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United States Department of Energy

Savannah River Site

Record of Decision
Remedial Alternative Selection for the TNX Area Operable Unit (U)

WSRC-RP-2003-4017

Revision 1

August 2003

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

RECORD OF DECISION
REMEDIAL ALTERNATIVE SELECTION (U)

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DECLARATION FOR THE RECORD OF DECISION

Unit Name and Location

TNX Area Operable Unit

Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Identification Number: 21

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 TNX Area Operable Unit (OU) is listed as a Resource Conservation and Recovery Act (RCRA) 3004(u) Solid Waste Management Unit/Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) unit in Appendix C of the Federal Facility Agreement (FFA) for the Savannah River Site (SRS).

The FFA is a legally binding agreement between regulatory agencies [United States Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control (SCDHEC)] and regulated entities [United States Department of Energy (USDOE)]. The agreement establishes the responsibilities and schedules for the comprehensive remediation of SRS. The Core Team for the TNX Area OU is a group of individuals with decision-making authority, including USDOE, USEPA, and SCDHEC remedial project managers. The following media are associated with this OU: soil, sediment, surface water and groundwater.

Statement of Basis and Purpose

This decision document presents the selected remedy for the TNX Area OU, at SRS near Aiken, South Carolina. The remedy 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). This decision is based on the Administrative Record File for this site.

SCDHEC and the USEPA concur with the selected remedy.

Assessment of the Site

Characterization activities at TNX have identified chemical and radionuclide constituents that present a potential risk to human and ecological receptors from exposure to sediment at the New TNX Seepage Basin (NTSB) and Old TNX Seepage Basin/Inactive Process Sewerline/Upper Discharge Gully (OTSB/IPSL/UDG) and to groundwater.

The response action selected in this Record of Decision (ROD) is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Description of the Selected Remedy

Based on the characteristics of the TNX Area OU, the OU has been subdivided into four major subunits: the NTSB/IPSL (904-102G); the TNX Burying Ground (TBG)/Vadose Zone (643-5G); the OTSB/IPSL/UDG (904-076G); and the TNX Groundwater (082-G). The selected alternatives for the TNX Area OU are described in the following paragraphs. To optimize resources and to effectively execute the remedial actions at the OTSB/IPSL/UDG and the Lower Discharge Gully (LDG) of the TNX Outfall Delta, Lower Discharge Gully and Swamp OU (TNXOD OU), the remediation of the LDG will be conducted with that of the OTSB/IPSL/UDG of the TNX Area OU.

New TNX Seepage Basin/Inactive Process Sewer Line

The NTSB/IPSL subunit consists of four sections – the IPSL that delivered wastewater to a small settling area (Inlet Basin), a larger basin (Main Basin) that is connected to the Inlet Basin and received the "decanted" wastewater, and an Overflow Discharge Area where wastewater was released when the Main Basin overflowed.

The selected remedy for the NTSB/IPSL subunit is Alternative NB-2a, Backfill with Institutional Controls. The selected remedy for this subunit entails the following:

- In situ grouting of the IPSL
- Discharge of surface water in the NTSB to an approved location (ground surface, permitted outfall, or wastewater treatment facility)
- Backfill of the Main Basin and Inlet Basin with clean soil
- Implementation of institutional controls to ensure the integrity of the backfilled basin, to prevent the future industrial worker from excavating contaminated media via access controls and field walkdown/maintenance, and to prevent residential use through property notices/restrictions. Institutional controls will remain in place in perpetuity or until the Core Team (USDOE, USEPA, and SCDHEC) concurs that no unacceptable risk to receptors is present.

The construction time to complete is approximately six months.

The source material in the NTSB/IPSL is considered low-level threat source material (LLTSM). There is no principal threat source material (PTSM) at the NTSB/IPSL.

TNX Burying Ground/ Vadose Zone

The selected remedy for the TBG/Vadose Zone subunit is Alternative V-2, Soil Vapor Extraction (SVE). The selected remedy for this subunit entails the following:

- Installation and operation of an active and passive SVE system in the TNX Vadose Zone.

The SVE system is currently operating as part of an Interim Remedial Action. Operations will continue under this ROD as a Final Action.

This remedy will treat the PTSM secondary source material at the TBG/Vadose Zone subunit.

Old TNX Seepage Basin/IPSL and Discharge Gully

The selected remedy for the OTSB/IPSL/DG subunit is Alternative OB-2bx, Engineered Cap with PTSM Removal and Institutional Controls. The selected remedy for this subunit entails the following:

- Removal of existing OTSB backfill
- Excavation of IPSL (where accessible) and associated radiologically contaminated soils for disposal
- Plugging the ends of any IPSL sections not excavated during this action with grout
- Excavation of the PTSM layer in the OTSB (2- to 3-ft soil interval at the original bottom of the inlet and main basins)
- Disposal of PTSM-contaminated soils and pipeline (estimated 2,180 yd^3 total) at an approved disposal facility
- Backfill of pipeline excavation and replacement of asphalt
- Backfill of the OTSB and DG
- Placement of an engineered cap (and associated institutional controls) over the OTSB and DG (from the TNX facility to the base of the slope at the TNX Outfall Delta)
- Installation of groundwater monitoring wells and vadose zone monitoring devices (e.g., lysimeters or tensiometers) to determine if waste left in place impacts or has the potential to impact groundwater above maximum contaminant levels (MCLs) beneath the subunit.
- Implementation of institutional controls to ensure the integrity of the engineered cap, to prevent the future industrial worker from excavating contaminated media via access controls and field walkdown/maintenance, and to prevent residential use through property

notices/restrictions. Institutional controls will remain in place in perpetuity or until the Core Team concurs that no unacceptable risk to receptors is present.

The construction time to complete is approximately twelve months.

This remedy will remove PTSM at the OTSB. The Core Team has decided that removing PTSM at this subunit is an important goal since the OTSB is near the SRS boundary. The engineered cap will prevent potential leaching of contaminants from deep soils at the OTSB and DG, and future industrial worker exposure to contaminants in surface soil at the DG.

TNX Groundwater

The selected remedy for the TNX Groundwater subunit is Alternative GW-4a, Extraction in High Chlorinated Volatile Organic Compound (CVOC) Area with Monitoring/Mixing Zone and Institutional Controls. The selected remedy for this subunit entails the following:

- Extraction of volatile organic compounds (VOCs) in the high concentration areas of the vadose zone (i.e., SVE)

- Continued operation of existing pump-and-treat system until groundwater monitoring determines that passive remediation (mixing zone) is appropriate.

- Use of continued monitoring and institutional controls. Institutional controls will consist of deed restrictions and/or administrative directives such as the Site Use Program, prohibiting installation of drinking water wells to prevent use of groundwater beneath TNX with concentrations of contaminants above MCLs. These controls will remain in effect until the Core Team concurs that constituent of concern (COC) concentrations in groundwater do not present unacceptable risk to receptors.

  At this time, decommissioning and decontamination of existing facilities and scheduled remediation of surface units will interfere with the implementation of a mixing zone monitoring system. Therefore, the applicability of a mixing zone application will be evaluated after conclusion of remediation of surface units and decontamination and decommissioning of the existing TNX facility. These activities are scheduled for completion in 2007. In the interim, groundwater will continue to be monitored to ensure that concentrations and extent are not increasing. Analytical results will be provided annually in the Comprehensive TNX Area Annual Groundwater and Effectiveness Monitoring Strategy Report. If any significant changes in contaminant levels or extent are identified, the Regulatory agencies will be contacted to determine if the groundwater monitoring or remedial strategy should be modified.

An interim action system is already operating, so construction is essentially complete.

The source material in the TNX Groundwater is considered LLTSM. There is no PTSM at the TNX Groundwater subunit.

The RCRA permit will be modified to reflect selection of the final remedy using the procedures in 40 CFR Part 270 and SCDHEC R. 61-79.

Statutory Determinations

Based on the *RCRA Facility Investigation/Remedial Investigation/Baseline Risk Assessment for the TNX Area Operable Unit* (WSRC 1999a) and the *Addendum to the RCRA Facility Investigation/ Remedial Investigation Report/ Baseline Risk Assessment for the TNX Area Operable Unit, Groundwater Radiological Characterization* (WSRC 2002c), the unit poses a risk to human health and the environment. Therefore, remedial actions discussed in the ***Description of the Selected Remedy*** have been identified as the selected remedies for the TNX Area OU. The selected remedies will be protective of human health and the environment based on an industrial land use scenario.

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 protective of human health and the environment.

The selected remedies are protective of human health and the environment, comply with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, are cost-effective, and utilize permanent solutions and alternative treatment technologies to the maximum extent practicable. By employing passive SVE, the remedy for the TBG also satisfies the statutory preference for treatment as a principal element (i.e., reduce the toxicity, mobility, or volume of materials through treatment). The Core Team has decided that removal and off-site disposal of the PTSM at the OTSB is preferable to treatment, since the OTSB is close to the SRS boundary.

In the long term, if the property is ever transferred to nonfederal ownership, the U.S. 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, in perpetuity, 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 TNX Area OU 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 Land Use Controls (LUCs) required by numerous remedial decisions at SRS are properly maintained and periodically verified. The unit-specific Land Use Control Implementation Plan (LUCIP) referenced in this ROD will provide details and specific measures required for the LUCs selected as part of this remedy. The USDOE is responsible for implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs selected under this ROD. The LUCIP, developed as part of this action, will be submitted concurrently with the Corrective Measures Implementation (CMI)/Remedial Action Implementation Plan (RAIP), as required in the FFA for review and approval by USEPA and SCDHEC. Upon final approval, the LUCIP will be appended to the LUCAP and is considered incorporated by reference into the ROD, establishing LUC implementation enforceable under CERCLA. The approved LUCIP will establish implementation, monitoring, reporting, and enforcement requirements for the unit. The LUCIP will remain in effect unless and until modifications are approved as needed to be protective of human health and the environment. LUCIP modification will only occur through another CERCLA document.

Data Certification Checklist

This is to certify that this ROD provides the following information:

- There is PTSM at this OU (see Sections VII and XI in the Decision Summary)
- COCs and their respective concentrations (see Section VII and Table 8 in the Decision Summary)
- Baseline risk represented by the COCs (see Section VII and Table 8 in the Decision Summary)
- Cleanup levels established for the COCs and the basis for the levels (see Section VIII and Table 8 in the Decision Summary)

- Current and future land and groundwater use assumptions used in the Baseline Risk Assessment (BRA) and ROD (see Section VI in the Decision Summary)

- Land and groundwater use that will be available at the site as a result of the selected remedy (see Section XI in the Decision Summary)

- 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 (see Tables 12 through 15 in the Decision Summary)

- Decision factor(s) that led to selecting the remedy (see Section X and Table 10 in the Decision Summary)

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10/2/03
Date

Jeffrey M. Allison, Manager
U. S. Department of Energy
Savannah River Operations Office

12/12/03
Date

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

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Date

R. Lewis Shaw
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Environmental Quality Control
South Carolina Department of Health and Environmental Control

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Date

Jeffrey M. Allison, Manager
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Savannah River Operations Office

Date

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

3/25/04
Date

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

DECISION SUMMARY
REMEDIAL ALTERNATIVE SELECTION (U)

TNX Area Operable Unit

WSRC-RP-2003-4017
Rev. 1

August 2003

Savannah River Site
Aiken, South Carolina

Prepared By:

Westinghouse Savannah River Company LLC
for the
U. S. Department of Energy under Contract DE-AC09-96SR18500
Savannah River Operations Office
Aiken, South Carolina

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LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
AWQC	Ambient Water Quality Criteria
BAF	bioaccumulation factor
bls	below land surface
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
Ci	curie
cm	Centimeter
CM	Contaminant migration
CMI	Corrective Measures Implementation
CMCOC	Contaminant migration constituent of concern
CMS/FS	Corrective Measures Study/Feasibility Study
COC	constituent of concern
CSM	conceptual site model
CVOC	chlorinated volatile organic compound
DG	Discharge Gully
DWPF	Defense Waste Processing Facility
EPC	exposure point concentration
ER	electrical resistivity
ESD	Explanation of Significant Difference
FFA	Federal Facility Agreement
ft	feet
ft^2	square feet
gal	gallon
ha	hectare
HI	hazard index
HQ	hazard quotient
HSWA	Hazardous and Solid Waste Amendments
in	inch
IPSL	inactive process sewer line
IROD	Interim Record of Decision
kg	kilogram
km	kilometer
L	liter
lb	pound
LDG	Lower Discharge Gully
LLC	Limited Liability Company
LLTSM	low-level threat source material
LUC	Land Use Controls
LUCAP	Land Use Controls Assurance Plan

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

LUCIP	Land Use Controls Implementation Plan
m	meter
m^2	square meter
MCL	maximum contaminant level
mg/kg	milligram/kilogram
µg/L	microgram per liter
mi	mile
msl	mean sea level
MZCL	mixing zone concentration limit
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Protection Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NFA	no further action
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NTSB	New TNX Seepage Basin
ODA	overflow discharge area
O&M	operating and maintenance
OTSB	Old TNX Seepage Basin
OU	operable unit
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
pCi	picocurie
PCR	Post-Construction Report
ppb	parts per billion
PTSM	principal threat source material
RAIP	Remedial Action Implementation Plan
RAO	remedial action objective
RCOC	Refined constituents of concern
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RG	remedial goal
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments Reauthorization Act
SB/PP	Statement of Basis/Proposed Plan
SCDHEC	South Carolina Department of Health and Environmental Control
SCHWMR	South Carolina Hazardous Waste Management Regulations
SRS	Savannah River Site
SVE	soil vapor extraction

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

TBC	to be considered
TBG	TNX Burying Ground
TCLP	toxicity characteristic leaching procedure
TES	Threatened, endangered, and sensitive
TNXOD OU	TNX Outfall Delta, Lower Discharge Gully and Swamp Operable Unit
TRV	toxicity reference value
UCL	upper confidence limit
UDG	Upper Discharge Gully
USC	unit-specific constituent
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
VIA	Value impact assessment
VCP	vitrified clay pipe
VOC	Volatile organic compound
WSRC	Westinghouse Savannah River Company, LLC
yd^3	cubic yard

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

Unit Name, Location, and Brief Description

TNX Area Operable Unit

Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Identification Number:
OU-CERCLIS number 21

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 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 United States Department of Energy (USDOE) owns SRS, which historically produced tritium, plutonium, and other special nuclear materials for national defense and the space program. Chemical and radioactive wastes are by-products of nuclear material production processes. Hazardous substances, as defined by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), are currently present in the environment at SRS.

