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Savannah River Site

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DIVISION OF SITE
ASSESSMENT & REMEDIATION

Interim Record of Decision
Remedial Alternative Selection for the Remediation of the Trichloroethylene Vadose Zone Source Unit at the C-Reactor Groundwater Operable Unit (U)

<u>CERCLIS Number: 82</u>

WSRC-RP-2004-4022

Revision 1

June 2004

Prepared by:
Westinghouse Savannah River Company LLC
Savannah River Site
Aiken, SC 29808

SRS

Prepared for U.S. Department of Energy under Contract No. DE-AC09-96SR18500

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

INTERIM RECORD OF DECISION
REMEDIAL ALTERNATIVE SELECTION (U)

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Savannah River Operations Office
Aiken, South Carolina

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DECLARATION FOR THE INTERIM RECORD OF DECISION

Unit Name and Location

Trichloroethylene (TCE) Vadose Zone Source Unit at the C-Reactor Groundwater Operable Unit (OU) (CRGW)

Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) Identification Number: 82

Savannah River Site (SRS), Aiken, South Carolina

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

Barnwell County, South Carolina

United States Department of Energy (USDOE)

The purpose of this Interim Record of Decision (IROD) is to select an interim remedy for the remediation of the TCE vadose zone source unit at CRGW. The CRGW is listed as a Resource Conservation and Recovery Act (RCRA) 3004(u) Solid Waste Management Unit (SWMU)/CERCLA unit in Appendix C of the Federal Facility Agreement (FFA) for the SRS. The FFA is a legally binding agreement between regulatory agencies (United States Environmental Protection Agency [USEPA] and South Carolina Department of Health and Environmental Control [SCDHEC]) and regulated entities United States Department of Energy (USDOE) that establishes the responsibilities and schedules for the comprehensive remediation of SRS.

The media associated with this operable unit are soils in the vadose zone, soils in the upper part of the Upper Three Runs aquifer, and groundwater in the Upper Three Runs aquifer. The source unit, which is the subject of the interim remedial action being selected in this document, consists only of contaminated soil in the vadose zone above the groundwater portion of the CRGW OU. A decision on action to remediate contamination within the groundwater portion of this OU is not being made at this time; that contamination will be addressed in the final CRGW Record of Decision.

Statement of Basis and Purpose

This decision document presents the selected interim remedy for the TCE vadose zone source at CRGW, in C Area at SRS, which was chosen in accordance with CERCLA, as amended by the Superfund Amendments Reauthorization Act (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The decision to use the selected interim remedy is based on the Administrative Record File for this site.

An SRS RCRA permit modification is not required at this time since this is an interim action for the TCE vadose zone source unit at this OU. However the RCRA permit will be revised to reflect selection of the final remedy using the procedures under 40 Code of Federal Regulations (CFR) Part 270, and South Carolina Hazardous Waste Management Regulations (SCHWMR) R.61-79.264.101; 270. The final RCRA permit modification will (1) include the final selection of remedial alternatives under RCRA, (2) be sought for the entire CRGW OU, and (3) include the necessary public involvement and regulatory approvals.

SCDHEC and USEPA concur with the selected interim remedy.

Assessment of the Site

TCE has been released into the environment at CRGW. TCE in the vadose zone source within C Area is currently leaching to the water table aquifer. The interim response action selected in this IROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Description of the Selected Remedy

CRGW includes a source subunit (soil), a groundwater subunit, and a surface water subunit located within the Fourmile Branch watershed. The source area for the TCE is not listed on the FFA as a separate OU but is actually a subunit of CRGW. The proposed interim action for CRGW is not a final action, but has been proposed to minimize the impact of CRGW on the watershed by removing principal threat waste from the source unit. Existing institutional controls that will remain in place for the duration of the interim action include site use-site clearance permits, control of the use of local groundwater, and groundwater monitoring. Job-specific institutional controls will consist of access control to the treatment area via the reactor area's limited access fence. These institutional controls will protect existing facilities and the health and safety of on-site workers and will monitor impact to local groundwater.

The results of the interim action will be reported in an effectiveness monitoring report to document that the shut down criterion for the interim action is satisfied. The effectiveness monitoring report will include temperature-monitoring data, mass removal rate, operating conditions, and data from confirmatory soil samples. Reduction in the TCE concentration will be confirmed with chemical analysis of confirmatory samples from source area soils. Data from the July 2002 source characterization will be included as baseline data.

The TCE vadose zone source comprises approximately 2000 cubic yards of TCE contaminated soil between the surface and the water table at 70 ft below ground surface. The mass of TCE in the vadose zone source is estimated at 288 pounds with a maximum concentration of 51,836 micrograms TCE/kilogram of soil (μg/kg). TCE in the source area is identified as a principal threat source material (PTSM) constituent of concern (COC) because of its mobility (WSRC 2003c) i.e., the ability to migrate from the source area soil to the aquifer in 10years or less. Minor amounts of tetrachloroethylene (PCE) are also present in the source area. Since PCE responds like TCE to thermal remediation and to simplify the discussion in this IROD by eliminating repetition of the phrase "TCE and PCE", PCE is implicitly considered with TCE.

The selected remedy for the TCE vadose zone source unit at CRGW is electrical resistance heating (ERH) with soil vapor extraction (SVE). A single six-phase heating array consisting of six input electrode/SVE wells equally spaced around the circumference of a 30-ft diameter circle and a central neutral electrode/SVE well will be centered on the highest contaminant levels in the TCE source.

The stratigraphy of the vadose zone in the TCE source includes two major fine-grained, low-permeability (clay- and silt-enriched) intervals interbedded with more permeable sand intervals. TCE concentrations are typically higher in the fine-grained intervals, which also have lower resistivity than the sandy strata and so are more amenable to ERH. At least two electrodes will be installed in the vadose zone of each electrode/SVE well to treat the fine-grained intervals; the SVE wells will be installed with screens in the permeable sand intervals above and below each ERH treatment zone. Electrical current passing through the fine-grained intervals between the electrode/SVE wells will heat the rock matrix by electrical resistance and vaporize the TCE and soil moisture. The TCE and water vapor will be extracted by the SVE wells and conveyed to the surface for treatment as necessary to comply with the air quality permit.

Since the interim action will be conducted in the vadose zone, it may be necessary to add electrolyte at each electrode to compensate for drying of the soils in the treatment zone. Based on the 1993 M-Area demonstration (USDOE 1995), 500 milligrams/liter (mg/L) NaCl solution will be added at each electrode at a rate of about 1.5 gal/hour. An injection permit will be obtained from SCDHEC for adding the electrolyte. The temperature of the treatment zone will be monitored with thermocouples. TCE boils at 86.7 degrees centigrade (°C), but the target heating temperature is generally 100°C. Vapor phase TCE is removed by the SVE system for treatment. The literature reports that similar systems typically achieve 100°C in about 10 days with better than 99% TCE removal in 120 days. Based on the performance of similar systems, the CRGW ERH-SVE system will have to operate for less than one year. An interim remedy review will be submitted five years after the system is shut down. The interim remedy review will include the data reported in the effectiveness monitoring report and post-interim action groundwater sampling data.

Savannah River Site Future Use Project Report (USDOE 1996) shows the Citizen's Advisory Board's future land use recommendations for C Area as heavy industrial (nuclear) and the surrounding area, including the CRGW, as industrial (nuclear). Under this future land use scenario, the industrial worker is the only potential human receptor.

Statutory Determinations

Based on the unit RCRA Facility Investigation (RFI)/Remedial Investigation (RI) report, the TCE vadose zone source subunit of the CRGW OU poses a threat to human health and the environment. The Core Team comprised of SCDHEC, USEPA, and USDOE representatives selected ERH-SVE as the interim remedy to permanently remove TCE from the CRGW vadose zone source. The future land use of the CRGW is assumed to be industrial land 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 to ensure that the remedy continues to provide adequate protection of human health and the environment within five years after commencement of the remedial action. Because this is an IROD, review of this OU and of this remedy will be continuing as USDOE continues to develop remedial alternatives for CRGW.

This interim action is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the limited-scope remedial action, and is cost-effective. Although this interim action is not intended to fully address the statutory mandate for permanence and treatment to the maximum extent practicable for the entire CRGW, this interim action utilizes treatment and thus is in furtherance of that statutory mandate. Because this interim action does not constitute the final remedy for the CRGW, the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element, although partially addressed in this remedy, will be addressed by the final response action. Subsequent actions are planned to address fully the threats posed by the conditions at this OU.

Data Certification Checklist

This IROD provides the following information:

- COCs and their respective concentrations (Section V)
- Alternative cleanup levels established for the constituents of concern (COCs) and the basis for the levels (Section VIII)
- Current and reasonably anticipated future land and groundwater use assumptions used in the IROD (Section VI)

- Potential land and groundwater use that will be available at the site as a result of the selected remedy (Section XI)

- 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 XI)

- 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) (Sections IX, X, XI)

- How source materials constituting principal threats are addressed (Section XII)

Authorizing Signatures

8/5/04
Date

Jeffrey M. Allison
Manager
U. S. Department of EnergySavannah River Operations Office

8/31/04
Date

Winston A. Smith
Director
Waste Management Division
U. S. Environmental Protection Agency – Region 4

9/13/04
Date

Robert W. King, Jr.
Deputy Commissioner
Environmental Quality Control
South Carolina Department of Health and Environmental Control

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INTERIM DECISION SUMMARY
REMEDIAL ALTERNATIVE SELECTION (U)

Remediation of the Trichloroethylene Vadose Zone Source Unit at the C-Reactor Groundwater Operable Unit (U)

CERCLIS Number: 82

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LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
°C	degrees centigrade
CBRP	C-Area Burning Rubble Pit
CCB	C-Area Coal Pile Runoff Basin monitoring network
CCP	C-Area Coal Pile Study monitoring network
CDB	C-Area Disassembly Basin monitoring network
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act, 1980
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CFR	Code of Federal Regulations
CM	contaminant migration
COC	constituent of concern
CPT	cone penetrometer test
CRGW	C-Reactor Groundwater
CRP	CBRP monitoring network
CRW	C-Area Reactor Groundwater monitoring network
CSB	C-Area Reactor Seepage Basin monitoring network
ERH	electrical resistance heating
FFA	Federal Facility Agreement
HBL	health-based limits
HSWA	RCRA Hazardous and Solid Waste Amendments, 1984
IAPP	Interim Action Proposed Plan
ICMI/RAIP	Interim Corrective Measures Implementation/Remedial Action Implementation Plan
IOU	integrator operable unit
IROD	Interim Record of Decision
kV	kilovolt
LLC	Limited Liability Company
MCL	maximum contaminant level
μg/kg	micrograms per kilogram
μg/L	microgram per liter
mg/L	milligrams per liter
NCP	National Oil and Hazardous Substances Pollution Contingency Plan, 1990
NEPA	National Environmental Policy Act, 1969
NPL	National Priorities List
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
OU	operable unit

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

PCE	tetrachloroethylene
pCi/L	picocuries per liter
PPE	personal protective equipment
PTSM	principal threat source material
RAO	remedial action objective
RCOC	refined constituent of concern
RCRA	Resource Conservation and Recovery Act, 1976
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RGO	remedial goal option
ROD	Record of Decision
SARA	CERCLA Superfund Amendments and Reauthorization Act, 1986
SCDHEC	South Carolina Department of Health and Environmental Control
SCHWMR	South Carolina Hazardous Waste Management Regulations
SRS	Savannah River Site
SVE	soil vapor extraction
SWMU	solid waste management unit
TCE	trichloroethylene
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WSRC	Westinghouse Savannah River Company

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

Unit Name, Location, and Brief Description

Trichloroethylene (TCE) Vadose Zone Source Unit at the C-Reactor Groundwater Operable Unit (OU) (CRGW)

Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) Identification Number: 82

Savannah River Site (SRS), Aiken, South Carolina

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

Barnwell County, South Carolina

United States Department of Energy (USDOE)

Savannah River Site (SRS) occupies approximately 310 square miles of land adjacent to the Savannah River, principally in Aiken and Barnwell counties of South Carolina (Figure 1). SRS is located approximately 25 miles southeast of Augusta, Georgia, and 20 miles south of Aiken, South Carolina.

