samples	Applicable	Samples are not subject to any requirements of 40 CFR Parts 261 through 268 or 270 when: • The sample is being transported to a laboratory for the purpose of testing; or • The sample is being transported back to the sample collector after testing. In order to qualify for the exemption in paragraphs (d)(1)(i) and (ii), a sample collector shipping samples to a laboratory must: • Comply with U.S. DOT, U.S. Postal Service, or any other applicable shipping requirements • Assure that the information provided in (1) thru (5) of this section accompanies the sample. • Package the sample so that it does not leak, spill, or vaporize from its packaging.	Water samples for purpose of conducting testing to determine its characteristics or composition will occur as part of the groundwater monitoring program.

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Table 4. Alternative RAOU-1 - Detailed Cost Estimate – No Action

Alternative RAOU-1 - R-Area Operable Unit
No Action
R-Area OU
Savannah River Site

Item	Quantity	Units	Unit Cost	Total Cost	
Direct Capital Costs					
No Action					
Subtotal - Direct Capital Cost				$0	*
Mobilization/Demobilization	20%	of subtotal direct capital		$0	*
Site Preparation/Site Restoration	20%	of subtotal direct capital		$0	*
Total Direct Capital Cost		(sum of * items)		**$0**	
Indirect Capital Costs					
Engineering & Design	18%	of direct capital		$0	
Project/Construction Management	25%	of direct capital		$0	
Health & Safety	5%	of direct capital		$0	
Overhead	30%	of direct capital		$0	
Contingency	20%	of direct capital		$0	
Total Indirect Capital Cost				**$0**	
Total Estimated Capital Cost				**$0**	
Direct O&M Costs	2.7%	discount rate for costs > 200 years duration[1]			
Annual Costs	200	years O&M		*Years 2010 - 2209*	
Subtotal - Annual Costs				$0	
Present Worth Annual Costs (2.7% Discount Rate)				$0	
Five Year Costs	0				
Remedy Review	0	ea	$15,000	$0	
Subtotal - Five Year O&M Costs				$0	
Present Worth Five Year Costs				$0	
Total Present Worth Direct O&M Cost				**$0**	
Indirect O&M Costs					
Project/Admin Management	100%	of direct O&M		$0	
Health & Safety	30%	of direct O&M		$0	
Overhead	30%	of direct O&M		$0	
Contingency	15%	of direct O&M		$0	
Total Present Worth Indirect O&M Cost				**$0**	
Total Estimated Present Worth O&M Cost				**$0**	
TOTAL ESTIMATED COST				**$0**	

1. Interest rate for costs with duration < 200 years (i.e., before 2209) is based on SRNS's 25 August 2009 Technical Memorandum.

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Table 5. Alternative RAOU-2 - Detailed Cost Estimate – Land Use Controls

Alternative RAOU-2 - R-Area Operable Unit
LUCs and MNA
R-Area OU
Savannah River Site

Item	Quantity	Units	Unit Cost	Total Cost	
Direct Capital Costs					
Land Use Controls					
Posting of Warning Signs	200	ea	$50	$10,000	
Land Use Control Implementation Plan	1	ea	$10,000	$10,000	
Deed Restrictions	1	ea	$5,000	$5,000	
Effectiveness Monitoring Plan	1	ea	$20,000	$20,000	
Subtotal - Direct Capital Cost				$45,000	*
Mobilization/Demobilization	20%	of subtotal direct capital		$9,000	*
Site Preparation/Site Restoration	20%	of subtotal direct capital		$9,000	*
Total Direct Capital Cost		(sum of * items)		**$63,000**	
Indirect Capital Costs					
Engineering & Design	18%	of direct capital		$11,340	
Project/Construction Management	25%	of direct capital		$15,750	
Health & Safety	5%	of direct capital		$3,150	
Overhead	30%	of direct capital		$18,900	
Contingency	20%	of direct capital		$12,600	
Total Indirect Capital Cost				**$61,740**	
Total Estimated Capital Cost				**$124,740**	
Direct O&M Costs	2.7%	discount rate for costs > 200 years duration[1]			
Annual Costs	200	years O&M		*Years 2010 - 2209*	
Access Controls	1	ea	$500	$500	
Annual Inspections / Maintenance	1	ea	$10,000	$10,000	
Well Monitoring (Annual Sampling & Analysis)	80	ea	$460	$36,800	
Subtotal - Annual Costs				$47,300	
Present Worth Annual Costs (2.7% Discount Rate)				$1,743,352	
Five Year Costs	40				
Monitoring Report	1	ea	$20,000	$20,000	
Remedy Review	1	ea	$15,000	$15,000	
Subtotal - Five Year O&M Costs				$35,000	
Present Worth Five Year Costs				$244,440	
Total Present Worth Direct O&M Cost				**$1,987,792**	
Indirect O&M Costs					
Project/Admin Management	100%	of direct O&M		$1,987,792	
Health & Safety	30%	of direct O&M		$596,338	
Overhead	30%	of direct O&M		$596,338	
Contingency	15%	of direct O&M		$298,169	
Total Present Worth Indirect O&M Cost				**$3,478,637**	
Total Estimated Present Worth O&M Cost				**$5,466,429**	
TOTAL ESTIMATED COST				**$5,591,169**	