The Federal Facility Agreement (FFA) (FFA 1993) for SRS lists the TNX Area Operable Unit (OU) as a Resource Conservation and Recovery Act Solid Waste Management Unit (RCRA)/CERCLA unit requiring further evaluation. The TNX Area OU required further evaluation through an investigation process that integrates and combines the RCRA Facility Investigation (RFI) process with the CERCLA remedial investigation (RI) process to determine actual or potential impact to human health and the environment from releases of hazardous substances to the environment.

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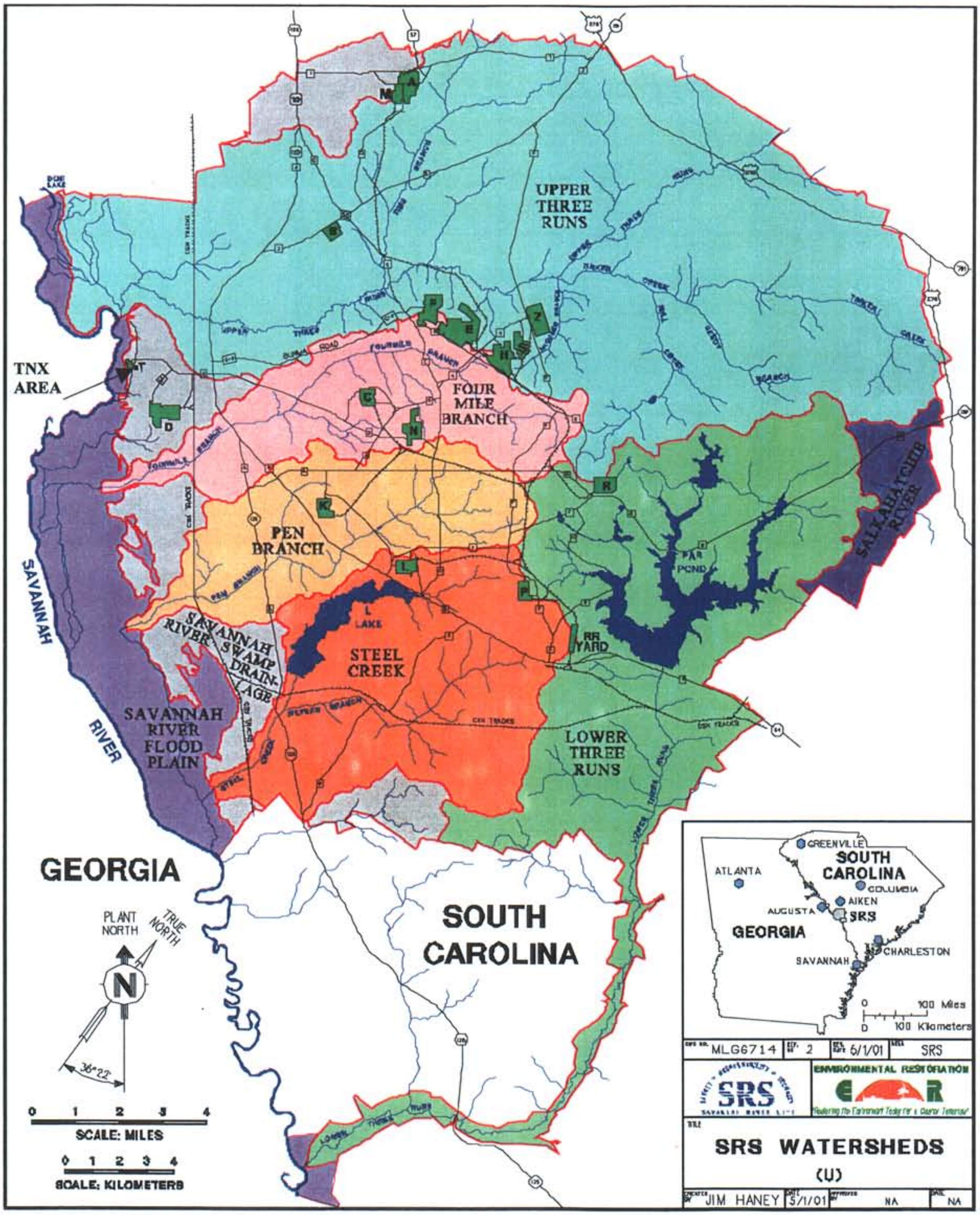

Figure 1. Location of the TNX Area OU within the Savannah River Site

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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 of at SRS. Past disposal practices have resulted in soil and groundwater contamination.

Hazardous waste handled at SRS is 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 SCDHEC, which was most recently renewed on September 5, 1995. Module IV 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 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 to fulfill these dual regulatory requirements. USDOE functions as the lead agency for remedial activities at SRS, with concurrence by the USEPA - Region IV and SCDHEC. The Core Team for the TNX Area OU is a group of individuals with decision-making authority, including USDOE, USEPA, and SCDHEC remedial project managers.

Operable Unit Operational and Compliance History

The TNX Area consists of three OUs: the TNX Area OU, the TNX Outfall Delta, Lower Discharge Gully and Swamp (TNX OD) OU, and the X-001 Outfall Drainage Ditch OU; two site evaluation areas: the Neutralization Sump 678-T and the TNX Area Process Sewer Lines As Abandoned; and three buildings: 678-T, 677-T and 672-T. It is anticipated that the X-001 Outfall Drainage Ditch OU, site evaluation areas and remaining TNX buildings will be included under an area-wide ROD. The TNX Area OU is located 0.4 km (0.25 mi) east of the Savannah River on a terrace between Upper Three Runs Creek to the north and Fourmile Branch to the south (Figure 1). TNX Area OU consists of four major subunits: the New TNX Seepage Basin (NTSB)/Inactive Process Sewer Line (IPSL); the TNX Burying Ground (TBG)/Vadose Zone; the Old TNX Seepage Basin (OTSB)/IPSL/Upper Discharge Gully (UDG); and the TNX Groundwater (082-G) (see Figures 2 and 3).

The TNX Area was a pilot-scale testing and evaluation facility that supported fuel and target manufacturing chemical processes and the Defense Waste Processing Facility (DWPF). Presently, the buildings and laboratories located in the TNX Area are undergoing decontamination and decommissioning.

Soil, sediment, surface water, and groundwater at the TNX Area OU were characterized to determine the nature and extent of contamination. The results of this characterization and risk assessment have been summarized in the TNX Area OU RCRA Facility Investigation/Remedial Investigation/Baseline Risk Assessment (RFI/RI/BRA) (WSRC 1999a), the Addendum to the RFI/RI/BRA for Groundwater Radiological Characterization (WSRC 2002c), and the Corrective Measures Study (CMS)/Feasibility Study (FS) (WSRC 2002d). The RFI/RI/BRA was approved by USEPA on January 15, 1999, and SCDHEC on December 9, 1998. The BRA Addendum for Groundwater

Radiological Characterization (WSRC 2002c) was approved by SCDHEC on September 9, 2002 and by USEPA on September 24, 2002. A pump-and-treat system consisting of four recovery wells feeding an air stripper was installed under an Interim Record of Decision (IROD) to contain and remediate that portion of the volatile organic compound (VOC) plume greater than 500 μg/L. This system has been operating effectively since 1996. In addition to the pump-and-treat system, two treatability studies using other technologies (i.e., GeoSiphon Cell and Soil Vapor Extraction [SVE]) have been performed to determine effectiveness of these technologies in removing VOCs from the vadose zone and groundwater. At this time, the treatability study for the GeoSiphon Cell has concluded, and the Core Team has agreed that the GeoSiphon cell will not be implemented as part of the remedial action. The SVE treatability study was successful, and the SVE network has been expanded under an Explanation of Significant Difference (ESD) to the IROD, which was approved in December 2001 by SCDHEC and in February 2002 by USEPA (WSRC 2001). The CMS/FS was approved by SCDHEC on March 18, 2002, and by USEPA on June 6, 2002 (WSRC 2002d). The Statement of Basis (SB)/Proposed Plan (PP) was approved by SCDHEC and by USEPA on January 8, 2003 (WSRC 2002f). A Groundwater and Effectiveness Monitoring Strategy Report is submitted annually to comply with the IROD and ESD. SRS will continue to evaluate the effectiveness of the on-going groundwater remediation in a comprehensive TNX Area Annual Groundwater and Effectiveness Monitoring Strategy Report. The report will be updated and submitted annually until the Core Team concurs that remedial goals (RGs) have been adequately achieved.

New TNX Seepage Basin/Inactive Process Sewer Line

The NTSB is an unlined earthen basin approximately 80 by 120 m (260 by 400 ft) in size. The NTSB, shown in Figures 2 and 3, includes the following four components:

- An Inlet Basin, 15 by 21 m (50 by 70 ft) in size and 1.2 m (4 ft) deep
- A Main Basin, 21 by 82 m (70 by 270 ft) in size and 2.1 m (7 ft) deep

- An Overflow Discharge Area (ODA), an irregularly shaped area defined by site topography with maximum lengths of 60 by 41 m (200 by 135 ft) and an area of approximately 2,500 m^2 (27,000 ft^2)

- A gravity-fed IPSL associated with the NTSB, a 20-cm (8 in) diameter vitrified clay pipe (VCP) sewer line that is approximately 2.4 m (8 ft) below grade at the highest elevation and approximately 1.2 m (4 ft) below grade at the inlet to the NTSB. The opening of the IPSL in the inlet basin of the NTSB is presently covered with sediment that has eroded from the sideslopes of the basin. The IPSL is approximately 61 m (200 ft) long, running west-northwest from the Inlet Basin to a manhole located on the west side of Road 4A (see Figure 2).

The operational history of the NTSB reveals that this basin was placed in operation in 1980 after closure of the OTSB. The NTSB operated until 1988. The NTSB, like the OTSB, received process wastewater flows from TNX pilot-scale simulations conducted in support of DWPF and the plant separations area. This wastewater consisted primarily of simulated nonradioactive sludge along with other nonradioactive wastes such as glass frit and laboratory sink discharges. No known hazardous waste was released to the basin. Prior to 1983, the discharges to the NTSB also included simulated nonradioactive salt supernate. On August 13, 1988, discharges to the NTSB were rerouted to the TNX Effluent Treatment Plant. When the IPSL was taken out of operation, the discharge from the process sewerline to the NTSB was plugged and a manhole where the process sewerline splits to the Effluent Treatment Plant and to the NTSB was filled with concrete, covering the outlet to the seepage basin. The process sewer line that fed the discharges to the Inlet Basin of the NTSB is inactive. However, the Main Basin and the Inlet Basin (two components of the NTSB) intermittently contain rainwater.

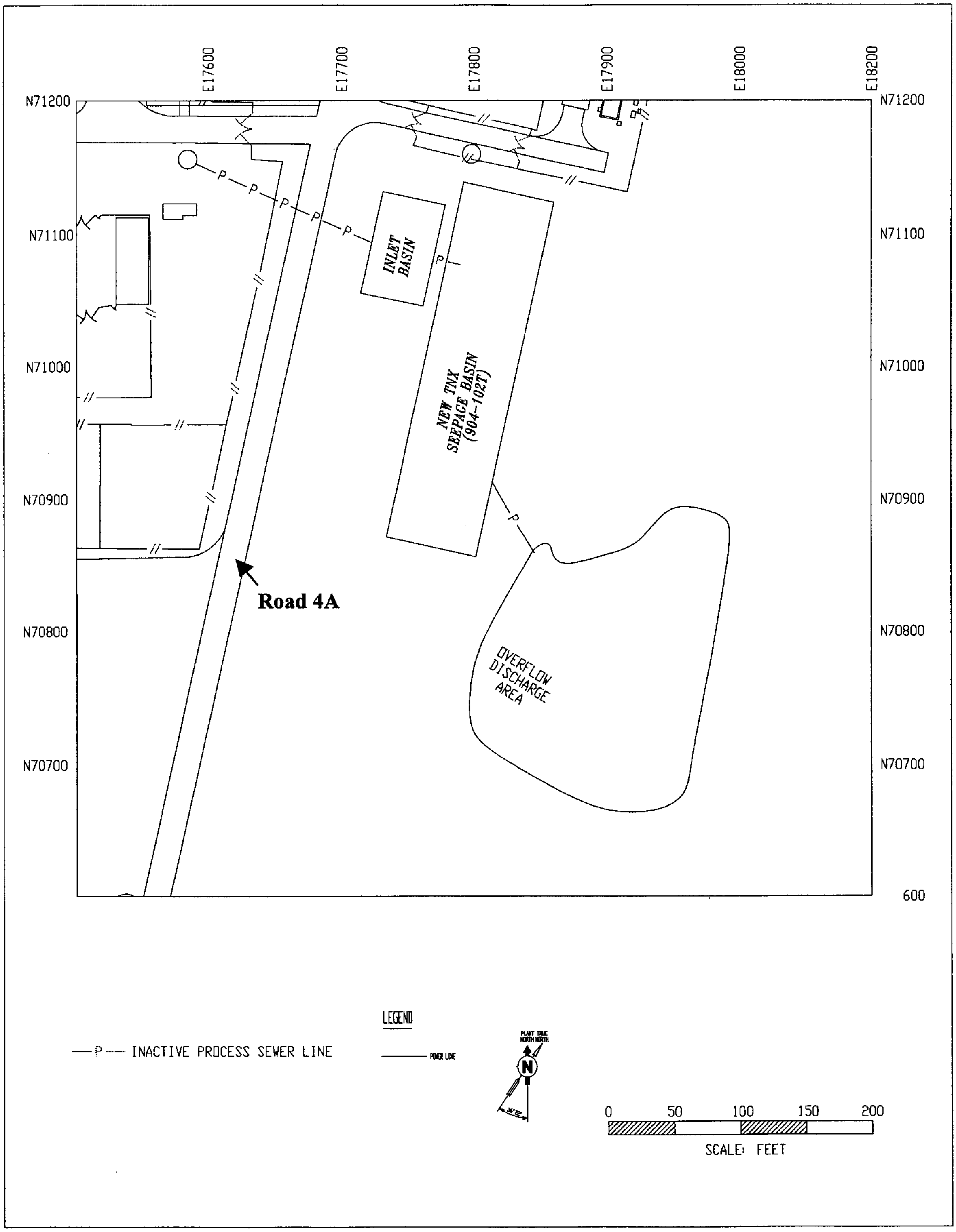

Figure 2. New TNX Seepage Basin Subunit

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Figure 3. Aerial Photograph of TNX Area OU and its Associated Subunits

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TNX Burying Ground/Vadose Zone

The TBG, which consisted of four known trenches at 6 to 8 ft below land surface (bls), was created in 1953 to dispose of debris from the accidental explosion of an experimental evaporator that was being used to concentrate a solution of uranyl nitrate (0.4 Ci) and nitric acid (Colven et al. 1953, Dunaway et al. 1987).