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

The Federal Facility Agreement (FFA) (FFA 1993) for SRS lists CRGW as a Resource Conservation and Recovery Act (RCRA)/CERCLA unit requiring further evaluation. CRGW 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 to human health and the environment of releases of hazardous substances to the environment.

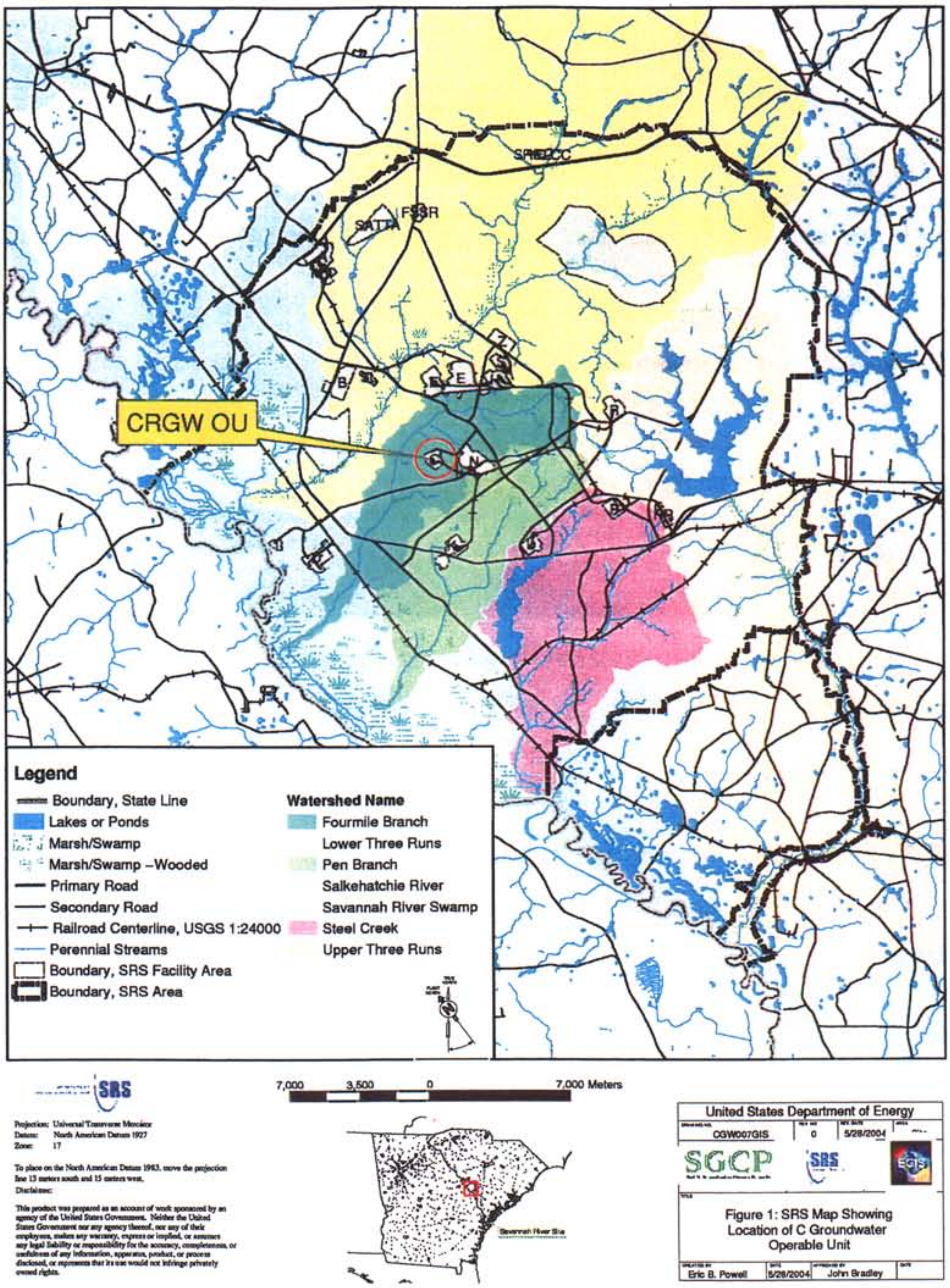

Figure 1. Location of CRGW within the Savannah River Site

CRGW is located in the west-central portion of SRS, entirely within the Fourmile Branch watershed (Figure 1). CRGW was defined to encompass all of the groundwater below C Area, north to unnamed tributaries of Fourmile Branch, west to Fourmile Branch, south to Castor Creek, and east to a line parallel to and 0.25 mile west of SRS Road 5 (Section 1.3 of the RFI/RI [WSRC 2003c]). CRGW includes several TCE and tritium plumes, which originated from different sources. The purpose of this Interim Record of Decision (IROD) is to select an interim action for the remediation of the TCE vadose zone source unit south of the C-Reactor building.

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 byproducts 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. Module VIII of the Hazardous and Solid Waste Amendments (HSWA) portion of the RCRA permit mandates corrective action requirements for non-regulated solid waste management units subject to RCRA 3004(u).

On December 21, 1989, SRS was included on the National Priorities List (NPL). The inclusion created a need to integrate the established RCRA facility investigation (RFI) program with CERCLA requirements to provide for a focused environmental program. In accordance with Section 120 of CERCLA 42 United States Code Section 9620, USDOE has negotiated an 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, under regulatory oversight provided by the USEPA - Region 4 and SCDHEC.

Operable Unit Operational and Compliance History

C-Reactor operated from March 1955 until June 1985; C-Reactor was placed on cold standby in 1987. TCE was released to the soil at a manhole along a storm sewer line south of the C-Reactor building. The source of contamination is unavailable or inconclusive. Figure 2 shows the location of the TCE vadose zone source relative to the reactor building and the location of soil borings, cone penetrometer tests (CPTs), and monitoring wells.

TCE in the vadose zone (the unsaturated zone above the water table) comprises a continuing source of groundwater contamination. The geometry of the TCE vadose zone source is a vertical cylinder approximately 60 feet in diameter extending from the surface to the water table about 70 feet below ground surface (bgs). The plume (Figure 3), which originates from the TCE vadose zone source, is moving southwest toward Castor Creek; the area of the plume is at least 180 acres within the 5.0-μg/L contour (the maximum contaminant level [MCL] for TCE).