1. Interest rate for costs with duration < 200 years (i.e., before 2209) is based on SRNS's 25 August 2009 Technical Memorandum.

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Table 6. Comparative Analysis Summary for the R-Area Operable Unit.

Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	State Acceptance	Cost	Comments
RAOU-1 – No Action	No	No	Very Low	Very Low	Very Low	Very Easy	No	$0	No Action alternative is required by NCP.
RAOU-2 – LUCs, and MNA for the RAGW Subunit.	Yes	Yes	Moderate	Low	Very High	Very Easy	Yes	$5,591,169	Groundwater MNA will be needed after completion of the removal actions, but no active remediation.

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Table 7. Land Use Controls for the R-Area Operable Unit

Type of Control	Purpose of Control	Duration	Implementation	Affected Areas[a]
1. Property Record Notices[b]	Provide notice to anyone searching records about the existence and location of contaminated areas.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Notice recorded by USDOE in accordance with state laws at County Register of Deeds office if the property or any portion thereof is ever transferred to non-federal ownership.	RAOU where hazardous substances are left in place at levels requiring land use restrictions.
2. Property record restrictions[c]: A. Land Use	Restrict use of property by imposing limitations.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Drafted and implemented by USDOE upon any transfer of affected areas. Recorded by USDOE in accordance with state law at County Register of Deeds office.	RAOU where hazardous substances are left in place at levels requiring land use restrictions.
3. Other Notices[d]	Provide notice to city &/or county about the existence and location of waste disposal and residual contamination areas for zoning/ planning purposes.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Notice recorded by USDOE in accordance with state laws at County Register of Deeds office if the property or any portion thereof is ever transferred to non-federal ownership.	RAOU where hazardous substances are left in place at levels requiring land use restrictions.
4. Site Use Program[e]	Provide notice to worker/developer (i.e., permit requestor) on extent of contamination and prohibit or limit excavation/penetration activity.	As long as property remains under USDOE control	Implemented by USDOE and site contractors Initiated by permit request	Subunits at RAOU where remedy components cannot be disturbed and where levels requiring land use and groundwater restrictions.
5. Physical Access Controls[f] (e.g., fences, gates, portals)	Control and restrict access to workers and the public to prevent unauthorized access.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Controls maintained by USDOE.	Security is provided at site boundaries in accordance with SRS procedures.
6. Warning Signs[g]	Provide notice or warning to prevent unauthorized uses.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Signage maintained by USDOE.	Warning signs will be posted in accordance with applicable site procedures and will be placed in appropriate areas of the RAOU.
7. Security Surveillance Measures	Control and monitor access by workers/public.	Until the concentration of hazardous substances associated with the unit have been reduced to levels that allow for unlimited exposure and unrestricted use.	Established and maintained by USDOE Necessity of patrols evaluated upon completion of remedial actions.	Security and surveillance measures are in place at the SRS boundary in accordance with RCRA-permit requirements.

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

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APPENDIX A -
RESPONSIVENESS SUMMARY

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Responsiveness Summary

The 45-day public comment period for the SB/PP for the RAOU began on July 14, 2010 and ended on August 28, 2010. No comments were received from the public.

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