This debris included materials such as conduits, drums, and structural steel. Between 1982 and 1984, most of the buried material was excavated and sent to the SRS Radioactive Waste Burial Ground. Waste in five areas within the original four trenches was not excavated due to numerous underground and above-ground obstructions (Figure 4). In 1996, an additional disposal area outside of the original four trenches was discovered. Three drums containing materials contaminated with radionuclides and metals were identified and uncovered in the additional disposal area. Once the drums were disposed, the area was thoroughly characterized and no soil contamination or additional drums were identified.

Currently, most of the TBG area lies under existing buildings and laboratories. The area is highly congested with structures, and overhead and underground obstructions. Groundwater beneath the TBG is known to be contaminated with chlorinated volatile organic compounds (CVOCs) sourced from releases to the vadose zone soil beneath the TBG, and has elevated concentrations of nitrates-nitrites from nitric acid and leached metals (mercury and radium).

Soil vapor samples obtained during treatability studies for SVE indicate that the CVOCs are present in the vadose zone at 6 to 14 m (20 to 45 ft) bls beneath the TBG and adjacent to Building 672-T. CVOCs in the groundwater and vadose zone resulted from clean-up/decontamination operations associated with the accidental explosion in 1953 and operations at TNX. Soil vapor extraction is on-going at the TBG as part of an Interim Remedial Action (WSRC 2002b).

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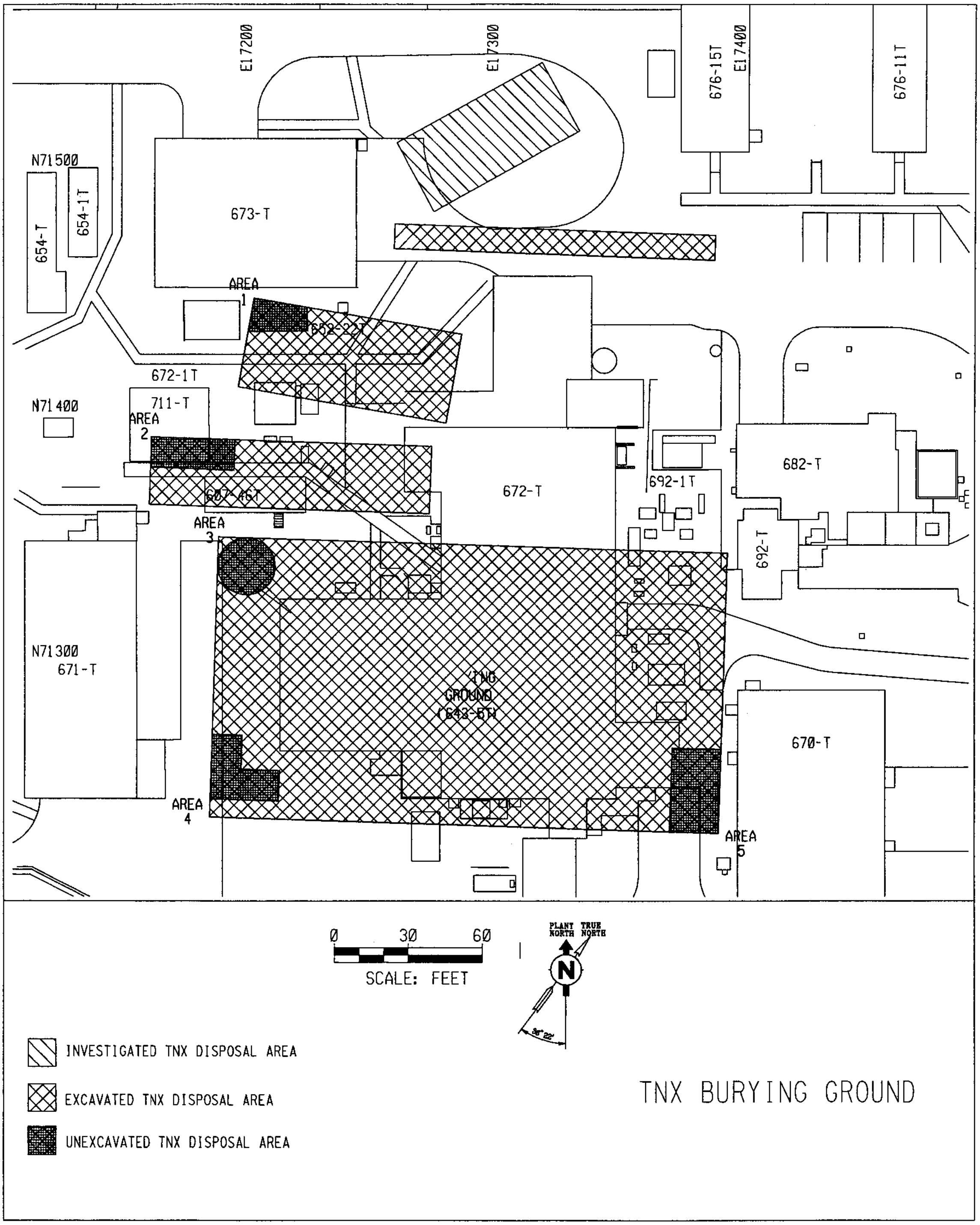

Figure 4. TNX Burying Ground Subunit

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Old TNX Seepage Basin/Inactive Process Sewer Line/ Discharge Gully

The OTSB was an unlined excavation approximately 24 by 53 m (80 by 175 ft). The OTSB, shown in Figures 3 and 5, primarily includes the following components:

- An Inlet Basin, approximately 13 by 10 m (43 by 33 ft) in size and 2.4 m (8 ft) deep
- A Main Basin, approximately 39 by 25 m (129 by 83 ft) in size and 3 m (10 ft) deep
- The IPSL (east and north lines), which is a 19.8- to 20-cm (7.8 to 8 in) diameter VCP, 50 m (165 ft) (east line) and 33 m (108 ft) (north line) long, and approximately 1.2 to 4 m (4 to 4.5 ft) bls
- The DG, which is a gully approximately 1,330 m^2 (14,318 ft^2) in area (the DG includes both the UDG of the TNX Area OU and the LDG of the TNXOD OU).

The OTSB was an unlined liquid-waste disposal area that operated from the mid-1950s until 1980. The OTSB received a number of chemicals ranging from inorganic salts and low-level radionuclides to organic solvents through a series of process sewer lines originating from Buildings 677-T and 678-T. These lines are now inactive.

The IPSL effluent was released via gravity flow, and most of the contaminant mass in the wastewater, including suspended solids, would have been discharged to the Inlet Basin; therefore, it is unlikely that significant residual material remains in the lines, and the IPSL is conservatively assumed to be contaminated at levels consistent with that in the Inlet Basin of the OTSB.

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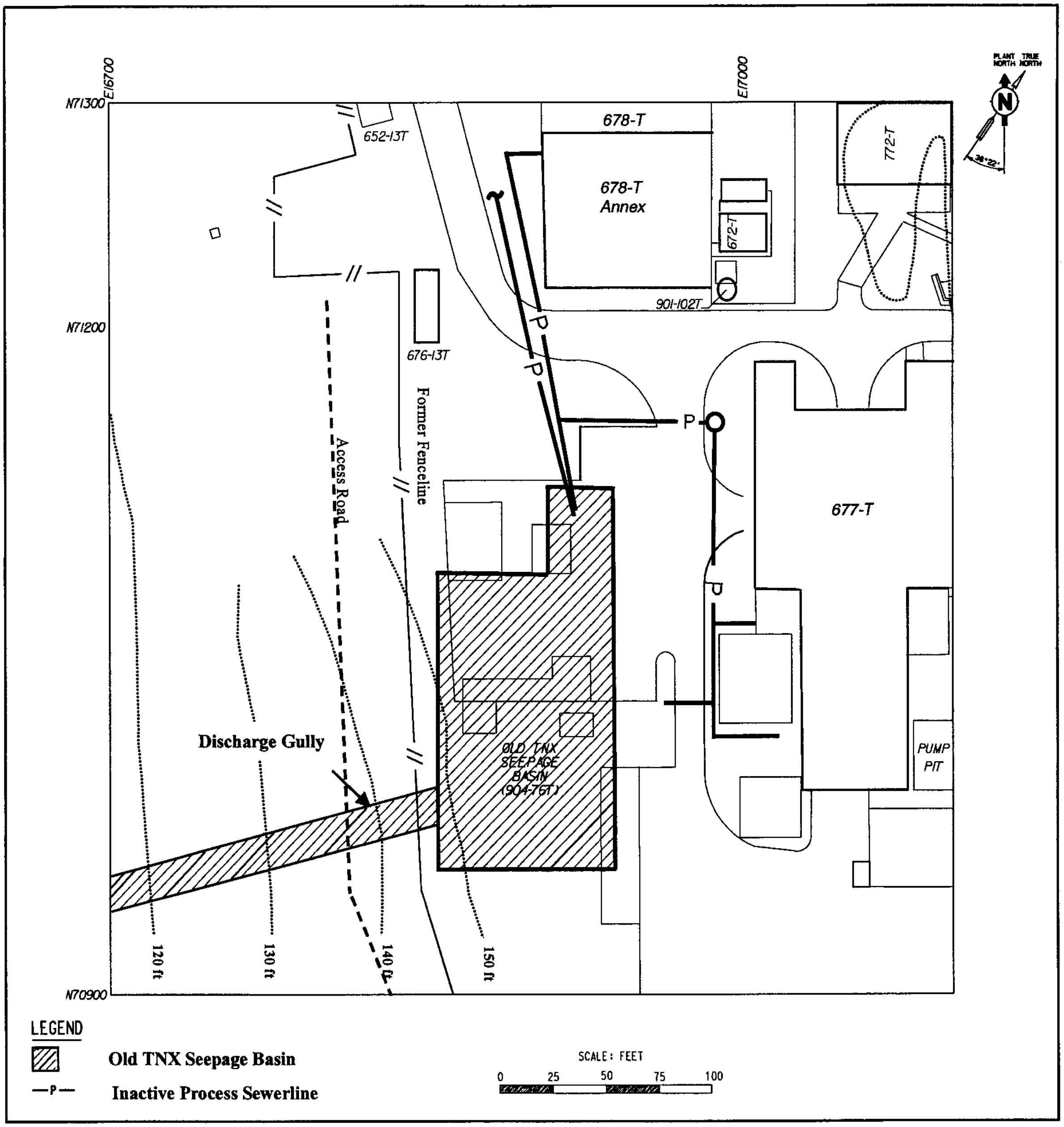

Figure 5. Old TNX Seepage Basin Subunit

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During periods of high flow, the Main Basin periodically overflowed downhill into the Savannah River flood plain adjacent to the TNX facility. In 1980, area wastewater was re-routed from the OTSB to the NTSB. During closure of the OTSB in 1981, the remaining liquid was drained to the nearby flood plain. As a result of these overflow events, erosion occurred in the hillside, forming a gully (DG) and a sediment fan (Outfall Delta), and contaminated the inner portion of TNX swamp (Inner Swamp).

The basin was backfilled with clean sand and clay, then covered with clay. A portion of the cover was vegetated, and an asphalt cover was placed over the remainder. The overflow discharge pipe was re-routed to drain stormwater runoff from the vegetated and asphalt surfaces covering the OTSB to the LDG.

The TNXOD OU was originally part of the TNX Area OU (WSRC 1997). The LDG and OD were formed during overflow and closure of the OTSB. However, in March 1998, USDOE, USEPA, and SCDHEC agreed to separate these subunits, and to identify a new OU (TNXOD OU). The OUs were separated on the slope between the TNX Area facility fenceline and the TNX Swamp. The OUs are contiguous, and the boundary is not well defined between the UDG and LDG. This separation allowed additional characterization activities in the TNX Swamp to be completed without impacting the remainder of the TNX Area OU.

During development of the CMS/FS for the TNXOD OU, the Core Team recognized that remedial options for the LDG of the TNXOD OU are similar to that of the OTSB/IPSL/UDG of the TNX Area OU (WSRC 2003). To execute the remedial work (i.e., rerouting of the stormwater discharge, infill of the DG and capping), it will be necessary to combine remediation of the LDG with the OTSB/IPSL/UDG. In addition, the concurrent execution of the remedial actions for the two subunits will be more cost effective. The selected remedy for the OTSB/IPSL/DG, discussed in Section XI of this document, includes the LDG. An explanation of the significant changes between the selected remedy and the preferred alternative identified in the proposed plan is provided in Section XIII.

TNX Groundwater

Groundwater monitoring has been performed at TNX since the 1980s. This monitoring has identified CVOC contamination (Figure 6). An IROD was issued in 1996 for removal of CVOCs from the groundwater to mitigate the migration of CVOCs. The remedial action entailed use of extraction wells and an air stripper. As of December 2002, 837,000,000 liters (221,000,000 gallons) of groundwater have been treated, and 46.22 kg (102.7 lb) of CVOCs have been removed.