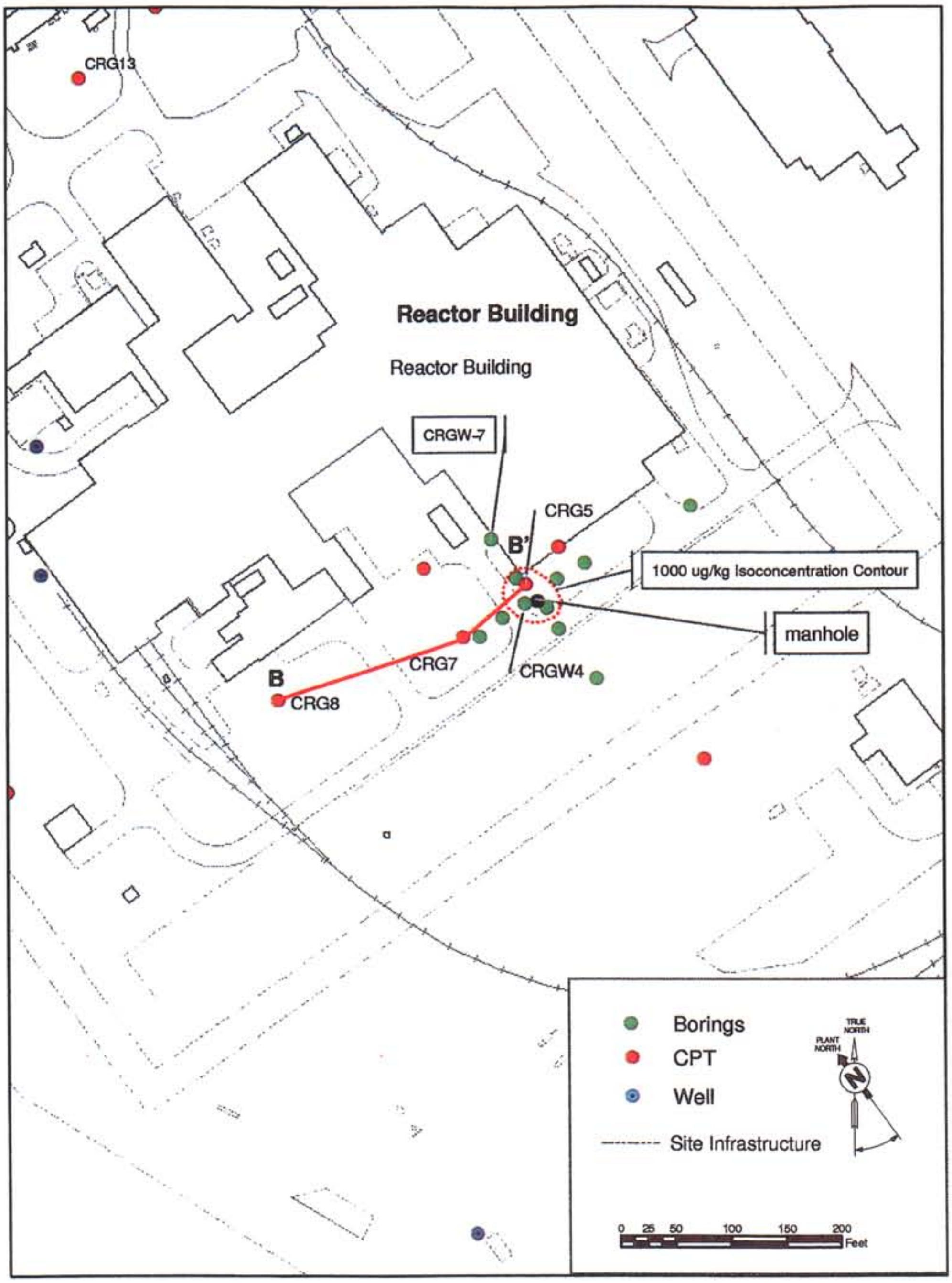

Figure 2. Layout of the TCE Vadose Zone Source Unit at CRGW

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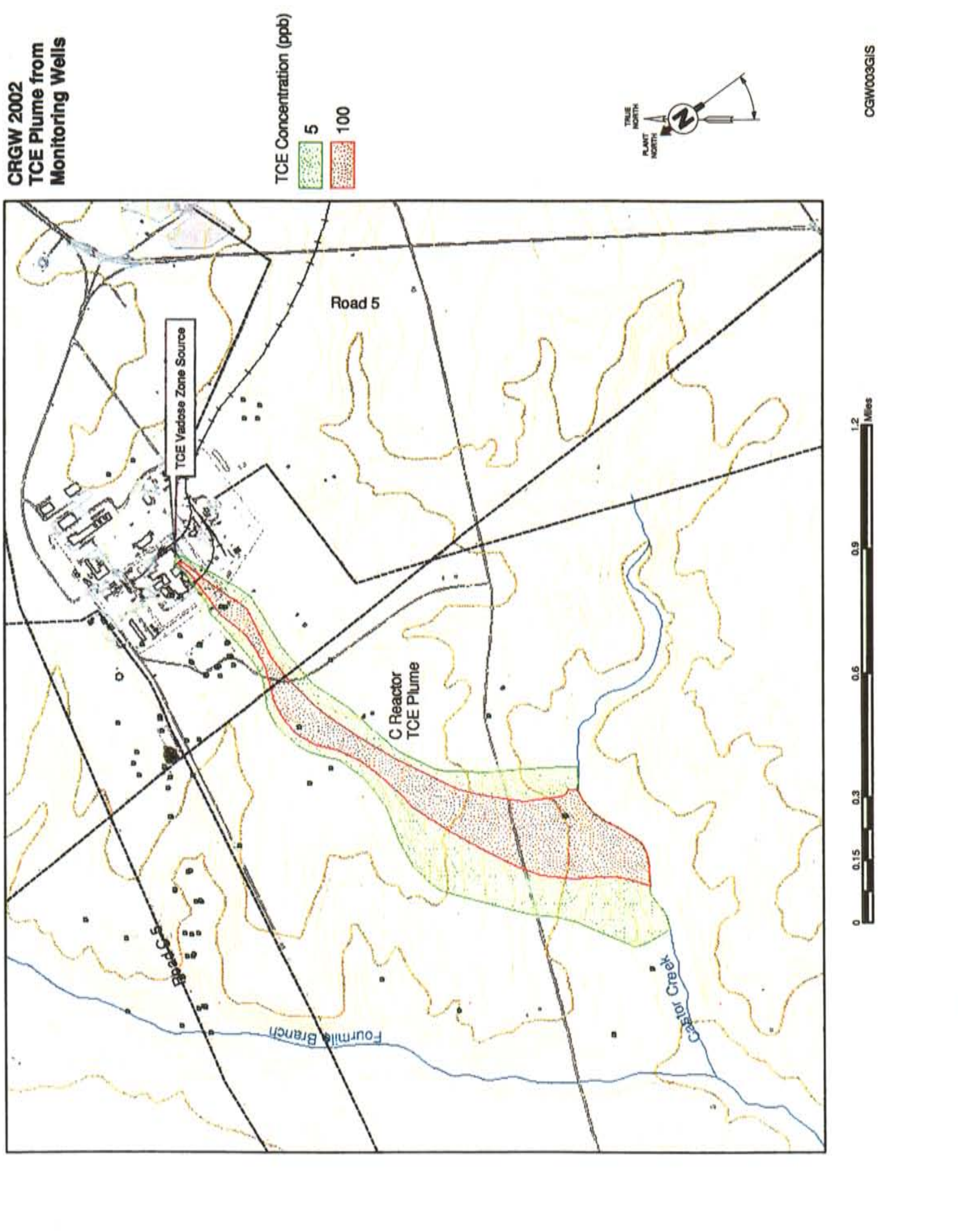

Figure 3. CRGW TCE Plume Map for Upper Three Runs Aquifer

CRGW includes the following groundwater monitoring networks:

- C-Area Burning/Rubble Pit (CBRP) monitoring network (CRP) (52 active wells),
- C-Area Coal Pile Runoff Basin monitoring network (CCB) (4 active wells),
- C-Area Coal Pile Study monitoring network (CCP) (2 active wells),
- C-Area Disassembly Basin monitoring network (CDB) (2 active wells),
- C-Area Reactor Groundwater monitoring network (CRW) (34 active wells),
- C-Area Reactor Seepage Basin monitoring network (CSB) (11 active wells).

Periodic groundwater monitoring in CRGW began in 1983; the earliest wells in CRGW (installed in 1978 at CSB) were used for health physics monitoring. OU-specific investigation of possible secondary sources of groundwater contamination within C Area began in February 2002, but earlier characterization of surface units within CRGW identified several secondary sources of groundwater contamination. TCE groundwater contamination that originated from the CBRP will be remediated under that OU; all of the tritium and lead contamination will be addressed as part of the CRGW OU.

The RFI/RI Report (WSRC 2003c) was submitted to SCDHEC and USEPA in December 2002. The Interim Action Proposed Plan (IAPP) for remediation of the TCE vadose zone source unit within CRGW (WSRC 2004) was approved in February 2004.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Both RCRA and CERCLA require that the public 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 Regulations (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 alternative for addressing the CRGW soils and groundwater.

The SRS Public Involvement Plan (USDOE 1994) is designed to facilitate public involvement in the decision-making process for permitting, closure, and the selection of remedial alternatives. The SRS Public Involvement Plan addresses the requirements of RCRA, CERCLA, and the National Environmental Policy Act, 1969 (NEPA). 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 to provide the public an opportunity to participate in the selection of the remedial action. The *Interim Action Proposed Plan for Remediation of the Trichloroethylene Vadose Zone Source Unit at the C-Reactor Groundwater Operable Unit (U)* (WSRC 2004), a part of the Administrative Record File, highlights key aspects of the investigation and identifies the preferred interim action for addressing the TCE vadose zone source unit at CRGW.

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

U. S. 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

Edisto Savannah District
Environmental Quality Control Office
206 Beaufort Street, Northeast
Aiken, South Carolina 29801
(803) 641-7670

An SRS RCRA permit modification is not required at this time since this is an interim action. However, the RCRA permit will be revised to reflect selection of the final selected remedy using the procedures under 40 CFR Part 270, and SCHWMR R.61-79.264.101; 270.

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

The IAPP 30-day public comment period began on March 17, 2004, and ended on April 16, 2004. No comments were received on the IAPP. The Responsiveness Summary, provided in Appendix A of the IROD, would have addressed any comments received during the public comment period. The blank Responsiveness Summary will be available in the final RCRA permit.

IV. SCOPE AND ROLE OF THE OPERABLE UNIT

The CRGW OU includes a potential source subunit (soil), a groundwater subunit, and a surface water subunit located within the Fourmile Branch watershed (Figure 1). The source area for the TCE is not listed on the FFA as a separate OU but is part of the groundwater OU and, therefore, is actually a subunit of the CRGW OU. The proposed interim action for the CRGW OU is not a final action but has been proposed to minimize the impact of the CRGW OU on the watershed by removing principal threat waste from the source unit. The results of the interim action will be reported in annual effectiveness monitoring reports until the shutdown criterion for the interim action is satisfied.

Due to the complexity of multiple contaminant areas, the SRS is divided into six integrator operable units (IOUs) for the purpose of managing a comprehensive cleanup strategy. The six IOUs at SRS are the Savannah River Floodplain Swamp and the five major streams that drain SRS (Figure 1) with their associated flood plains and wetlands.

The Lower Three Runs IOU includes about six square miles that are actually in the Salkahatchee River watershed. Waste units within an IOU are evaluated and remediated individually.

The CRGW is located within the Fourmile Branch IOU. Upon disposition of all operable units within the Fourmile Branch IOU, a final comprehensive ROD for the IOU will be pursued with additional public involvement.

The estimated TCE inventory in the vadose zone source is 288 pounds; the highest concentration of TCE found during characterization is 51,836 μg/kg. TCE in the vadose zone source unit was identified as a PTSM COC because of its mobility, i.e., ability to migrate from the source area to the aquifer in 10 years or less. The TCE vadose zone source is the origin of a 180-acre groundwater plume, which is moving southwest toward Castor Creek.

Electrical resistance heating (ERH) with soil vapor extraction (SVE) will be implemented in the TCE vadose zone source as part of this interim action.

Since this is an interim response action, a final decision will be required to address CRGW.

V. OPERABLE UNIT CHARACTERISTICS

In the vadose zone source area, TCE is the only refined constituent of concern (RCOC). TCE is a contaminant migration (CM) COC and a principal threat source material (PTSM) COC based on mobility (WSRC 2003c).

TCE in the vadose zone is confined to a vertical cylindrical body, which expands with depth. The circular area outlined by the 1,000-μg/kg contour in the interval 19 to 30 feet below surface is less than 60 feet in diameter (Figure 4). In the interval 55 to 72 feet below surface, the 1,000-μg/kg contour is elliptical with dimensions of 90 feet by 160 feet (Figure 5). In June 2002, the water table was about 70 feet below surface under the TCE vadose zone source unit. The highest TCE concentration in the vadose zone source