The unit is at an elevation of 46 m (150 ft) above mean sea level (msl). Local topography is relatively flat and slopes westward toward the Savannah River. A portion of the Savannah River flood plain swamp lies immediately west of the TNX Area OU at an elevation of 29 m (95 ft) msl.

During high stages of the river, portions of the swamp may be flooded. The swamp has stands of cypress and tupelo in low-lying areas and bottomland hardwoods at higher elevations. The water table is approximately 11 m (35 ft) bls at the NTSB, 14 m (45 ft) bls at the TBG, and 17 m (55 ft) bls at the OTSB. The water table elevation ranges from approximately 37 m (120 ft) above msl at the NTSB to 27 m (90 ft) above msl in the Savannah River flood plain. There is an upward gradient between the shallow and deeper aquifer systems below the Crouch Branch confining unit.

This upward gradient is such that groundwater beneath the TNX facility and flood plain areas moves progressively from the deeper aquifer system to the shallow aquifer and then discharges in the Savannah River flood plain or Savannah River. In the Savannah River flood plain, the X-008 outfall ditch intersects the water table and is a groundwater discharge area.

The TNX Area comprises several different vegetative communities. These provide a variety of habitats for wildlife, and may be exposed to contaminants in surface runoff and groundwater seeps as well as in existing soils and sediments. Habitat quality varies from poor within the industrial area, which is largely composed of buildings and parking areas, to high in areas along the Savannah River flood plain to the west. Based on field observations, literature review, and interpretation of limited aerial photographs, five major vegetative community types are identified within the vicinity of the OU. The major plant community types include the following:

- Fragmented vegetation within the industrial area
- Grassy areas maintained by mowing
- Upland (transitional) hardwood forest
- Bottomland hardwood forest
- Swamp forest

Animal species were observed inhabiting the unit and surrounding area. The well-developed overstory and variety of plant species in these communities, combined with the availability of water, make the area surrounding the OU attractive to wildlife species, including mammals, birds, reptiles, and aquatic life.

A threatened, endangered, and sensitive (TES) species survey was conducted at the unit. No TES species of plants or animals were observed during the ecological unit reconnaissance. This is consistent with a U.S. Forest Service finding that no TES species are known to occur near the TNX Area OU (LeMaster 1995).

The TNX Area OU does not contain wetlands or water wells that could be used as a drinking water supply.

The interim action taken for groundwater and PTSM in the vadose zone beneath the TBG are the only actions taken at the site at this time.

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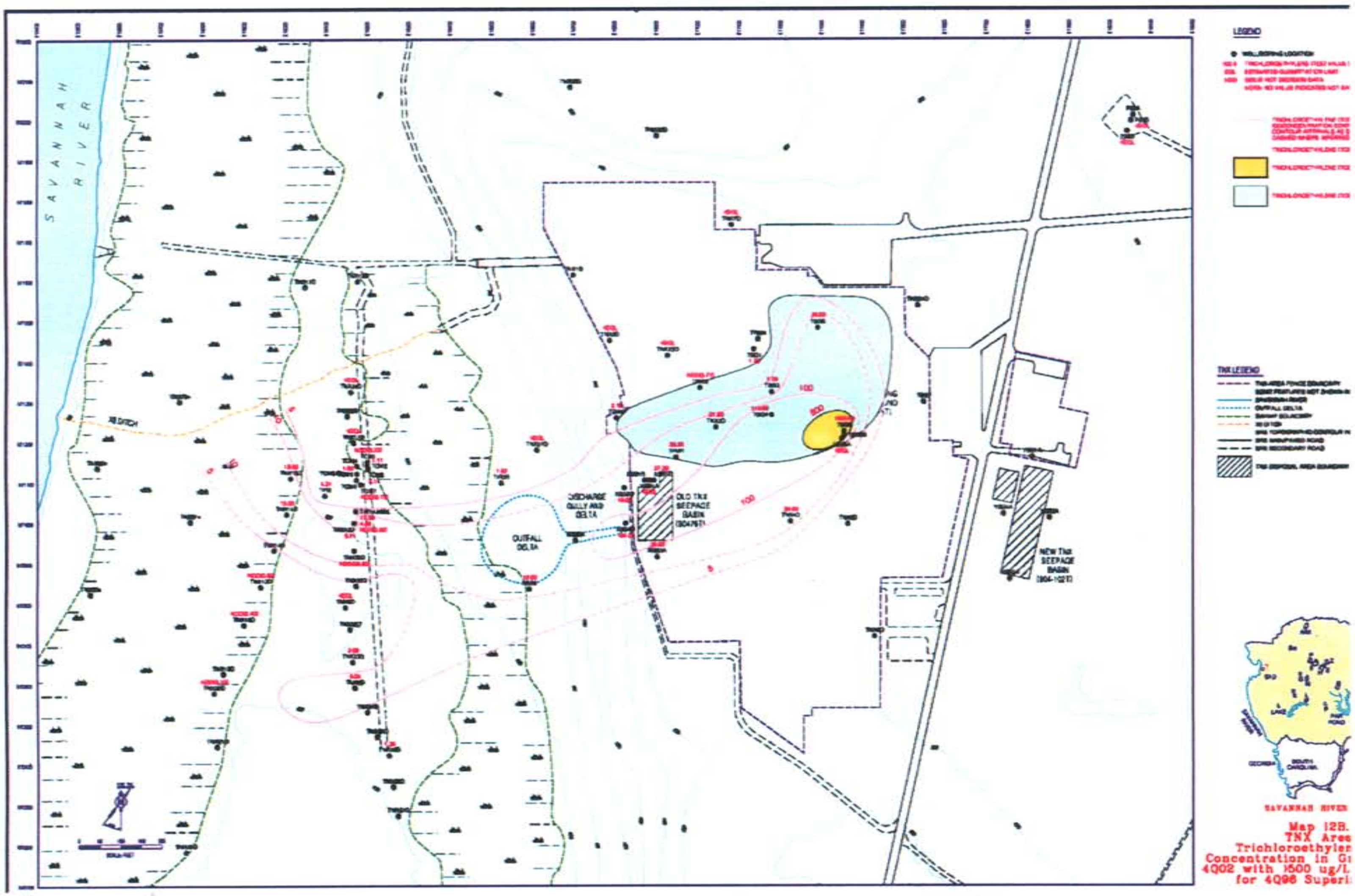

Figure 6. **TNX Area Trichloroethylene Plume in Groundwater, Fourth Quarter 2002**

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III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Both RCRA and CERCLA require that the public be given an opportunity to comment on the proposed remedy via draft permit modification under RCRA or a proposed plan under CERCLA. 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 alternative for addressing the TNX Area OU soils, sediment, surface water and groundwater. The Administrative Record File must be established at or near the facility at issue.

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 and provide the public an opportunity to participate in the selection of the remedial action. The SB/PP for the TNX Area OU, a part of the Administrative Record File, highlights key aspects of the investigation and identifies the preferred action for addressing the TNX Area OU.

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

U.S. Department of Energy
Public Reading Room
Gregg-Graniteville Library
University of South Carolina – Aiken
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
8901 Farrow Road
Columbia, South Carolina 29203
(803) 896-4000

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

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 SB/PP 45-day public comment period began on January 22, 2003 and ended on March 7, 2003. No comments were received during the public comment period.

IV. SCOPE AND ROLE OF THE OPERABLE UNIT WITHIN THE SITE STRATEGY

RCRA/CERCLA Programs at SRS

RCRA/CERCLA units (including the TNX Area OU) at SRS are subject to a multi-stage RI process that integrates the requirements of RCRA and CERCLA as outlined in the FFA (FFA 1993). The RCRA/CERCLA processes are summarized below:

- investigation and characterization of potentially impacted environmental media (such as soil, sediment, groundwater, and surface water) comprising the waste site and surrounding areas

- evaluation of risk to human health and the local ecological community

- screening of possible remedial actions to identify the selected technology which will protect human health and the environment

- implementation of the selected alternative

- documentation that the remediation has been performed competently

- evaluation of the effectiveness of the technology

The steps of this process are iterative in nature and include decision points that require concurrence between USDOE as owner/manager, USEPA and SCDHEC as regulatory oversight agencies, and the public. Figure 7 is a flow chart presenting the process of logic and documentation.

The ROD provides a description of the selected remedial actions and responses to stakeholder concerns received during the public comment period prior to implementation of the selected alternatives.

Operable Unit Remedial Strategy

The overall strategy for addressing the TNX Area OU was to (1) characterize the waste unit, delineating the nature and extent of contamination and identifying the media of concern (perform the RFI/RI); (2) perform a BRA to evaluate media of concern, COCs, exposure pathways, and characterize potential risks; and (3) evaluate and perform a final action to remediate, as needed, the identified media of concern.

Contaminated soils within the Savannah River flood plain adjacent to the TNX Facility are being managed in a separate OU with the exception of the LDG of the TNXOD OU. To execute the remedial actions at the OTSB/IPSL/UDG and the LDG of the TNXOD OU and to optimize resources, the remedial action at the LDG will be conducted concurrently with that of the OTSB/IPSL/UDG of the TNX Area OU (see Section XII for an explanation of significant changes).

The contaminated soils, sediments, surface water and groundwater associated with the TNX Area OU and the LDG of the TNXOD OU are being addressed in this ROD. After implementation of remedial actions for the TNX Area OU and the remainder of the TNXOD OU, SRS will manage all source control units to prevent impact to the watershed. Upon disposition of all source control and groundwater subunits within the watershed, a final comprehensive ROD for the Savannah River Flood Plain Swamp Watershed will be issued.

V. OPERABLE UNIT CHARACTERISTICS

This section presents the conceptual site model (CSM) for the TNX Area OU, provides an overview of the characterization activities conducted at TNX, presents the characterization results and COCs, and provides an overview of the contaminant transport analysis.

Conceptual Site Model (CSM) for the TNX Area OU

The CSM for the TNX Area OU is presented in Figure 8, which represents the CSM in a schematic cross section of the four subunits: the NTSB/IPSL, the TBG/Vadose Zone; the OTSB/IPSL/DG, and the TNX Groundwater. Detailed CSM diagrams for each of the subunits supporting the baseline risk assessment are provided in Section VII. The CSM identifies the known and suspected sources of contamination, the known and potential routes of migration and the types of contaminants and potentially affected media. The exposure routes and the known and potential human and ecological receptors will be presented in the summary of operable unit risks in Section VII.

Primary Sources of Contamination

The RFI/RI/BRA report for the TNX Area OU evaluated the following three suspected primary source units: NTSB, TBG, and OTSB including the IPSL. The suspected primary sources of contamination included past wastewater discharges to the NTSB and OTSB/IPSL, and buried wastes in the TBG.

Primary Source Mechanisms

Hazardous and/or radioactive wastes could have been or could be released from the primary sources of contamination by the following mechanisms:

- Discharge of NTSB wastewater during operation
- Infiltration and percolation of NTSB wastewater into subsurface soil
- Overflow of OTSB wastewater during operation and closure
- Infiltration and percolation of OTSB wastewater into subsurface soil
- Infiltration and percolation of IPSL waste into the underlying soil
- Leaching of contaminants from the buried wastes in TBG and infiltration/percolation from other TNX operations.

Secondary Sources of Contamination

The soil, sediment, and surface water at the NTSB, soil at the OTSB/DG, and soil at the TBG are considered secondary source material in the RFI/RI/BRA because they contain contaminated media only. Secondary sources of contamination include the following:

- soil in the ODA associated with the NTSB
- sediment and surface water in the NTSB
- subsurface soil beneath the NTSB
- subsurface soil beneath the OTSB and the IPSL
- soil in the DG associated with the OTSB, and
- subsurface soil in the TBG.

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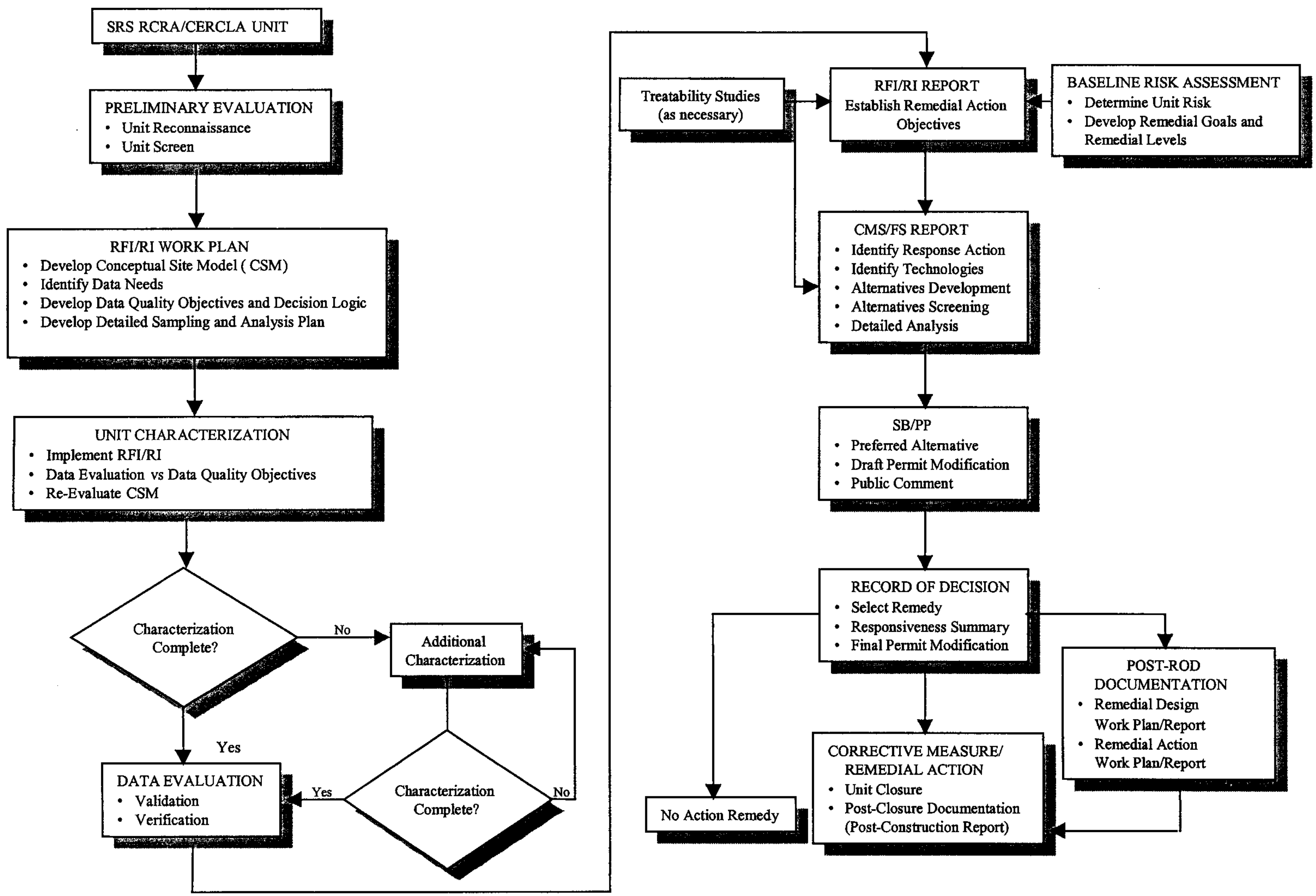

Figure 7. RCRA/CERCLA Logic and Documentation

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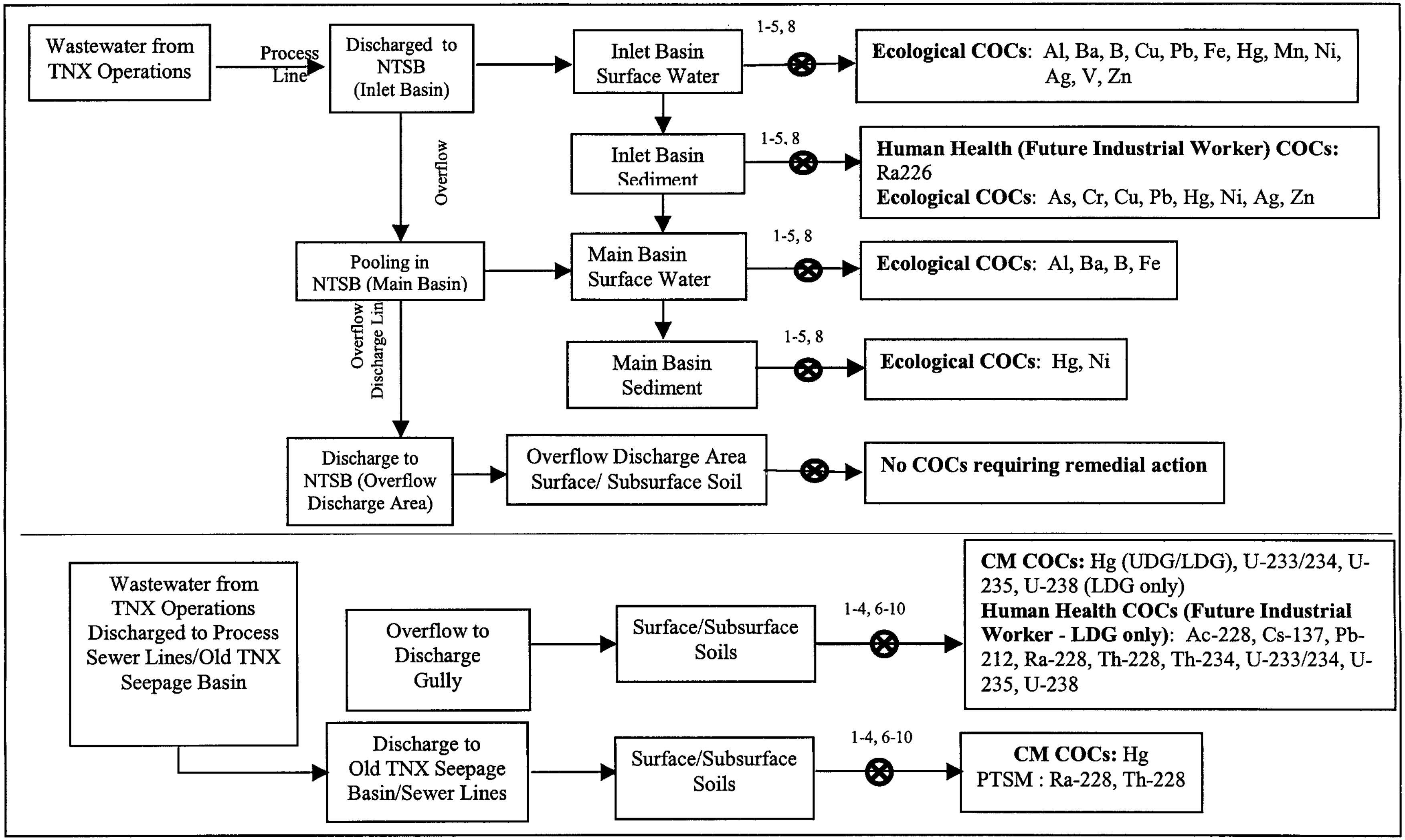

Figure 8. Conceptual Site Model for the TNX Area OU

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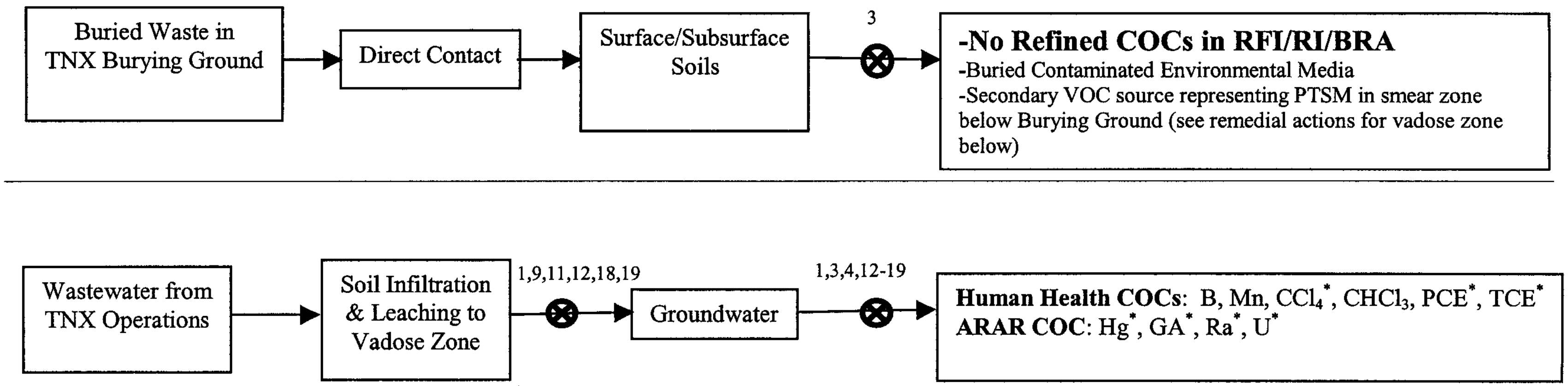

NOTES FOR REMEDIAL ACTIONS:

(1) No Action
(2) Access Controls
(3) Land Use Restrictions
(4) Monitoring
(5) Earthen Cover
(6) Asphalt Cap
(7) Engineered Cap
(8) Removal/Excavation/Off-site Disposal
(9) In Situ Stabilization
(10) Cement-based Ex Situ Treatment
(11) Soil Vapor Extraction (SVE)
(12) Dual Media Extraction
(13) GeoSiphon
(14) Monitoring/Mixing Zone
(15) Extraction Wells
(16) Permeable Treatment Walls
(17) Air Stripping
(18) Air Sparging
(19) Chemical Oxidation

REFINED COC ABBREVIATIONS

Al = Aluminum	Pb = Lead
Ag = Silver	V= Vanadium
As = Arsenic	Zn = Zinc
Ba =Barium	CCl_4 = carbon tetrachloride
B = Boron	$CHCl_3$ = chloroform
Cr = Chromium	PCE = tetrachloroethylene
Cu = Copper	TCE = trichloroethylene
Fe = Iron	Ra = Radium
Hg = Mercury	U = Uranium
Mn = Manganese	Th = Thorium
Ni = Nickel	GA = Gross Alpha

OTHER NOTES:

* Groundwater constituent exceeded MCL value.
NTSB = New TNX Seepage Basin

⊗ = pathway break for remedial considerations

COC = Constituent of Concern
ARAR = Applicable or relevant and appropriate requirement

Figure 8. Conceptual Site Model for the TNX Area OU (Continued)

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Secondary Sources Mechanism

Environmental media serves both as a reservoir via chemical bonding and biotic uptake, and as a secondary release mechanism for contaminants from the TNX Area OU. The following secondary environmental release mechanisms are addressed by the RFI/RI/BRA (WSRC 1999a, WSRC 2002e):

- Dust and/or volatile emissions from the surface water and soil/sediment in the Inlet Basin and ODA associated with the NTSB
- Biotic uptake occurring in the DG associated with the OTSB and the Inlet Basin and ODA associated with the NTSB
- Infiltration and percolation of surface waters in the ODA associated with the NTSB
- Leaching of contaminants from sediment and subsurface soil in the NTSB to the groundwater
- Leaching of contaminants from subsurface soil in the OTSB, beneath the IPSL, and in the DG to the groundwater
- Leaching of contaminants from subsurface soil in the TBG to the groundwater

Media Assessment

The RFI/RI/BRA report (WSRC 1999a) and BRA Groundwater Radiological Addendum (WSRC 2002c) contain the detailed information and analytical data for all the investigations conducted and samples taken in the media assessment of the TNX Area OU. Information and data for the LDG of the TNXOD OU are provided in the RFI/RI/BRA for the TNXOD OU (WSRC 2002e). These documents are available in the Administrative Record File (see Section III of this document).

The investigations conducted to characterize TNX Area OU soils, sediment, surface water and groundwater are summarized in Table 1.

Background Investigation

Background soil samples and upgradient surface water, sediment, and groundwater samples were obtained to establish baseline concentrations for evaluation of potential contaminants and pathway information.

New TNX Seepage Basin/Inactive Process Sewer Line

Soils and Sediments

- A source material evaluation has determined that the material at the NTSB is considered LLTSM.

- Radium-226 is identified as the only human health refined constituent of concern (RCOC) requiring remedial action for future industrial workers exposed to the sediment in the Inlet Basin.

- Radium-226 and uranium-238 are identified as human health RCOCs for the future industrial worker and future resident scenarios exposed to the ODA subunit soil; however, because concentrations are within the natural background range, radium-226 and uranium-238 are not a problem warranting action. There are human health RCOCs for the future resident in the ODA (barium, manganese, and nickel), but since this area will be industrial, institutional controls and deed restrictions will prevent residential exposure. The Core Team has agreed that the RCOCs based on the residential scenario do not require remedial action.

- Mercury and nickel are identified as ecological RCOCs for sediment-dwelling biota in the Main Basin.

- Arsenic, chromium, copper, lead, mercury, nickel, silver, and zinc are identified as ecological RCOCs for sediment-dwelling biota in the Inlet Basin subunit. Additionally, chromium, lead and mercury are also identified as ecological RCOCs for the Inlet Basin sediment for predatory animals such as the heron.

- The IPSL associated with the NTSB was not characterized during development of the RFI/RI/BRA report. Because IPSL effluent was released via gravity flow, it is unlikely that significant residual material remains in the line. While it is uncertain whether or not there was leakage from the sewerline to adjacent soil, most of the contaminant mass in the wastewater, including suspended solids, would have been discharged to the Inlet Basin. Therefore, constituent concentrations, if any, released to the soil adjacent to the sewerline would not be any higher than in the basin sediment. Because the IPSL is at least 1.2 m (4 ft) bls along its entire length, it does not represent an exposure pathway for human or ecological receptors. A conservative contaminant migration analysis was performed to estimate impact to the groundwater from potential sewerline leaks. The analysis assumed that a 0.6 m (2 ft) zone around the entire length of the sewerline is contaminated at the maximum detected concentrations in the soil/sediment samples in the NTSB. The results of the analysis indicate that there would be no contaminant migration constituents of concern (CMCOCs) from soil surrounding the IPSL (WSRC 2002c). Based on these assumptions, and the knowledge that neither the Inlet nor Main Basin have contaminants that are not mitigated by adequate cover, contamination from the IPSL, if any, would not present a problem warranting action.

- No CMCOCs were identified for soil or sediments.

- Figure 9 presents a schematic cross section of the NTSB, showing the RCOCs.