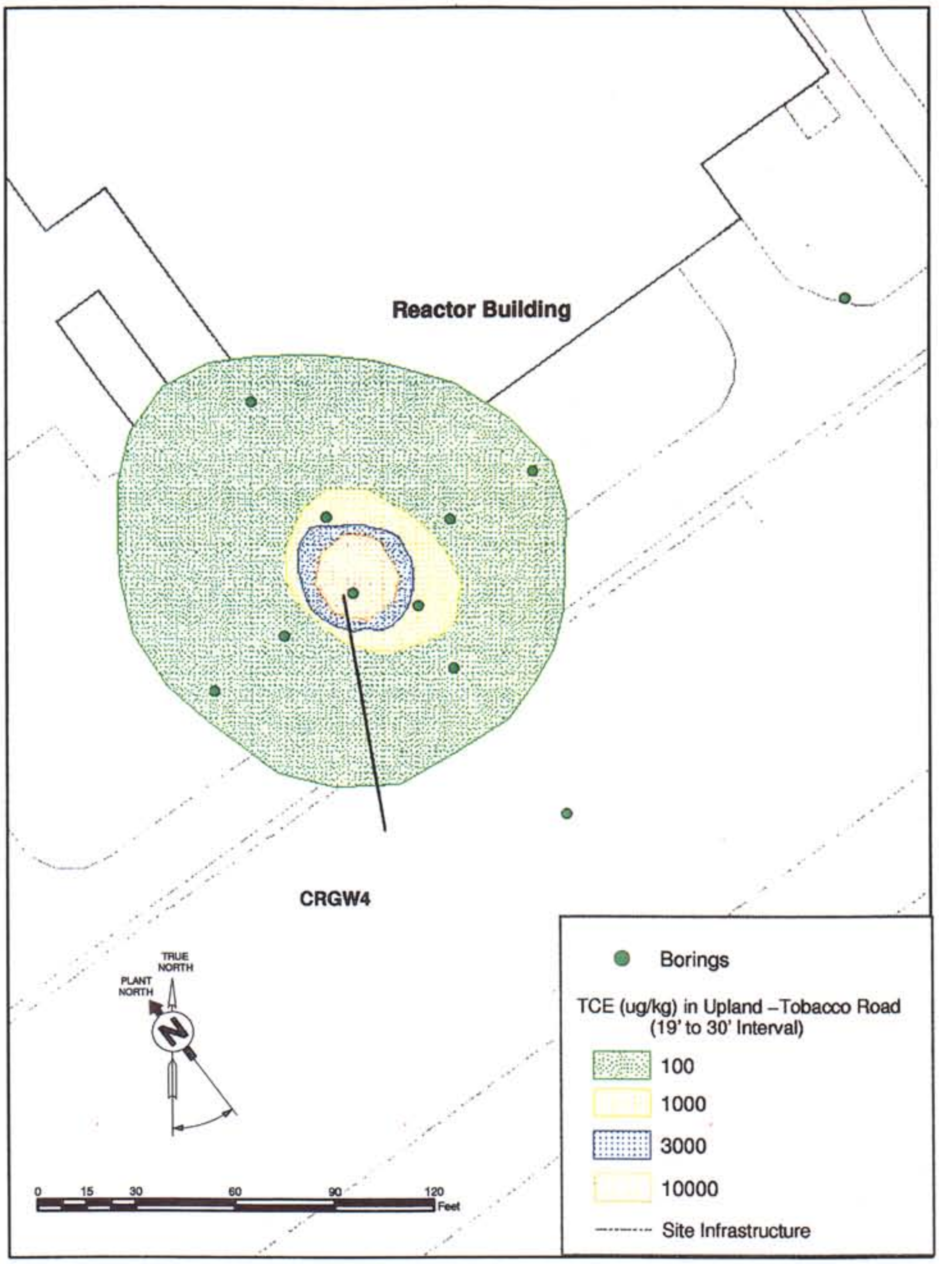

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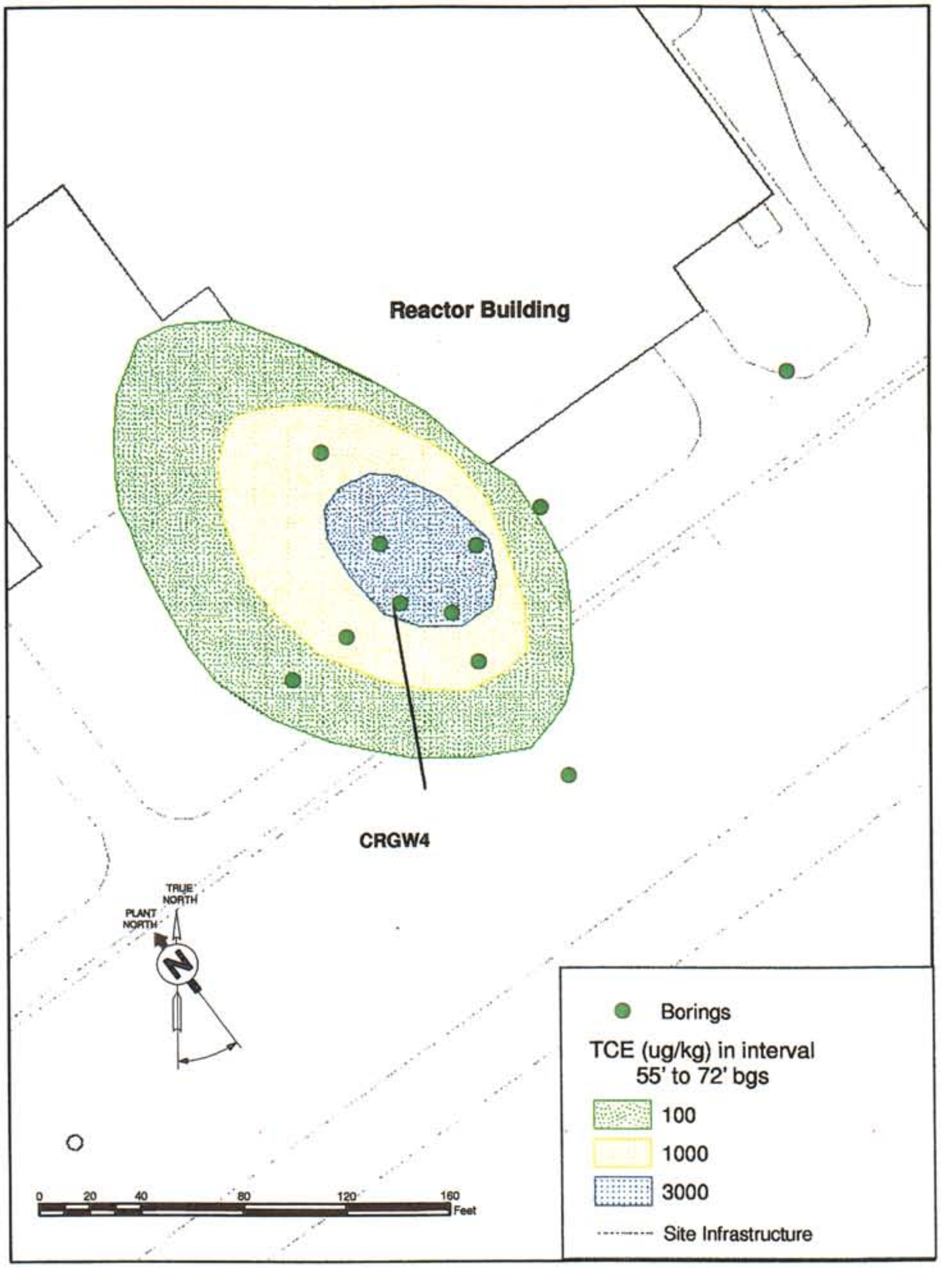
Figure 4. TCE ISO-concentration Map for the Interval 19 to 30 feet Below Ground Surface in the TCE Vadose Zone Source Unit at CRGW



CGW001GIS

Figure 5. **TCE ISO-concentration Map for the Interval 55 to 72 feet Below Ground Surface in the TCE Vadose Zone Source Unit at CRGW**

area is 51,836 μg/kg at a depth of 28 feet in boring CRGW-4, which is assumed to be the center of mass of the source area. The total mass of TCE in the vadose zone is estimated as 288 pounds (WSRC 2003a) and the mass of TCE adsorbed on soil particles below the water table is about 102 pounds. TCE in the vadose zone source unit is regarded as a principal threat waste because of its mobility.

Tritium was produced during the operation of the reactor and was released from numerous sources. No tritium has been produced since C-Reactor was shut down in June 1985. Tritiated water is still stored in tanks and basins within the reactor building (primary source), but the secondary tritium source in the soil is considered depleted. The source of tritium contamination in the groundwater is assumed to be depleted because current groundwater concentrations are less than historical levels (up to 257,000 pCi/L) and C Reactor is not producing tritium (WSRC 2003c). The highest groundwater concentrations are located downgradient of the reactor area in the body of the plume, indicating there are no continuing sources associated with the reactor area.

C Area is situated on a hilltop with radial drainage of surface runoff and groundwater. TCE and tritium have contaminated the local groundwater, the TCE plume flows southwest from C-Reactor toward Castor Creek and Fourmile Branch; the 5.0-μg/L (MCL) contour encloses at least 180 acres (Figure 3). The tritium plume is not shown as the Interim Action only addresses the TCE vadose zone source unit. Figure 6 is a schematic cross-section of the CRGW TCE vadose zone source area showing the relationship between local stratigraphy and TCE concentrations (see Figure 2 for location).

The Upper Three Runs aquifer comprises the local water table aquifer. The tan clay confining zone consists of about six feet of clay and sandy clay, which separates the Upper Three Runs aquifer into upper and lower zones. Wells screened below the tan clay upgradient of the C-Area Reactor Seepage Basins (about 1,000 feet west of C-Reactor) have not exceeded TCE or tritium MCLs (5.0 μg/L and 20,000 picoCuries/liter [pCi/L], respectively).

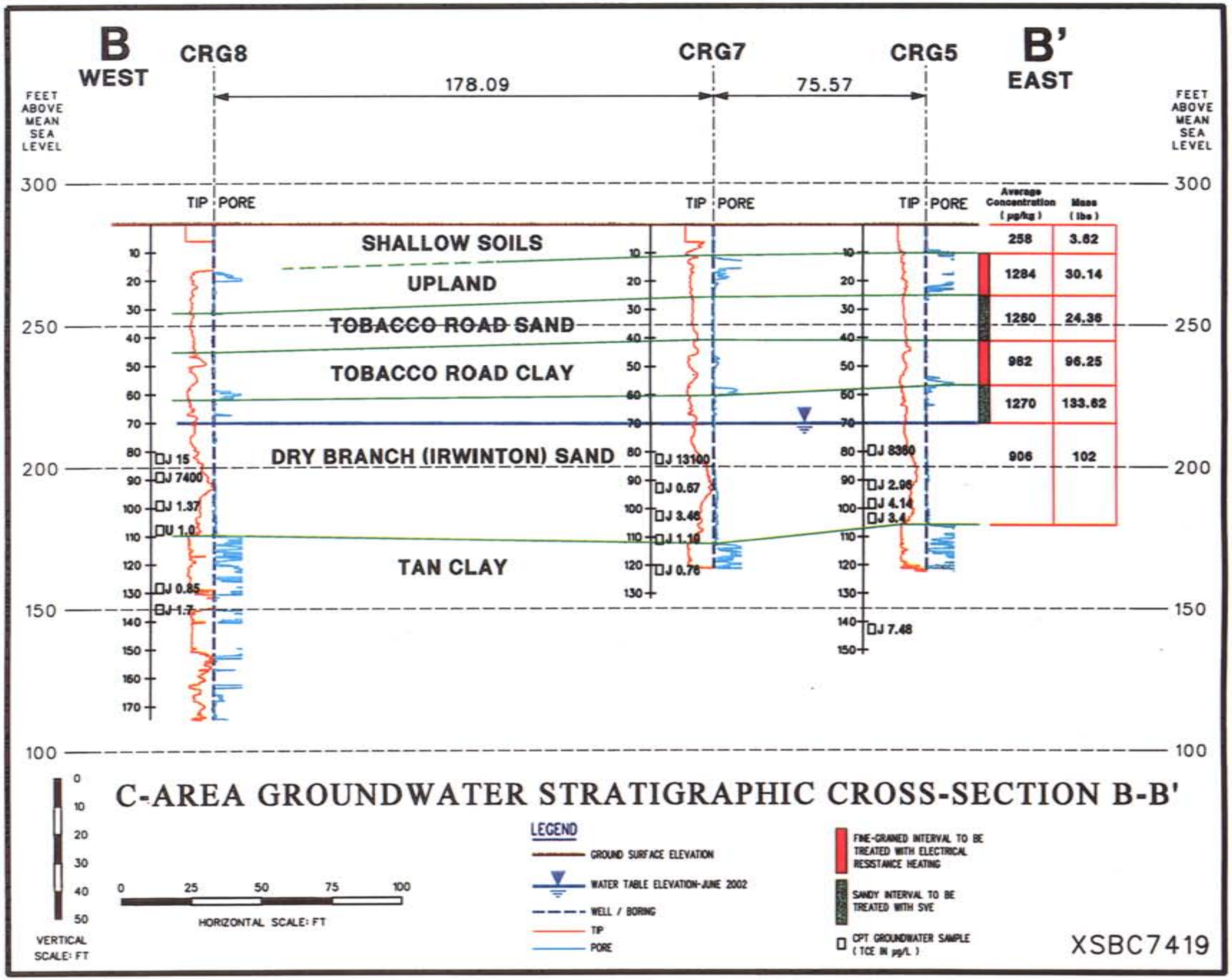


Figure 6. Schematic Cross Section of the CRGW OU Source Area (see Figure 2 for location)

As discussed in Section 2, Groundwater in CRGW has been periodically monitored from monitoring wells since 1983. Groundwater samples were collected using cone penetrometer technology and analyzed from 1997 through 2002. Soil samples from the vadose zone source area were collected and analyzed in July 2002. These data are reported in Appendix C of the RFI/RI (WSRC 2003c) summarized in Figure 6. The C-Area Reactor Seepage Basins, which were among the waste sites where tritiated water was managed, were closed by solidification and stabilization and covered with a low permeability soil cover in 2002.

Conceptual Site Model for the CRGW

Facilities, activities, maintenance, and process spills and leaks associated with reactor operations within the C Area limited area fence were the primary source for the CRGW. Specifically, TCE was disposed into or adjacent to an open grate of a storm sewer. The conceptual site model (CSM) for CRGW (Figure 7) shows subsurface soils in the vadose zone as a secondary source. The secondary release mechanisms are infiltration, percolation, and leaching to groundwater. Both groundwater and surface water are exposure media because contaminated groundwater emerges along the seepline to become contaminated surface water. The interim action described in this IROD is intended to remove the TCE contamination in the secondary source.

Media Assessment

The TCE vadose zone source was investigated in a soil gas survey in February 2002. The soil gas survey identified a hotspot near a storm sewer grate at the southern corner of the assembly area of the reactor building. In July 2002, 11 soil borings were sampled to further delineate the lateral and vertical distribution of contamination. Groundwater beneath the TCE vadose zone source was sampled by CPT in September and October 2000 and April through August 2001.

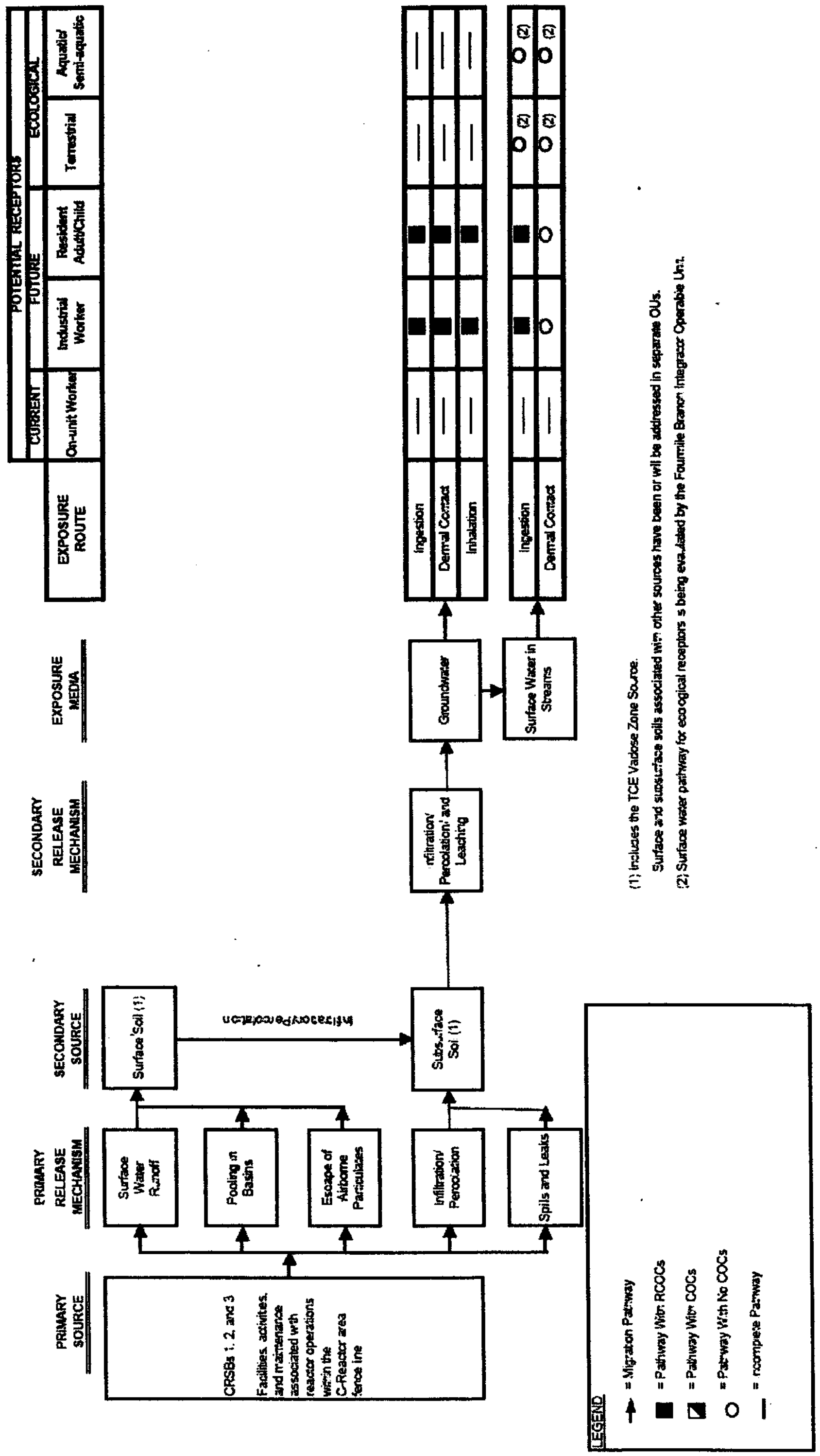


Figure 7. Conceptual Site Model

Soil Investigation

The July 2002 soil borings were generally sampled in one-foot intervals from near the surface to depths as deep as 116 feet. Savannah River Technology Center performed headspace analysis on 975 samples. The soil boring locations are shown on Figure 2.

Groundwater Investigation

Groundwater samples were collected from eight CPT locations beneath and adjacent to the TCE vadose zone source. The primary target of this interim action is TCE contamination in the vadose zone soils; groundwater information is only discussed to document the impact to groundwater from this secondary source. SRS plans to install at least two groundwater-monitoring wells at the TCE vadose zone source area to establish baseline conditions before deployment of the interim action.

Media Assessment Results

Soil

TCE in the vadose zone source area is regarded as a principal threat waste because of its mobility; TCE is also a recognized carcinogen.

The local stratigraphy, shown on Figure 6, is discussed in reverse stratigraphic order. The vadose zone in the source area consists of surface soils, the Upland Formation, the Tobacco Road Formation, and the upper beds of the Dry Branch Formation. The surface soils are predominantly sand with increasing silt to a depth of about 10 feet bgs. The Upland section (10 to 27 feet bgs) consists of low permeability interbedded silt and clay, which rest unconformably on the Tobacco Road sand. Locally relief on the Upland/Tobacco Road unconformity is minor. An earlier unconformity divides the Tobacco Road Formation into an upper sandy interval and a lower silt- and clay-rich interval. The upper Tobacco Road sand (27 to 41 feet bgs) consists of fine- to coarse-grained sand with minor clay laminae. The lower fine-grained Tobacco Road strata

(41 to 63 feet bgs) consist of several sandy silt and clay beds interbedded with fine clayey sand. A thin clay (63 to 64 feet bgs) is picked as the top of the Dry Branch Formation, because of its similarity to Dry Branch clays such as the "tan clay". The water table occurs at 70 feet bgs in the upper Dry Branch sandy interval, known as the Irwinton Sand. The Irwinton Sand (64 to 105 feet bgs) consists of fine- to coarse-grained sand with minor lenses of tan silt and clay.

The highest TCE concentration encountered in the source area during the July 2002 investigation was 51,836 μg/kg at a depth of 28 feet bgs in the upper Tobacco Road sand in boring CRGW-4. CRGW-4 is considered the center of mass of the source area. Figure 6 shows the average TCE concentration by stratigraphic interval at the TCE vadose zone source. Figures 4 and 5 show the areal extent of TCE contamination at two levels (19 to 30 feet bgs and 55 to 72 feet bgs) within the source area. Figure 6 shows the mass of TCE by stratigraphic interval.

The volume of soil, which requires treatment, comprises approximately 2000 cubic yards of TCE-contaminated soil between the surface and the water table at 70 ft below ground surface.

Groundwater

TCE contamination in the vadose zone is the target of the interim action discussed in this IROD; the source area impact on local groundwater is included to demonstrate that the interim action is warranted. Samples collected during the July 2002 soil boring investigation indicate that the total mass of TCE adsorbed on the aquifer matrix is approximately 102 pounds; the highest adsorbed concentration below the water table is 3972 μg/kg at a depth of 80 feet in boring CRGW-7. The adsorbed TCE is largely confined to the upper part of the Upper Three Runs Aquifer (upper Irwinton Sand of the Dry Branch Formation) above a depth of 88 feet. The tan clay occurs at a depth of approximately 105 feet in the source area.

The TCE concentrations encountered during CPT sampling of the groundwater in the 2001 investigation are presented on Figure 6. The highest TCE concentration was 13,100 µg/L (J-qualified) in the 81- to 84-foot sample from CPT CRG7, which is located about 75 feet west of the center of mass of the source area (Figure 2). Beneath the source area, TCE concentrations exceeding the MCL (5 µg/L) are also confined to upper part of the Upper Three Runs Aquifer, except for a single anomalous sample near the top of the lower aquifer zone (J 7.48 µg/L in the 141-144 interval in CPT CRG5). West of the source area, Figure 6 shows the highest concentration in CPT CRG8 (J 7,400 µg/L) in the interval 88 to 91 feet; TCE contamination is moving deeper in the aquifer as the TCE plume migrates southwest toward Castor Creek (Figure 3).

Site Specific Factors

C Area is a heavily developed, but largely inactive industrial complex. This development increases the potential for cultural interferences during installation and operations of the interim action, but the development also makes 13.8 kilovolt (kV) power readily available for the interim action. Site preparation and access will be easier because of the developed nature of the surface above the source area.

Contaminant Transport Analysis

As discussed above in the media assessment results for groundwater, TCE contamination in the groundwater in the unconfined upper part of the Upper Three Runs Aquifer beneath the vadose zone source area exceeds the MCL for TCE by 2600 times (13,100 µg/L divided by 5 µg/L). The objective of this interim action is to remove the TCE from the vadose zone source area. At the CRGW vadose zone source, groundwater in the upper Upper Three Runs aquifer flows southwest toward Castor Creek.

SESOIL modeling of the TCE vadose zone source identified TCE as a CM COC (Section 6.2.4 of the RFI/RI, WSRC 2003c). Leachate concentrations are reduced by dilution upon reaching the aquifer. Contaminant migration modeling predicts that TCE will leach to groundwater above its MCL; predicted concentration in the first year is 816 µg/L, reaching the maximum (1200 μg/L) in 25 years. Disposal ceased in the early 1970s (WSRC 2003c) and TCE has been leaching from the vadose zone source area since that time; the TCE remaining in the vadose zone is the most recalcitrant fraction, adsorbed on silt and clay particles.

VI. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

Land Uses

Less than 5% of the total land within SRS boundaries is developed, including roads and parking lots, production facilities, and office buildings. Reservoirs and ponds account for approximately 1.7% and the remaining 93.3% is undeveloped woodlands and pine plantations. The current land use for C Area is an inactive industrial nuclear facility. The only potential human receptor under the current land use is an industrial worker who is infrequently exposed to contaminated media in the TCE vadose zone source and groundwater during sampling activities.