Table 1. History of Environmental Activities Performed at the TNX Area OU

Investigation Dates	Media Sampled	Location	Number of Borings/Samples
New TNX Seepage Basin/IPSL/ODA			
1985	Soil Sludge	Basin & vicinity Basin	54 samples, 6 borings; 1 sample
1992	Sediment Soil	Basin Background	3 samples 2 samples
Jan. – Aug. 1996	Soil Surface Water Geotechnical	ODA Main Basin & Inlet Basin Basin Vicinity	2 samples; 1 boring 3 samples 1 sample
Jan. – Feb. 1998	Soil Sediment Geotechnical	Inlet Basin, Main Basin & ODA Inlet Basin & Main Basin Inlet Basin, Main Basin & ODA	48 samples 5 samples 1 sample 4 samples
Old TNX Seepage Basin/IPSL/DG			
December 1974	Liquid	Basin, Building Sumps, Sewer line	Unknown
December 1980	Soil	Basin & vicinity	6 samples; 3 borings
January 1983	Soil, Groundwater	Basin	3 wells; 3 core; 3 surface soil
November 1983	Soil	Basin & vicinity	9 borings
July 1986	Aerial Rad Survey	TNX Area OU	N/A
August 1992	Ground penetrating radar	Basin & vicinity	28 lines
Jan. – Aug. 1996	Geotechnical Soil	Basin Basin Sewer Line DG	3 borings 2 borings 30 borings 21 borings
August – Sept. 2000	Soil Surface Water	LDG Discharge Gully Pipe	12 borings 1 sample
May – July 2002	Geotechnical Soil, *TCLP/Radionuclides	Basin vicinity Basin	3 samples; 1 boring 42 samples; 14 borings
TNX Burying Ground			
November 1988	Soil	TBG, all areas	42 samples; 14 borings
Jan. – Sep. 1996	Soil Soil	Areas 1 through 5 Suspect Area New Suspect Area Previously Excavated Area Perimeter	5 borings 2 borings 9 borings 7 borings 14 borings
May – June 2001	Soil	TBG, 15 locations	CPT lithology, 14 locations 72 soil vapor samples
TNX Groundwater			
Jan. – Sep. 1996	Groundwater	OTSB TBG NTSB General Area New Wells Background	5 wells 8 wells; 2 Hydropunch 4 wells 12 wells 3 wells 3 wells
July 1999 – On-going	Groundwater	TNX flood plain Burying Ground NTSB OTSB General Area Background	38 wells 7 wells 4 wells 6 wells 11 wells 3 wells

*TCLP – toxicity characteristic leaching procedure

Surface Water

- The results of the surface water analyses revealed that the standing surface water resulting from rainfall in the Inlet Basin has been contaminated with aluminum, barium, boron, copper, iron, lead, manganese, mercury, nickel, silver, vanadium, and zinc at levels that present a risk to aquatic biota. The standing surface water resulting from rainfall in the Main Basin has been contaminated with aluminum, barium, boron, and iron at levels that present a risk to aquatic biota (see Figure 9).

TNX Burying Ground/Vadose Zone

- No final human health or ecological COCs or CMCOCs were identified for the TBG.
- Data from an ongoing SVE treatability study indicate the presence of a continuing secondary source of VOCs in the vadose zone that impact groundwater at concentrations above maximum contaminant levels (MCLs). This secondary source material is considered PTSM and warrants action. SVE operations at the TBG are ongoing as part of an Interim Remedial Action (WSRC 2002b).
- Figure 10 presents a schematic cross section of the TBG/vadose zone.
- Due to numerous underground and above ground obstructions, several TBG areas were not thoroughly investigated during RFI/RI characterization activities. These areas include previously excavated areas located beneath buildings and five unexcavated TBG areas. The unexcavated areas may contain buried contaminated materials, but these materials are not expected to be contaminated at concentrations that would pose a risk to human health or the environment based on an industrial land use scenario. Once decontamination and decommissioning of the obstructing facilities and utilities have been completed, sampling will be conducted. If post-decommissioning characterization reveals contamination requiring remediation, then an appropriate action will be added to the remedy through an ESD or ROD.

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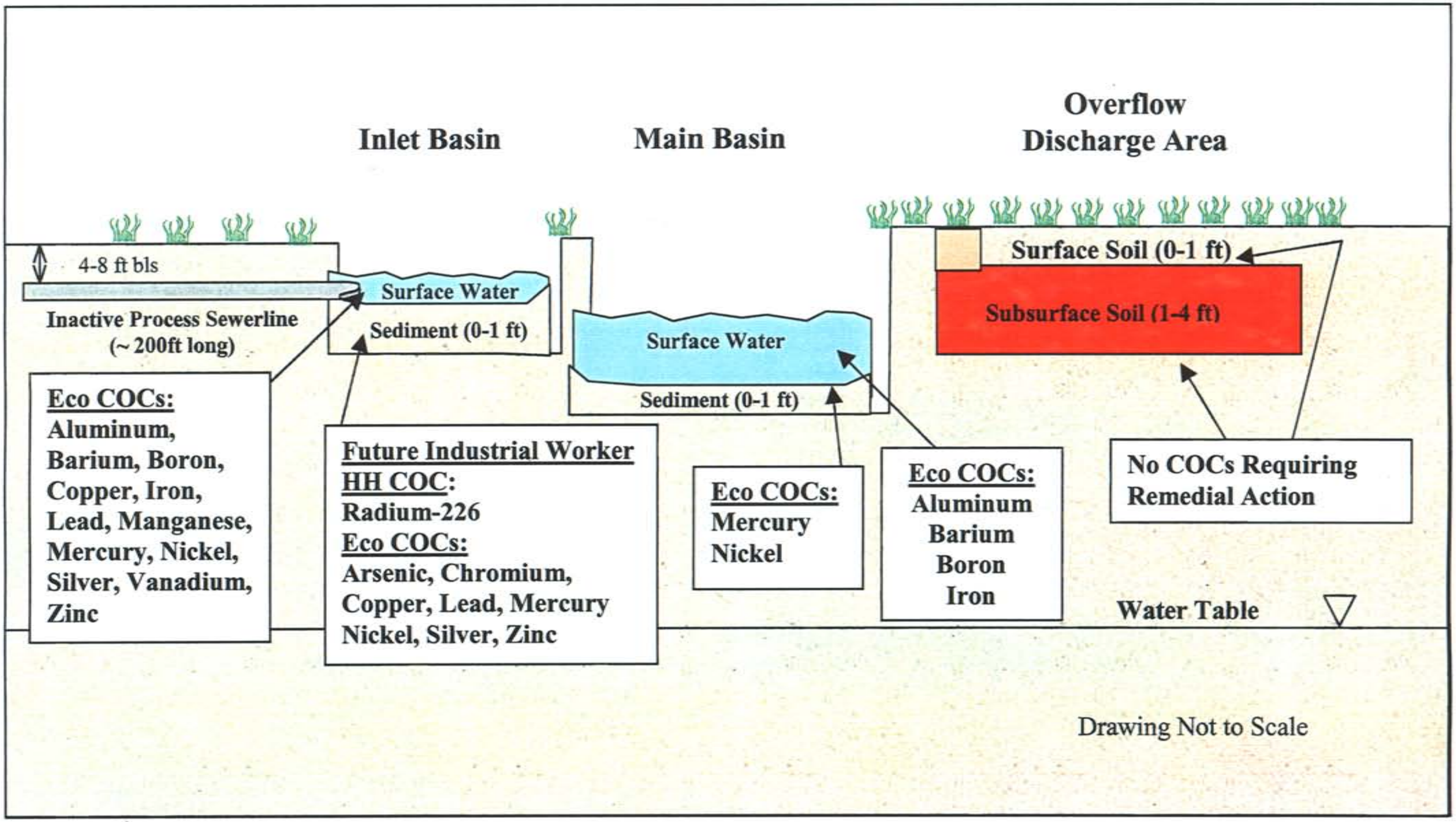

Figure 9. Schematic Cross Section of the New TNX Seepage Basin Showing COCs and Extent of Contamination

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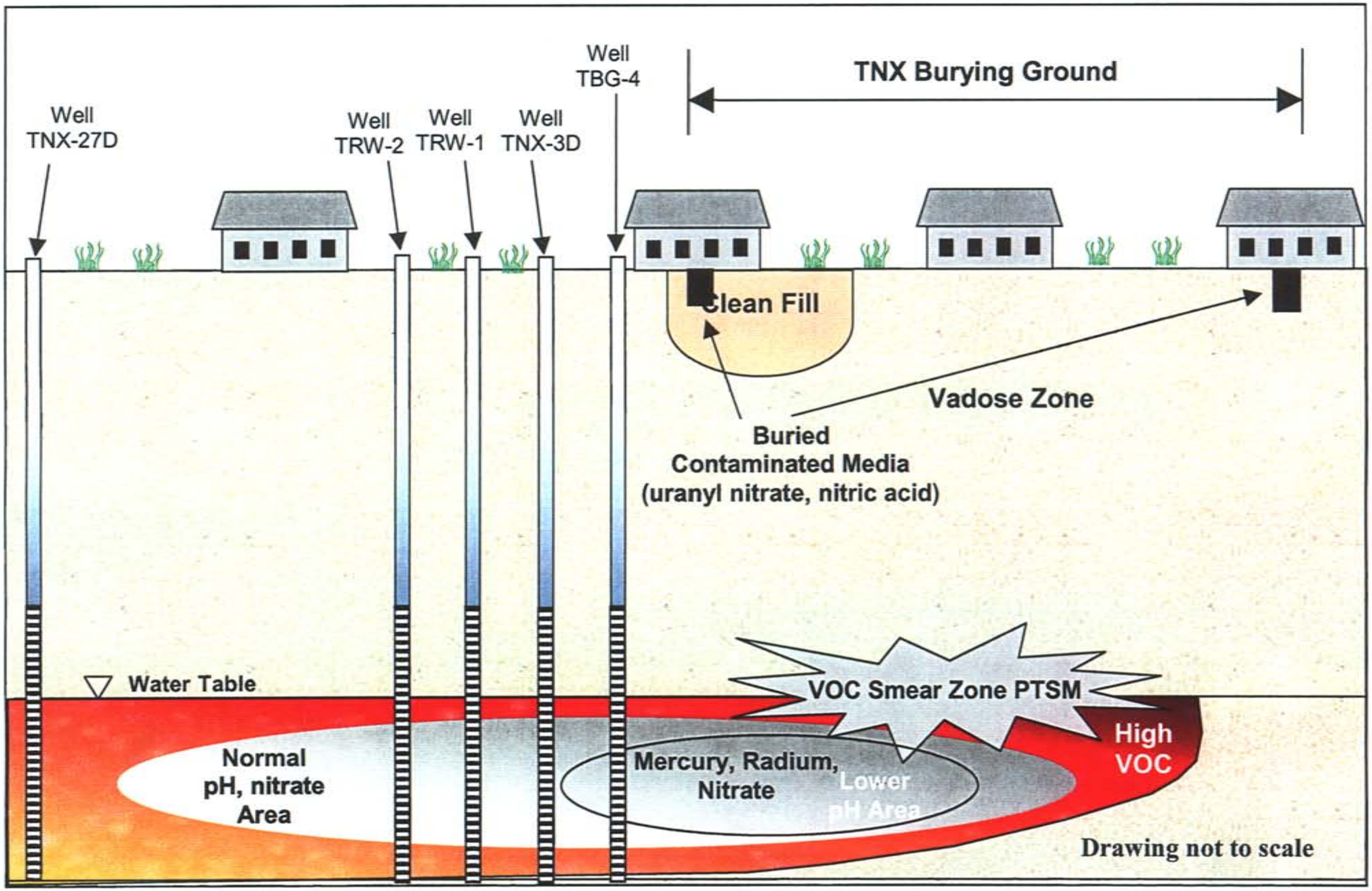

Figure 10. **Schematic Cross Section of the TNX Burying Ground Showing COCs and Extent of Contamination**

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Old TNX Seepage Basin/Inactive Process Sewer Line/ Discharge Gully

- No final ecological RCOCs were identified for this unit.

- Deep soils at the OTSB/IPSL/DG (approximately 4 to 27 ft bls) are contaminated with mercury. Deep soils at the DG are also contaminated with uranium-233/234, uranium-235 and uranium-238. Based on the contaminant concentrations and predicted mobilities, this contaminated soil serves as a potential source that could eventually result in groundwater levels in excess of the MCL (i.e., CMCOCs).

- Soil at the elevation of the original basin bottom is also contaminated with thorium-228 and radium-228 at levels that exceed the PTSM threshold criteria. The PTSM material is present in a 0.6 to 0.9 m (2 to 3 ft) thick layer at a depth of 2 to 3 m (7 to 10 ft) in the Inlet Basin, and at a depth of 2.7 to 3.7 m (9 to 12 ft) in the Main Basin.

- The IPSL is likely contaminated at levels consistent with basin soils.

- Actinium-228, cesium-137, lead-212, radium-228, thorium-228, thorium-234, uranium-233/234, uranium-235, and uranium-238 are human health RCOCs for the future industrial worker at the DG.

- Figure 11 presents a schematic cross section of the OTSB/IPSL/DG.

- RFI/RI characterization activities indicated that perched water occurred at multiple depths beneath the OTSB/IPSL/DG (e.g., 7, 11, 15, 23 ft bls) depending on the sample location. This perched water may be in contact with contaminated soil.

- In May 2002, samples were taken from 14 borings within the OTSB, at three intervals (8 to 10 ft bls, 10 to 12 ft bls, and 12 to 14 ft bls). All samples were tested using the toxicity characteristic leaching procedure (TCLP), and none were determined to be RCRA-hazardous. The soil pH values were high (ranging from 6.1 to 11.5).

- Polychlorinated biphenyls (PCBs) were elevated in samples from the two borings in the inlet basin (maximum 1.03 mg/kg at 8 to 10 ft).