The proposed future land use for SRS is industrial. *Savannah River Site Future Use Project Report* (USDOE 1996) shows the Citizen Advisory Board's future land use recommendations for C Area as heavy industrial (nuclear) and the surrounding area, including the CBRP OU, as industrial (nuclear). Under this future land use scenario, the industrial worker is the only potential human receptor. The Report further recommended that future residential use of SRS land should be prohibited.

Groundwater Uses/Surface Water Uses

Currently groundwater in the Upper Three Runs Aquifer is not used for any purpose; surface water in the streams associated with CRGW is also not used for any purpose. Under the current and future land use scenarios, institutional controls on the use of groundwater and surface water will remain in place indefinitely.

Contaminated groundwater migrates through the Upper Three Runs Aquifer and emerges to surface waters, which flow into the Savannah River along the western boundary of SRS. Surface water sampling indicates that TCE contamination in Castor Creek is attenuated before it reaches the Fourmile Branch. The highest concentration of TCE found in surface water samples collected along Castor Creek was 3.96 μg/L in November 1998, which is less than the MCL of 5 μg/L.

VII. SUMMARY OF OPERABLE UNIT RISKS

Baseline Risk Assessment

A baseline risk assessment was not performed as a component of the RFI/RI process to evaluate risks associated with CRGW. Exceedances of MCLs provide the basis for determining whether remedial action is necessary and justification for performing remedial actions. The interim action is intended to remove the source of groundwater contamination at CRGW.

Summary of the Fate and Transport Analysis

As discussed in Section V under the media assessment results for groundwater and contaminant transport analysis subsections, TCE contamination in the groundwater in the Upper Three Runs Aquifer beneath the vadose zone source area exceeds the MCL for TCE. The objective of this interim action is to remove the TCE from the vadose zone source area.

TCE in the vadose zone source was identified as a CM COC during SESOIL modeling (Section 6.2.4 of the RFI/RI, WSRC 2003c). TCE has been leaching from the vadose zone source area since disposal ceased in the early 1970s; TCE adsorbed on silt and clay particles in the vadose zone is the most recalcitrant fraction.

Contaminant migration modeling (WSRC 2001) predicts that TCE will leach to groundwater above its MCL, reaching a maximum concentration of 1200 μg/L in 25 years. Observed concentrations in the CPT groundwater samples (Figure 6) exceeded the predicted maximum concentration in the immediate area of the TCE vadose zone source. However, remediation of a vadose zone source can result in dramatic reduction of TCE in the underlying groundwater. At CBRP (WSRC 2003b), groundwater samples collected before the interim remedial action (SVE only) on the source was implemented in September 1999 ranged as high as 130,000 μg/L. The maximum TCE concentration in samples collected in June 2003 was 1,050 μg/L (a 99.2% reduction in less than four years).

Based on modeling and water balance calculations, TCE flux to Castor Creek will continue to increase for the next 10 to 20 years and then diminish at a rate dependent on whether the source is depleted or continuous. The estimated mass flux of TCE discharge to Castor Creek via the Southern TCE Plume is less than 20 pounds per year. The modeling predicts that TCE concentrations at the distal edge will increase above MCLs within 5 to 15 years, remaining above MCLs for more than 50 years.

Discussion of Principal Threat Source Material

TCE in the vadose zone source unit was identified as the only PTSM COC because of its mobility.

Risk Assessment Summary

A baseline risk assessment was not performed as a component of the RFI/RI process to evaluate risks associated with CRGW. The interim action is intended to remove the source of groundwater contamination at CRGW.

Conclusions

The interim remedial action for the TCE vadose zone source at CRGW is warranted because TCE concentrations in the groundwater beneath the source unit exceed MCLs. At other waste sites TCE concentrations similar to those in the OU groundwater have resulted in unacceptable carcinogenic risk for future residents. The intended future land use for C Area is heavy industrial (nuclear) and the surrounding area, including the CBRP OU, is industrial (nuclear). Under existing institutional controls, the future industrial worker would not be exposed to TCE-contaminated groundwater, but there is no assurance that institutional controls will continue in perpetuity.

VIII. REMEDIAL ACTION OBJECTIVES AND REMEDIAL GOALS

The interim remedial action objective (RAO) for the TCE vadose zone source unit at CRGW is to implement a remedial action that will reduce TCE concentrations in the source unit so that any leaching of the contaminant will not cause groundwater to exceed the MCL (5.0 μg/L). The current and anticipated future land use for C Area (including the TCE vadose zone source) is heavy industrial (nuclear). The current worker or future industrial worker would not be exposed to TCE-contaminated groundwater, because existing institutional controls prohibit any use of shallow groundwater.

During the October 22, 2003 Scoping Meeting, one of the uncertainties for the TCE vadose zone source unit questioned whether the calculated remedial goal option (RGO) was an appropriate value to measure remedial system effectiveness in soil. The Core Team agreed that alternative criteria (as proposed in USEPA 2001) could be used in place of the RGO. Essentially, this means that instead of using attainment of a calculated RGO to assess remedial system closure, closure will be assessed by evaluating five parameters including 1) site characterization, 2) system design, 3) performance monitoring, 4) assessment of rate-limited vapor transport, and 5) mass flux analysis.

There are no chemical-specific or location-specific ARARs relevant to establishing RAOs for TCE in the vadose zone at CRGW. Since the interim action will be confined to the vadose zone, MCLs for TCE in groundwater will not be ARARs for remediation of the TCE vadose zone source unit. The only action-specific ARARs for the interim action will be the Clean Air Act, the Pollution Control Act, the Underground Injection Control Program, and Occupational Safety and Health Administration (OSHA) regulations to protect the health and safety of workers. OSHA is an implied ARAR for all activities at SRS. Air quality and injection permits will be required for the interim action.

IX. DESCRIPTION OF INTERIM ALTERNATIVES

Three interim alternatives were considered for the TCE vadose zone source at CRGW. TCE remaining in the source area is the most recalcitrant fraction, adsorbed on fine-grained sand, silt, and clay particles. Organic matter content is typically low in the stratigraphic column at CRGW; TCE is much harder to remove from peat and organic materials. It is assumed that existing institutional controls will be maintained for all three alternatives.

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

Alternative 1. No Action

Under this alternative, no action would be taken at the CRGW OU to reduce TCE concentrations in the source area. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR § 300.430(e)(6), requires consideration of a no action alternative to serve as a basis against which other alternatives can be compared. Because no action would be taken, TCE in the source area would continue to migrate to groundwater. There would be no reduction or mitigation of risk. Interim remedy reviews would be provided every five years because no action would not reduce TCE concentrations in the groundwater below the MCL.

Estimated capital cost: $0

Present worth Operation and Maintenance (O&M) cost: $0

Total estimated cost: $0

Time to implement: Not applicable

Operating time: 500 years, or until the source is depleted to groundwater

Alternative 2. Soil Vapor Extraction

An active SVE system would be installed and operated in the vadose zone at the CRGW source unit. The system would include approximately seven shallow SVE wells and 36 deep SVE wells. The wells would be connected via manifold to a vacuum pumping system; recovered vapor phase material would be treated and discharged per an air quality control permit.

Since the interim action will be confined to the vadose zone, the only action-specific ARAR for Alternative 2 will be the Clean Air Act.

Based on the performance of the CBRP SVE system, the CRGW SVE system would have to operate for seven years. Interim remedy reviews would be submitted every five years while the system is in operation, with one 5-year review cycle beyond shutdown. Effectiveness monitoring reports would be submitted annually.

Estimated capital cost: $2,540,000

Present worth O&M cost: $4,568,000

Total estimated cost: $7,108,000

Time to implement: 6 months

Operating time: 7 years

Alternative 3. Electrical Resistance Heating with Soil Vapor Extraction

An ERH-SVE system would be installed and operated in the vadose zone at the CRGW source unit. The system would include seven electrode/SVE wells. The SVE wells would be connected via manifold to a vacuum pumping system; recovered vapor phase material would be treated and discharged per an air quality control permit. Electrical current would be passed through the soil between electrodes; electrical resistance of the soil would result in heating.

Since the interim action will be conducted in the vadose zone, it may be necessary to add electrolyte at each electrode to compensate for drying of the soils in the treatment zone. Based on the 1993 M-Area demonstration, 500-mg/L NaCl solution will be added at each electrode at a rate of about 1.5 gal/hour. An injection permit will be obtained from SCDHEC for adding the electrolyte.

Since the interim action will be confined to the vadose zone, the only action-specific ARARs for Alternative 3 will be the Clean Air Act, the Pollution Control Act, and the Underground Injection Control Program.

The temperature of the treatment zone would be monitored with thermocouples. TCE boils at 86.7°C, but the target heating temperature is generally 100°C. Vapor phase TCE is removed by the SVE system for treatment. The literature reports that similar systems typically achieve 100°C in about 10 days with better than 99% TCE removal in 120 days. Based on the performance of similar systems, the CRGW ERH-SVE system would have to operate for less than one year. An interim remedy review would be submitted five years after the system is shut down.

Total capital cost: $3,563,000

Present worth O&M cost: $1,230, 000

Total estimated cost: $4,793,000

Time to implement: 6 months

Operating time: 1 year

X. COMPARATIVE ANALYSIS OF ALTERNATIVES

A set of nine criteria established by the NCP is used to compare alternatives. The criteria were derived from the statutory requirements of CERCLA Section 121. The NCP [40 CFR § 300.430 (e) (9)] sets forth nine evaluation criteria that provide the basis for evaluating alternatives and selecting a remedy. The nine criteria are categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria. Threshold criteria must be satisfied for an alternative to be eligible for selection. Primary balancing criteria are used to weigh major tradeoffs among the alternatives. Modifying criteria are taken into account after public comment is received on the Proposed Plan. The criteria are listed below:

Threshold Criteria

1) overall protection of human health and the environment (under industrial land use scenario);

2) compliance with ARARs;

Primary Balancing Criteria

3) long-term effectiveness and permanence;

4) reduction of toxicity, mobility, or volume through treatment;

5) short-term effectiveness;

6) implementability;

7) cost;

Modifying Criteria

8) state acceptance; and

9) community acceptance.

Brief descriptions of all nine criteria are given below.

1. Overall Protection of Human Health and the Environment - The remedial alternatives are assessed to determine the degree to which each alternative eliminates, reduces, or controls threats to human health and the environment through treatment, engineering methods, or institutional controls.

The no action alternative will not be protective of human health and the environment because continued institutional controls on the use of groundwater cannot be assured. Both Alternatives 2 and 3, SVE and ERH- SVE, will reduce the mass of TCE in the source area to prevent further migration of TCE to the groundwater in excess of the MCL. ERH-SVE will reduce the mass of TCE significantly faster than SVE alone.

2. Compliance with ARARs - ARARs are federal and state environmental regulations that establish standards that remedial actions must meet unless waived consistent with the NCP. There are three types of ARARs: (1) chemical-specific, (2) location-specific, and (3) action-specific.

Chemical-specific ARARs are usually health- or risk-based levels or methodologies that, when applied to unit-specific conditions, result in the establishment of numerical values. Often these numerical values are promulgated in federal or state regulations.

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in specific locations. Some examples of specific locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats.

Action-specific ARARs are usually technology- or remedial activity-based requirements or limitations on actions taken with respect to hazardous substances or unit-specific conditions. These requirements are triggered by the particular remedial activities selected to accomplish a remedy.

In addition to ARARs, compliance with other criteria, guidance, and proposed standards that are not legally binding but may provide useful information or recommended procedures should be reviewed as to-be-considered when setting remedial objectives.

There are no ARARs for the no action alternative. The only ARARs that will apply to the interim action are air quality permitting (which will be required for either Alternative 2 or 3) and pollution control permit and underground injection permit for Alternative 3. Air emissions can be controlled below permit levels by engineering controls such as lower extraction rates for either Alternative 2 or 3 or lower voltage input for Alternative 3. A pollution control permit will be required for discharge of steam condensate. An injection permit will be required for the addition of electrolyte to maintain soil moisture around the electrodes during ERH. A health and safety plan will be prepared and followed to ensure OSHA compliance.

<u>3. Long-Term Effectiveness and Permanence</u> - The remedial alternatives are assessed based on their ability to maintain reliable protection of human health and the environment after implementation.

No action does not provide effective long-term protection. Alternatives 2 and 3 provide long-term protection by permanently reducing TCE concentrations in the source area.

<u>4. Reduction of Toxicity, Mobility, or Volume Through Treatment</u> - The remedial alternatives are assessed based on the degree to which they employ treatment that reduces toxicity (the harmful nature of the contaminants), mobility (the ability of the contaminants to move through the environment), or volume of contaminants associated with the unit.

No action does nothing to reduce the toxicity, mobility, or volume of TCE contamination in the source area. Alternatives 2 and 3 would reduce TCE concentrations in the source area below levels that are likely to leach to groundwater above the MCL.

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 (e.g., air emissions), and the time until protection is achieved.

No action does not provide effective short-term human health protection for surrounding communities, but no action provides effective short-term protection for current workers. Alternatives 2 and 3 will use engineering controls such as catalytic oxidation or activated carbon filtration to reduce TCE levels in the off gas.

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.

There is no construction required for no action, so it can be implemented immediately. Alternatives 2 and 3 will require about 6 months for implementation; both use familiar construction practices during installation. SRS already has several SVE systems in operation and hosted an ERH-SVE demonstration in 1993, so operational expertise is readily available on site.

7. Cost - The evaluation of remedial alternatives must include capital and operational and maintenance costs. Present value costs are estimated within +50/-30 percent per USEPA guidance. The cost estimates given with each alternative are prepared from information available at the time of the estimate. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market

conditions, final project scope, final project schedule, and other variable factors. As a result, the final project costs may vary from the estimates presented herein.

No cost is considered for the no action alternative, but reviews of the interim remedy will be required for many years. Alternative 2 will require about $2,540,000 in capital cost and $4,568,000 in O&M cost over a 7-year period. Alternative 3 will require $3,563,000 in capital cost and $1,230,000 in O&M cost over a 1-year period. Total cost for ERH-SVE is about 67% of the cost for SVE alone.

8. State Acceptance - The state reviews and comments on the IAPP. The state's concurrence or opposition to the preferred alternative is considered.

SCDHEC has concurred with both interim actions: SVE and ERH-SVE.

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.

The public was notified of the public comment period through the SRS *Environmental Bulletin*, a newsletter sent to citizens in South Carolina and Georgia, and through notices in the *Aiken Standard*, the *Allendale Citizen Leader*, the *Augusta Chronicle*, the *Barnwell People-Sentinel*, and *The State* newspapers. The public comment period was also announced on local radio stations. The IAPP and preferred alternative were presented to the Facility Disposition and Site Remediation Committee of the Savannah River Site Citizen's Advisory Board in an open public meeting held on May 4, 2004, in Aiken, SC. The *Responsiveness Summary* in Appendix A of this IROD is blank, reflecting that no public comments were received.

XI. THE SELECTED INTERIM REMEDY

Detailed Description of the Selected Interim Remedy

The Selected Interim Remedy for the CRGW source unit is Alternative 3, ERH- SVE. ERH uses the electrical resistance of soil to heat the soil in situ by passing an electrical current through the soil. The heat vaporizes volatile organic contaminants in the soil. These vapors are withdrawn by the SVE system and treated and discharged per an air quality control permit. Figure 8 is a generalized graphic of an ERH-SVE system.

One downgradient groundwater monitoring well will be installed about 60 feet west of the center of the TCE vadose zone source. A second well will be installed directly beneath the ERH array to establish a baseline before ERH operation; this well will be removed during operation and replaced when operations are complete. One of the existing upgradient multilevel wells will be selected for background monitoring. These wells will provide potentiometric information for design as well as water quality data. Because of the high potential for above ground and buried interferences at the CRGW source unit, the exact locations of the monitoring wells have not been determined at this time. A well permit will be filed and the wells will be installed before design of the ERH-SVE system is initiated.

There have been at least 22 deployments of ERH, using either six-phase or three-phase current, generally at highly developed sites with numerous surface interferences. In several cases the systems have been installed through the floors of existing buildings, without structural damage to the buildings. The technology is well suited to remediation of recalcitrant volatile organic compounds (VOCs) in fine-grained, low permeability strata; VOCs usually boil at a lower temperature than water. Most of the deployments in the literature reached treatment temperatures of 100°C within 10 days of implementation. The average recovery efficiency reported for TCE is better than 99% in less than 120 days. This short period of performance allows valuable property to be returned to unrestricted use in a relatively short period.

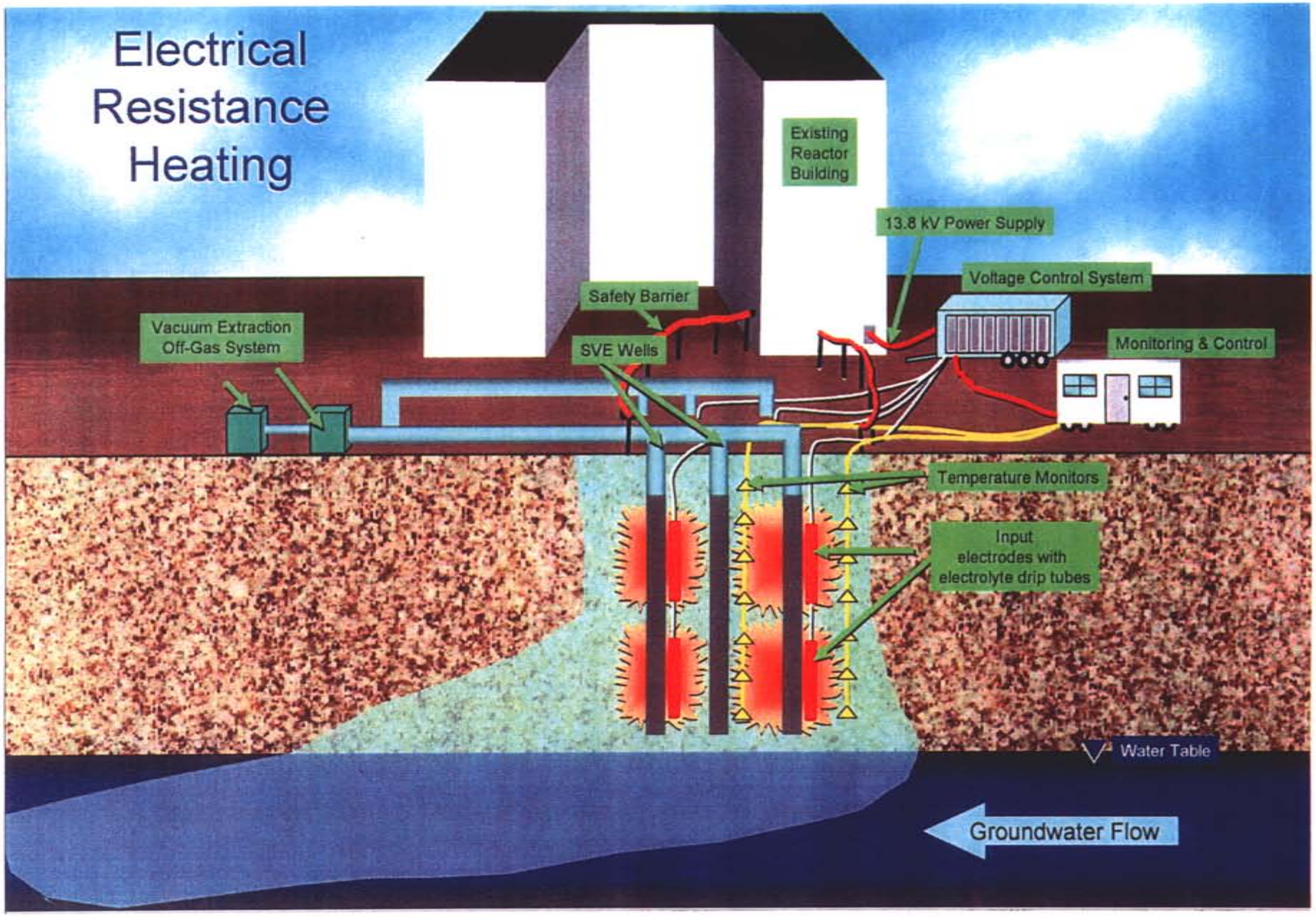


Figure 8. **Generalized Graphic of an ERH-SVE System**

ERH-SVE was demonstrated near M Area at SRS in November 1993 (USDOE 1995). During the 25-day demonstration, initial concentrations of 4,529 μg/kg (tetrachloroethylene [PCE]) and 181 μg/kg TCE were reduced by 99.7%. The calculated mass half-life (the period in which contaminant mass is reduced by one half) for PCE and TCE in the M-Area demonstration is about 3 days. PCE boils at 121 °C and TCE boils at 86.7 °C, so a TCE-dominated system would probably have a shorter mass half-life.

The ERH-SVE alternative was selected because it is highly effective in a short period of time and has a lower total cost than SVE. The total capital and O&M cost for ERH-SVE is about 67% of that for SVE alone. ERH-SVE is also more effective than SVE alone at removing volatile contaminants from low permeability soils. The stratigraphic section at the CRGW source unit consists of interbedded clay and sand, TCE is tightly bound to the fine soil particles in the clays with a maximum concentration of 51,836 μg/kg (28 feet below ground surface [bgs] in boring CRGW-4 at the center of the source as shown in Figure 3). Assuming a 3-day mass half-life based on the M-Area demonstration (USDOE 1995), the RAO would be attained in 30 days. ERH current flows readily through fine-grained strata, which impede the movement of liquids and vapors. The contaminants are vaporized and driven into the more permeable sands for recovery by the SVE wells. The ERH array should be adaptable to the crowded conditions around the C-Reactor building. Performance can be monitored without shutting the system down for a protracted build-up test. Thermocouples installed within the array can monitor formation temperature in the treatment zone, the off gas can be analyzed for concentration of the target compound, and groundwater monitoring can be conducted without disturbing the system. Reduction in the TCE concentration will be confirmed with chemical analysis of continuous soil cores in the intervals 19 to 30 and 55 to 72 feet bgs near CRGW-4 before the ERH-SVE system is dismantled.