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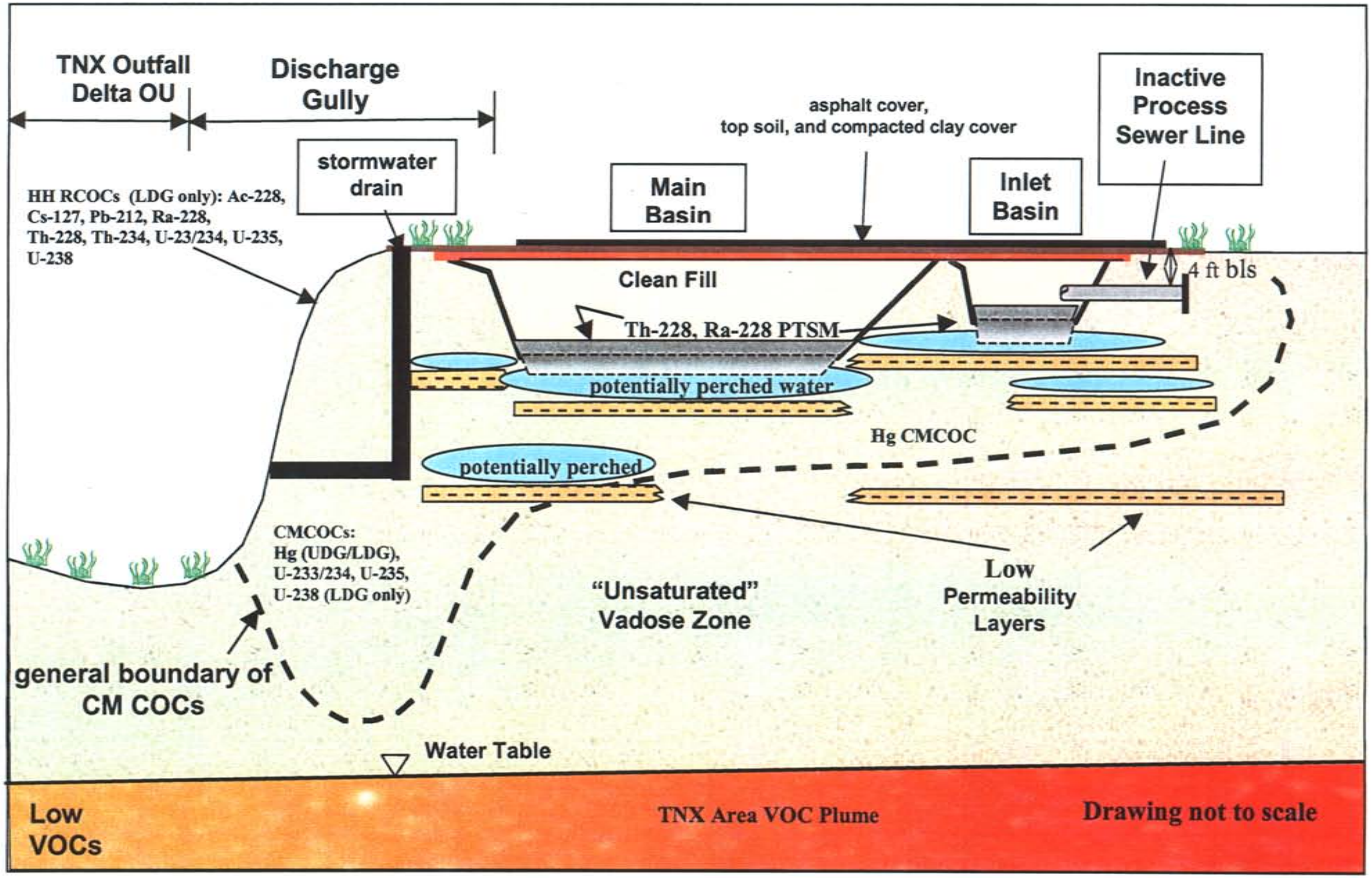

Figure 11. Schematic Cross Section of the Old TNX Seepage Basin Showing COCs and Extent of Contamination

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TNX Groundwater

- Groundwater at the TNX Area OU is contaminated with carbon tetrachloride, tetrachloroethylene (PCE), and trichloroethylene (TCE) above MCLs. These constituents have a potential to discharge to surface water above MCLs.

- Chloroform was retained as a groundwater human health COC for the future resident in the TNX Area OU RFI/RI/BRA. Chloroform does not exceed the MCL.

- Manganese and boron were retained as groundwater human health COCs for the future resident in the TNX Area OU RFI/RI/BRA because they contribute to a noncarcinogenic hazard index (HI) greater than 1 for the contaminated groundwater at the TNX Area OU. There are no MCLs for these constituents. The HI for this medium is dominated by the health hazard contribution of the VOCs found in the groundwater. By reducing the VOC concentrations to within MCLs, the groundwater HI will be reduced so that remediation of the manganese and boron in groundwater will be unnecessary. Therefore, manganese and boron do not require remedial action.

- A localized area of groundwater downgradient of the TBG (near TBG-4) is contaminated with mercury and gross alpha (primarily radium-226) above the MCL. It is thought that these contaminants are the result of acid-leaching of naturally occurring mercury and radium-226 from soil by low pH groundwater beneath the TBG (see Figure 10).

- Gross alpha, total uranium, total radium, and mercury are identified as RCOCs in the Groundwater BRA Addendum (WSRC 2002c). Total uranium and mercury were identified in the approved TNXOD OU RFI/RI/BRA as CMRCOCs (WSRC 2002e).

- No ecological RCOCs have been identified for groundwater.

VI. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

Land Uses

Current and expected future land uses are discussed in the following paragraphs.

Current Land Use

Currently the TNX Area OU is not in use but is in an industrial use area. Access to the SRS is controlled by USDOE. General public access is prohibited and site access is limited by security personnel and fences. Limited access control is already in effect around the TNX Area OU. The Savannah River is approximately 0.4 kilometers (¼ mile) from the TNX area site boundary. The adjacent non-industrial area is undeveloped and wooded. No evidence of casual trespassing (e.g., people, litter, campsites) has been observed during unit visits. Groundwater use in the vicinity of the TNX Area OU is controlled under the Site Use Program and is not currently being used for consumption by on-unit workers.

The only potential occasional visitors to the TNX Area OU would be the known on-unit workers who come to the area on an infrequent or occasional basis. This worker is an adult SRS employee working at or near the TNX Area OU industrial complex under current land use conditions. This includes, but is not limited to, researchers, environmental samplers, or personnel in close proximity to the subunits, and workers performing decontamination and decommissioning on buildings in the TNX Area. The worker is assumed to have frequent exposure to unit-specific constituents in industrial portions of the TNX Area OU. However, his/her exposure to unit-specific constituents (USCs) in nonindustrial portions of the TNX Area OU (e.g., the TNX DG) is considered infrequent. The receptors would be following the SRS procedures and protocols for sampling or entering contaminated waste units.

Future Land Use

The future land use at the TNX Area OU will be industrial. This future land usage is consistent with the *Future Use Report Stakeholder Recommendations for SRS Land and Facilities* (USDOE 1996) and the *Federal Facility Agreement Implementation Plan* (WSRC 1996). The potential future uses of this unit are as a research and development (pilot scale) industrial facility and possibly as an industrial manufacturing facility. According to the *Future Use Report Stakeholder Recommendations for SRS Land and Facilities* (USDOE 1996), "residential uses of SRS land should be prohibited." If land use conditions remain industrial, the only future human receptors are considered to be industrial workers. However, until deed notifications are established, the possibility exists that new buildings could be constructed and the area at or near the TNX Area OU could be converted to residential use in the future. Although residential development is unlikely, a hypothetical residential exposure scenario for both adults and children is presented for comparative purposes. This is in accordance with Environmental Protection Agency (EPA) Region IV guidance (USEPA 1995), which states that residential development cannot be entirely ruled out. However, future use of the land is not likely to change from current use.

Groundwater Uses/Surface Water Uses

SRS does not use the water table (Upper Three Runs and Gordon aquifers) aquifer for drinking water or irrigation purposes and currently controls any drilling in this area. Therefore, as long as USDOE maintains control of SRS, the aquifer beneath the TNX Area OU will not be used as a potential drinking water source or for irrigation.

Surface runoff from the TNX Area may enter the drainages (one near NTSB, one near OTSB). However, these drainages are not being used for irrigation or other beneficial uses.

For future land use scenarios, receptors include hypothetical industrial workers for ingestion only and on unit residents for ingestion and showering. The hypothetical recreational trespasser is not considered a receptor for groundwater exposure.

VII. SUMMARY OF OPERABLE UNIT RISKS

Baseline Risk Assessment

As a component of the RFI/RI process, a BRA (WSRC 1999a) and a Groundwater BRA Addendum (WSRC 2002c) were performed to evaluate risks associated with the TNX Area OU. The BRA included human health and ecological risk assessments. The results of the risk assessments are summarized in the following paragraphs. The RFI/RI/BRA and CMS/FS for the TNXOD OU provide summaries of the risks associated with the LDG of the TNXOD OU (WSRC 2002e, WSRC 2003).

Exposure Routes

Exposure routes for human and ecological receptors at the TNX Area OU may include the following:

- Ingestion of contaminated media, including soil, sediment, surface water, groundwater, biota, and homegrown produce
- Inhalation of volatile emissions and particles
- Dermal contact with contaminated media, including soil, sediment, surface water, and groundwater

Receptors (Human and Ecological)

Human and ecological receptors are identified based on physical and operational knowledge of the site and local demographics, as well as known and hypothetical land uses.

Human receptors may include the following:

- Known on-unit workers
- Hypothetical industrial workers
- Hypothetical on-unit residents (age adjusted adult/child for all carcinogenic exposures, noncancer effects evaluated for a child and an adult)
- Recreational trespassers (an adolescent)

The hypothetical on-unit industrial worker exposure scenario addresses long-term risks to workers who are exposed to unit-related constituents while working within an industrial setting. The hypothetical on-unit industrial worker is an adult who works in an outdoor industrial setting in direct proximity to the contaminated media for the majority of the time.

The hypothetical on-unit resident exposure scenario evaluates the long-term risks to individuals expected to have unrestricted use of the unit. It assumes that residents live on-unit and are chronically exposed (both indoors and outdoors) to unit-related constituents. The hypothetical on-unit resident includes adults and children who are exposed to all the contaminated media. For all noncarcinogenic exposures to residents, a child and an adult are the receptors that are evaluated. For all carcinogenic exposures to residents, a weighted average child/adult is evaluated. This assumes that a portion of the overall lifetime exposure to carcinogens occurs at a higher level of intensity during the first six years of a child's life.

The recreational trespasser exposure scenario evaluates long-term risks to individuals expected to routinely trespass on the unit. This receptor would most likely consist of a local adolescent who would have easy access to the unit and would utilize the unit for wading or playing activities.

Ecological receptors may include the following:

- Terrestrial ecological receptors (e.g., soil dwelling invertebrates, omnivorous birds, and herbivorous and insectivorous mammals)
- Aquatic and semi-aquatic biota (e.g., benthic invertebrates, amphibians, fish, and top predators that feed on these species)

Summary of Human Health Risk Assessment

Based on the existing analytical data, an evaluation was conducted to estimate the human health and environmental problems that could result from the current physical and waste characteristics of the TNX Area OU. The RFI/RI/BRA and CMS/FS for the TNXOD OU provide summaries of the risks associated with the LDG of the TNXOD OU (WSRC 2002e, WSRC 2003).

Sites with carcinogenic risks less than 1×10^{-6} (residential scenario) are considered for no further action (NFA). Sites with carcinogenic risks greater than 1×10^{-6} (residential scenario) and less than 1×10^{-4} (industrial scenario) are within the risk management range requiring institutional or engineering controls. Typically, risks greater than 1×10^{-4} require the evaluation of active remedial options such as treatment or removal.

Sites with a non-carcinogenic HI less than 1 are considered for NFA. Sites with a non-carcinogenic HI between 1 and 3 are within the risk management range requiring institutional or engineering controls. Typically, an HI greater than 3 requires the evaluation of active remedial options such as treatment or removal.

Table 2 summarizes the RCOCs requiring remediation for future industrial workers associated with sediments pertaining to the TNX Area OU subunits and includes COCs, exposure routes, maximum and minimum detected concentrations, detection frequencies, and exposure point concentrations (EPCs).

Table 3 summarizes the cancer toxicity data associated with sediments pertaining to the TNX Area OU.

Table 4 summarizes the risk to future industrial workers exposed to COCs present in the sediments pertaining to the TNX Area OU.

Table 2. Summary of Refined Constituents of Concern and Medium-Specific Exposure Point Concentrations

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
New TNX Seepage Basin- Inlet Basin

Exposure Route	Constituent of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Min	Max					
Sediment Onsite - Direct Contact	Radium-226	0.691	3.63	pCi/g	6/6	3.63	pCi/g	MAX

Key
MAX: maximum concentration

Table 3. Cancer Toxicity Data Summary

Pathway: Ingestion, Inhalation

Constituent of Concern	Oral Cancer Slope Factor	Inhalation Cancer Slope Factor	Slope Factor Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (M/D/Y)
Radium-226	2.96E-10	2.75E-09	Risk/pCi	A	HEAST	7/1/95

Pathway: External (Radiation)

Constituent of Concern	Cancer Slope or Conversion Factor	Exposure Route	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (M/D/Y)
Radium-226	6.74E-06	External exposure	Risk/yr per pCi/g	A	HEAST	7/1/95

Key
HEAST: Health Effects Summary Table USEPA
A: Human carcinogen

Table 4. Risk Characterization Summary - Carcinogens

Scenario Timeframe:	Future							
Receptor Population:	Industrial Worker							
Receptor Age:	Adult							
Medium	**Exposure Medium**	**Exposure Route**	**Constituent of Concern**	**Carcinogenic Risk**				
				Ingestion	**Inhalation**	**Dermal**	**External (Radiation)**	**Exposure Routes Total**
Sediment	Sediment	Sediment Onsite-Direct Contact	Radium-226	NA	NA	NA	1.1E-06	1.1E-06
							Sediment Risk Total =	1.1E-06
Key NA: Not applicable								

New TNX Seepage Basin/Inactive Process Sewer Line

Inactive Process Sewer Line

No human health RCOCs have been identified.

Inlet Basin

The results of the assessment indicate that radium-226 is the only constituent present in the sediments at the 0- to 0.3-m (0- to 1-ft) depth interval within the Inlet Basin that poses a human health risk (1.1×10^{-6} to future industrial workers).

Main Basin

No human health RCOCs have been identified.

Overflow Discharge Area

No human health RCOCs have been identified for the industrial worker. Barium, manganese, and nickel have been identified as RCOCs for the future resident scenario. Since this area will remain industrial, institutional controls and deed restrictions will prevent residential exposure. Therefore, these residential RCOCs do not require remedial action.

TNX Burying Ground and Vadose Zone

No human health RCOCs have been identified.

Old TNX Seepage Basin/Inactive Process Sewer Line/ Upper Discharge Gully

No human health RCOCs have been identified.

TNX Groundwater

Groundwater at the TNX Area OU is contaminated with carbon tetrachloride, PCE, and TCE above MCLs with a potential to discharge to surface water above MCLs. Chloroform in groundwater is also a human health COC for the future resident, but it does not exceed the MCL.