The shutdown criterion for the Selected Interim Remedy is that the temperature in the treatment zone must exceed 86.7°C (boiling point of TCE) for at least 30 days, cumulatively. In the event that the system is shut down for more than 18 consecutive days, thermocouple temperatures will be monitored to ensure soil temperatures do not decrease below 86.7 C, the temperature at which TCE will begin to condense. If temperatures fall below 86.7 C, then the 30-day heating period will restart. As discussed in Section VIII, achieving a calculated RGO in the treatment zone is technically impracticable based upon past experience at SRS. The Core Team agreed that remedial system closure will be assessed by evaluating five parameters: 1) site characterization, 2) system design, 3) performance monitoring, 4) rate-limited vapor transport, and 5) mass flux analysis.

Within one year of ERH-SVE system shutdown, the results of the interim action will be reported in an effectiveness monitoring report, which will include temperature-monitoring data, mass removal rates, operating conditions, and analytical data from confirmatory soil cores. Reduction in the TCE concentration will be confirmed with chemical analysis of confirmatory samples. Data from the July 2002 source characterization will be included as baseline data. An interim remedy review will be submitted five years after the system is shut down. The interim remedy review will include the data reported in the effectiveness monitoring report and post-interim action groundwater sampling data.

ARARs that the selected interim remedy will attain include South Carolina Air Pollution Control Regulations and Standards (R.61.62), Water Pollution Control (R.61.9), and Underground Injection Control (R.61.87). The air quality permit will establish the daily limit for VOC release from the vapor recovery system. The pollution control permit will control the release of steam condensate to the National Pollutant Discharge Elimination System outfall. The underground injection permit will control the injection of electrolytes at the ERH electrodes.

The Selected Interim Remedy may change from that discussed in this IROD due to new information, design considerations, or construction technologies. Changes to the Selected Interim Remedy will be documented in the Administrative Record in accordance with requirements of the NCP.

Based on information currently available, the lead agency believes the Selected Interim Remedy provides the best balance of tradeoffs among the other alternatives with respect to the evaluation criteria. USDOE expects the Selected Interim Remedy to satisfy the statutory requirements in CERCLA Section 121(b) to (1) be protective of human health and the environment, (2) comply with ARARs, (3) be cost-effective, (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable, and (5) satisfy the preference for treatment as a principal element.

Cost Estimate for the Selected Interim Remedy

Table 1 presents a detailed, activity-based breakdown of the estimated costs (estimated capital cost, O & M cost and time, and present worth costs) associated with implementing and maintaining the Selected Interim Remedy. The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the Selected Interim Remedy. 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 will be documented in the Administrative Record in accordance with requirements of the NCP. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to –30 percent of the actual project cost.

Estimated Outcomes of Selected Interim Remedy

The interim RAO for the TCE vadose zone source unit at CRGW will be attained in less than one year. The *Savannah River Site Future Use Project Report* (USDOE 1996) shows heavy industrial (nuclear) as the recommended future land use for C Area (including the CRGW vadose zone source unit) and industrial (nuclear) for the surrounding area.

Table 1. Detailed Cost for Electrical Resistance Heating with SVE

Alternative S-3, Electrical Resistance Heating and Soil Vapor Extraction
IAPP for Vadose Zone Soil
C-Area Reactor Groundwater Operable Unit
Savannah River Site

Item	Quantity	Units	Unit Cost	Total Cost
CAPITAL COSTS				
Direct Capital Costs				
Submittals	1	ls.		$50,000
Technical Consulting (SRTC/Equipment Engineering)	1	ls		$12,000
Mobilization	1	ls		$11,000
Site Preparation (Surveys and Erosion Control)	1	ls		$31,000
Construction				
Electrial Resistance Heating System	1	ls		$820,000
ERH Electrode (7 wells, 14-inch borehole)	1	ls		$124,000
Thermocouple Piezometers (8 piezometers)	1	ls		$25,000
SVE System	1	ls		$158,000
Monitoring Well	1	ls		$13,750
Final Submittals/Start up	1	ls		$200,000
Demobilization & Site Restoration	1	ls		$20,000
Construction Management (25% Construction Cost)	1	ls		$300,688
Total Direct Capital Cost				$1,765,438
Other Capital Costs				
Engineering & Design	20%	of direct capital		$353,088
Project Management	10%	of direct capital		$176,544
Health & Safety	5%	of direct capital		$88,272
Total Other Capital Cost				$617,903
Subtotal Estimated Capital Cost				$2,383,341
Site Overhead	30%	of subtotal estimated capital		$715,002
Subtotal Estimated Capital Cost				$3,098,343
Contingency	15%	of total estimated costs		$464,751
Total Estimated Capital Cost				$3,563,094
OPERATION & MAINTENANCE (O&M) COSTS				
Direct O&M Costs	3.9%	discount rate		
Annual Costs	1	year O&M period		
Operations Cost	1	yr	$160,000	$160,000
Maintenance Cost	1	yr	$170,000	$170,000
Waste Management	1	yr	$25,000	$25,000
Subtotal - Annual Costs				$355,000
Present Worth Annual Costs				$341,675
Additional Annual Costs	6	year O&M period		
Performance/Groundwater Monitoring	1	yr	$80,000	$80,000
Subtotal - Annual Cost				$80,000
Present Worth Annual Costs				$420,740
Five Year Costs				
Remedy Review	2	ea	$14,000	$14,000
Subtotal - Five Year O&M Costs				$14,000
Present Worth Five Year Costs				$21,112
Total Present Worth Direct O&M Cost				$783,526
Other O&M Costs				
Project/Admin Management	10%	of direct O&M		$78,353
Health & Safety	5%	of direct O&M		$39,176
Total Present Worth Other O&M Cost				$117,529
Subtotal Present Worth O&M Cost				$901,055
Site Overhead	30%	of subtotal PW O&M		$270,317
Subtotal Present Worth O&M Cost				$1,171,372
Contingency	5%	of total PW O&M		$58,569
Total Present Worth O&M Cost				$1,229,940
TOTAL ESTIMATED COST				$4,793,034

The Selected Interim Remedy will have little or no effect on either dissolved phase or adsorbed TCE contamination below the water table; this contamination will have to be remediated within the aquifer or attenuated at the seepline. Attainment of the interim RAO will not change the available land use nor will it immediately change the available groundwater use. However, source removal will deprive the plume of additional mass and will result in TCE concentrations below the MCL (5 μg/L) throughout the plume in about 30 years (WSRC 2001). In the continuous source with no remediation scenario, the plume stabilizes above MCLs after 60 years.

Waste Disposal and Transport

The interim action will remediate TCE (low concentrations of PCE may also be present) within the vadose zone at CRGW. CRGW area is a non-listed waste site.

Waste will be managed according to the waste management plan included in the RAIP and in accordance with the Waste Management Plan approved by the regulators.

XII. STATUTORY DETERMINATIONS

Based on the unit RFI/RI report, TCE in the vadose zone source at CRGW poses a threat to human health and the environment. Because of its mobility, TCE in the CRGW vadose zone source unit is regarded as PTSM. Therefore, Alternative 3, ERH-SVE, has been selected as the interim remedy to permanently remove TCE from the CRGW vadose zone source so that leaching of any residual TCE will not cause groundwater to exceed the MCL (5.0 μg/L). ERH-SVE is more cost effective (about 67% of the total cost) than SVE alone; PTSM in the vadose zone source is also removed much faster by ERH-SVE, less than one year versus 7 years for SVE alone.

The Selected Interim Remedy is not intended to fully address the statutory mandate for permanence and treatment to the maximum extent practicable, but this interim action utilizes treatment and thus is in furtherance of that statutory mandate. Because this interim action does not constitute the final remedy for the CRGW, the statutory preference for remedies that employ treatment to reduce toxicity, mobility, or volume will be addressed by the final response action. Subsequent actions are planned to address fully the threats posed by the conditions at this OU.

This interim remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure. An interim remedy review will be conducted within five years after shut down of the ERH-SVE system to ensure that the remedy is, or will be, protective of human health and the environment.

XIII. EXPLANATION OF SIGNIFICANT CHANGES

The remedy selected in this IROD does not contain any significant changes from the preferred alternative presented in the IAPP. No comments were received during the public comment period.

XIV. RESPONSIVENESS SUMMARY

The Responsiveness Summary serves the dual purposes of (1) presenting stakeholder concerns about the site and preferences regarding the remedial alternatives, and (2) explaining how those concerns were addressed and how the preferences were factored into the remedy selection process. All comments, written or oral, received during the public comment period are addressed in the Responsiveness Summary. The Responsiveness Summary, included as Appendix A of this document, is blank, reflecting that no public comments were received.

XV. POST-IROD DOCUMENT SCHEDULE AND DESCRIPTION

Development of the *Interim Corrective Measures Implementation/Remedial Action Implementation Plan (ICMI/RAIP) for Remediation of the Trichloroethylene Vadose Zone Source Unit at the C-Reactor Groundwater Operable Unit* will begin within 30 days of SCDHEC and USEPA approval of the IROD (anticipated about June 30, 2004). The ICMI/RAIP will be submitted 220 days after approval of the IROD (anticipated about January 6, 2005). Construction mobilization for the Selected Interim Remedy, ERH-SVE, will begin within 20 days of receipt of SCDHEC and USEPA approval of the ICMI/RAIP (anticipated about July 6, 2005). The anticipated construction start date for the Selected Interim Remedy is September 30, 2005 and the anticipated construction completion date is April 4, 2006.

XVI. REFERENCES

FFA 1993. *Federal Facility Agreement for the Savannah River Site.* Administrative Docket No. 89-05-FF (Effective date: August 16, 1993) http://www.srs.gov/general/enviro/erd/ffa/ffaa.pdf

USDOE 1994. *Public Involvement, A Plan for the Savannah River Site.* United States Department of Energy, Savannah River Operations Office, Aiken, South Carolina

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http://www.epa.gov/ada/download/reports/epa_600_r01_070.pdf

WSRC 2001. *Groundwater Transport Modeling for Southern TCE and Tritium Plumes in the C-Area Groundwater Operable Unit (U).* WSRC-TR-2001-00206, Revision 0, June, Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina

WSRC 2003a. *Rendering and Visualization of C-Reactor Soil Contamination (U).* WSRC-RP-2003-4006, Revision 0, January, Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina

WSRC 2003b. *Focused Corrective Measures Study/Feasibility Study Report for the C-Area Burning/Rubble Pit (131-C) Operable Unit (U).* WSRC-RP-2002-4164, Revision 1, October, Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina

WSRC 2003c. *RCRA Facility Investigation/Remedial Investigation Report for the C-Area Reactor Groundwater (CRGW) Operable Unit (U).* WSRC-RP-2003-4073, Revision 0, December, Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina

WSRC 2004. *Interim Action Proposed Plan for Remediation of the Trichloroethylene Vadose Zone Source Unit at the C-Reactor Groundwater Operable Unit (U).* WSRC-RP-2003-4141, Revision 1.1, February, Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina

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APPENDIX A -

RESPONSIVENESS SUMMARY

Responsiveness Summary

The 30-day public comment period for the Interim Action Proposed Plan for Remediation of the Trichloroethylene Vadose Zone Source Unit at the C-Reactor Groundwater Operable Unit (U) began on March 17, 2004, and ended on April 16, 2004. No public comments were received.

The TCE vadose zone source unit is the subject of the interim remedial action selected in this IROD. This interim action only treats contaminated soil in the vadose zone above the groundwater portion of the CRGWOU. Contamination within the groundwater portion of this OU will be addressed in the final CRGW ROD.

Public Comments