Manganese and boron were retained as groundwater human health COCs for the future resident in the TNX Area OU RFI/RI/BRA because they contribute to the noncarcinogenic HI for the contaminated groundwater at the TNX Area OU. There are no MCLs for these constituents. The HI for this medium is dominated by the health hazard contribution of the VOCs found in the groundwater. By reducing the VOC concentrations to within MCLs, the groundwater hazard index will be reduced so that it will not be necessary to remediate the manganese and boron in groundwater. Therefore, manganese and boron do not require remedial action.

A localized area of groundwater downgradient of the TBG (near well TBG-4) is contaminated with mercury and gross alpha (primarily radium-226) above their respective MCLs. No widespread contaminant plume is discernable, and these constituents do not present a problem warranting action at this time.

Groundwater from isolated wells in the TNXOD OU exceeds the MCL for gross alpha, total radium, total uranium, and mercury. The Groundwater BRA Addendum (WSRC 2002c) identifies gross alpha, total radium, uranium, and mercury as RCOCs. Uranium and mercury were identified in the TNXOD OU RFI/RI/BRA (WSRC 2002e) as CM RCOCs. Prior to 2001, total uranium concentration was calculated by converting the activity per liter of uranium-233/234, uranium-235 and uranium-238 to mass per liter and summing the results for comparison with the total uranium MCL of 30 μg/L. The maximum concentration of total uranium detected was 42.5 μg/L, obtained from TCM-7 during the fourth quarter of 2000. In 2001, TNX Area groundwater exceeded the MCL for total uranium in two wells, TCM-3 (30.4 μg/L) and TCM-7 (38.5 μg/L), in a limited area of the TNXOD OU during the first quarter sampling (WSRC 2002a). No contaminant plume is discernable, and these constituents do not present a problem warranting action at this time.

Lower groundwater pH occurs in areas of TNX where higher levels of radionuclides (uranium and radium) and mercury are present. Acidic conditions will increase the mobility of metals and radionuclides through leaching. Because pH conditions can vary widely due to environmental (e.g., wetland and/or recharge rates) or anthropogenic (e.g., disposal of nitric acid) sources, it is uncertain whether the source of mercury and radiological constituents in groundwater is process-related or natural and whether low pH conditions are responsible for the elevated concentrations. It is also uncertain whether the magnitude (concentration) or extent (location/size) of the isolated areas of contamination will increase with time. It is likely groundwater pH will gradually increase due to natural processes, and the contaminants will adsorb to the sediments or precipitate, thereby reducing contaminant concentrations in groundwater. Although these constituents do not present a problem warranting action, their presence in groundwater will continue to be monitored and reported annually in the Comprehensive TNX Area Annual Groundwater and Effectiveness Monitoring Strategy Report. Institutional and land use controls, as described in Section VI, will be utilized to prevent use of potentially contaminated groundwater.

Table 5 provides a groundwater risk summary and a comparison of RCOC concentrations to MCLs.

Summary of Ecological Risk Assessment

The purpose of the ecological risk assessment component of the BRA is to evaluate the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to unit-related constituents based on a weight-of-evidence approach. Based on the analytical data pertaining to the TNX Area OU, the results of the ecological risk assessment are discussed. Table 6 identifies the ecological exposure pathways of concern. Table 7 provides the COC concentrations expected to provide protection to ecological receptors.

Table 5. Groundwater Comparison to MCL and Risk Summary

Constituent of Concern	Frequency of Detects	Minimum Detected Value	Maximum Detected Value	Average Value	MCL	Risk Summary[1]
Boron	105/129	12.7 μg/L	1550 μg/L	280 μg/L	None	Future Resident: noncancer HQ = 0.24 Future Worker: noncancer HQ = 0.04 Future Resident: cancer risk = NA[2] Future Worker: cancer risk = NA[2]
Manganese	129/129	1 μg/L	464 μg/L	71.6 μg/L	None	Future Resident: noncancer HQ = 0.23 Future Worker: noncancer HQ = 0.04 Future Resident: cancer risk = NA[2] Future Worker: cancer risk = NA[2]
Carbon tetrachloride	33/129	1.04 μg/L	361 μg/L	11.1 μg/L	5 μg/L	Future Resident: noncancer HQ = 1.67 Future Worker: noncancer HQ = 0.26 Future Resident: cancer risk = 5.0E-05 Future Worker: cancer risk = 8.3E-06
Chloroform	32/133	0.06 μg/L	14.9 μg/L	1.32 μg/L	100 μg/L	Future Resident: noncancer HQ = 0.01 Future Worker: noncancer HQ = 0.01 Future Resident: cancer risk = 2.2E-06 Future Worker: cancer risk = 3.6E-08
Mercury	32/129	0.08 μg/L	2.68 μg/L	0.199 μg/L	2 μg/L	Future Resident: noncancer HQ = 0.06 Future Worker: noncancer HQ = 0.01 Future Resident: cancer risk = NA[2] Future Worker: cancer risk = NA[2]
Tetrachloroethylene	24/133	1.08 μg/L	28 μg/L	1.73 μg/L	5 μg/L	Future Resident: noncancer HQ = 0.02 Future Worker: noncancer HQ = 0.01 Future Resident: cancer risk = 1.9E-06 Future Worker: cancer risk = 4.3E-07
Trichloroethylene	68/125	1.12 μg/L	1430 μg/L	61.2 μg/L	5 μg/L	Future Resident: noncancer HQ = 0.95 Future Worker: noncancer HQ = 0.15 Future Resident: cancer risk = 2.3E-05 Future Worker: cancer risk = 3.4E-06
Groundwater Total Hazard Index (noncancer): Groundwater Total Cumulative Risk (cancer):						Future Resident: noncancer HI = 3.18 Future Worker: noncancer HI = 0.52 Future Resident: cancer risk = 7.7E-05 Future Worker: cancer risk = 1.2E-05
Gross alpha	242/348	0.520 pCi/L	40.2 pCi/L	5.60 pCi/L	15 pCi/L	MCL comparison
Ra-226 + Ra-228	65/92	1.32 pCi/L	20.7 pCi/L	3.07 pCi/L	5 pCi/L	MCL comparison
Radium-226	59/92	0.476 pCi/L	15.6 pCi/L	1.87 pCi/L	5 pCi/L	MCL comparison[3]
Radium-228	18/92	0.859 pCi/L	5.07 pCi/L	1.20 pCi/L	5 pCi/L	MCL comparison[3]
Uranium-233/234	59/92	0.080 pCi/L	16.3 pCi/L	2.28 pCi/L	10 pCi/L	MCL comparison[4]
Uranium-235	21/92	0.156 pCi/L	1.42 pCi/L	0.411 pCi/L	0.5 pCi/L	MCL comparison[4]
Uranium-238	60/92	0.152 pCi/L	15.7 pCi/L	2.33 pCi/L	10 pCi/L	MCL comparison[4]
Mercury, total	18/57	0.141 μg/L	2.37 μg/L	0.354 μg/L	2.0 μg/L	MCL comparison
Uranium, total	29/52	0.021 μg/L	42.5 μg/L	17.1 μg/L	30 μg/L	MCL comparison

Notes:

[1]Risk summaries provided for RCOCs identified in the *RFI/RI/BRA for the TNX Area OU* (WSRC-RP-96-00808, Rev. 1.2, January 1999. Future resident scenario includes ingestion and showering pathways. Future industrial worker scenario includes ingestion pathway only.
Per Core Team agreement, maximum concentrations were compared to MCLs for the RCOCs identified in the *Addendum to the RFI/RI/BRA for the TNX Area OU, Groundwater Radiological Characterization*, WSRC-RP-2001-4180, Rev. 1, October 2002.

[2]NA= not applicable. Cancer risk not calculated for these constituents.

[3]As part of total radium.

[4]As part of total uranium.

HI – hazard index, HQ – hazard quotient

Table 6. Ecological Exposure Pathways of Concern

Exposure Medium	Sensitive Environment Flag (Y or N)	Receptor	Threatened/ Endangered Species Flag (Y or N)	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Sediment	No	Sediment-dwelling biota	No	Direct contact with constituents in sediment.	Protection of benthic invertebrate communities from toxic effects of contaminants in order to maintain species diversity, biomass, and nutrient cycling (trophic structure).	Measured concentrations in sediment compared to literature-based sediment toxicity benchmarks.
	No	Heron	No	Ingestion, respiration, and direct contact with constituents and aquatic biota in sediments.	Protection of bird communities that feed on aquatic organisms in order to ensure that exposure to contaminants in aquatic prey and abiotic media does not have a negative impact on growth, survival or reproduction.	Measured concentrations in sediment used to model food chain uptake and compared to literature-based toxicity reference values (TRVs).
Surface water	No	Aquatic biota	No	Direct contact with constituents in surface water.	Protection of aquatic biota communities from toxic effects of contaminants in order to maintain species diversity, biomass, and nutrient cycling (trophic structure).	Measured concentrations in surface water compared to literature-based surface water toxicity benchmarks (i.e., Ambient Water Quality Criteria).

Table 7. COC Concentrations Expected to Provide Adequate Protection of Ecological Receptors

Habitat Type / Name	Exposure Medium	COC	Protective Level	Units	Basis	Assessment/Measurement Endpoint
New TNX Seepage Basin (Inlet Basin)	Sediment	Arsenic	8.2	mg/kg	HQ=1	Protection of benthic invertebrate communities from toxic effects of contaminants in order to maintain species diversity, biomass, and nutrient cycling (trophic structure). Measured concentrations in sediment compared to literature-based sediment toxicity benchmarks. *Protection of bird communities that feed on aquatic organisms in order to ensure that exposure to contaminants in aquatic prey and abiotic media does not have a negative impact on growth, survival or reproduction. Measured concentrations in sediment used to model food chain uptake and compared to literature-based toxicity reference values.
		Chromium	80 493*	mg/kg	HQ=1	
		Copper	70	mg/kg	HQ=1	
		Lead	35 105*	mg/kg	HQ=1	
		Mercury	0.15 16*	mg/kg	HQ=1	
		Nickel	30	mg/kg	HQ=1	
		Silver	1.0	mg/kg	HQ=1	
		Zinc	150	mg/kg	HQ=1	
	Surface Water	Aluminum	87	µg/L	HQ=1	Protection of aquatic biota communities from toxic effects of contaminants in order to maintain species diversity, biomass, and nutrient cycling (trophic structure). Measured concentrations in surface water compared to literature-based surface water toxicity benchmarks (i.e., Ambient Water Quality Criteria).
		Barium	3.9	µg/L	HQ=1	
		Boron	750	µg/L	HQ=1	
		Copper	1.51	µg/L	HQ=1	
		Iron	1000	µg/L	HQ=1	
		Lead	0.15	µg/L	HQ=1	
		Manganese	22.7	µg/L	HQ=1	
		Mercury	0.012	µg/L	HQ=1	
		Nickel	20.5	µg/L	HQ=1	
		Silver	0.012	µg/L	HQ=1	
		Vanadium	20	µg/L	HQ=1	
		Zinc	13.7	µg/L	HQ=1	
New TNX Seepage Basin (Main Basin)	Sediment	Mercury	0.15	mg/kg	HQ=1	Protection of benthic invertebrate communities from toxic effects of contaminants in order to maintain species diversity, biomass, and nutrient cycling (trophic structure). Measured concentrations in sediment compared to literature-based sediment toxicity benchmarks.
		Nickel	30	mg/kg	HQ=1	
	Surface Water	Aluminum	87	µg/L	HQ=1	Protection of aquatic biota communities from toxic effects of contaminants in order to maintain species diversity, biomass, and nutrient cycling (trophic structure). Measured concentrations in surface water compared to literature-based surface water toxicity benchmarks (i.e., Ambient Water Quality Criteria).
		Barium	3.9	µg/L	HQ=1	
		Boron	750	µg/L	HQ=1	
		Iron	1000	µg/L	HQ=1	

HQ – hazard quotient

New TNX Seepage Basin/Inactive Process Sewer Line

Inlet Basin

Arsenic, chromium, copper, lead, mercury, nickel, silver, and zinc are present in the sediments at concentration levels that present an ecological risk to sediment-dwelling biota. Lead, mercury, and chromium concentration levels also pose a risk to predatory animals such as the heron.

The standing surface water that collects in the Inlet Basin as a result of rainfall may be contaminated with aluminum, barium, boron, copper, iron, lead, manganese, mercury, nickel, silver, vanadium, and zinc at concentration levels that present a risk to aquatic biota.

Main Basin

Mercury and nickel concentration levels in the basin sediment present a risk to sediment-dwelling biota.

The standing surface water in the Main Basin that collects as a result of rainfall may be contaminated with aluminum, barium, boron and iron at concentration levels that present a risk to aquatic biota.

Overflow Discharge Area

No ecological RCOCs have been identified.

TNX Burying Ground and Vadose Zone

No ecological RCOCs have been identified.

Old TNX Seepage Basin/Inactive Process Sewer Line and Discharge Gully

No ecological RCOCs have been identified.

Summary of Contaminant Fate and Transport Analysis

The CSM used for the analysis of contaminant fate and transport is presented in Figure 8. The analysis was based on the data collected during sampling investigations conducted in 1996 and 1998.

New TNX Seepage Basin/ Inactive Process Sewer Line

No refined CMCOCs have been identified.

TNX Burying Ground and Vadose Zone

There is evidence from SVE tests that a continuing source of VOC contamination to the groundwater exists in the vadose zone beneath the TBG in the vicinity of the 500 ppb groundwater isoconcentration contour. This secondary source is considered PTSM.

Old TNX Seepage Basin/Inactive Process Sewer Line/ Discharge Gully

Deep soils at the OTSB/IPSL/DG (approximately 1.2 to 8.2 m [4 to 27 ft] bls) are contaminated with mercury and uranium. Based on the mercury and uranium concentrations and mobilities, this contaminated soil is a potential source that could result in constituent levels in excess of the MCL.

The IPSL is likely contaminated at levels consistent with basin soils.

Summary of Principal Threat Source Material Analysis

Old TNX Seepage Basin/Inactive Process Sewer Line and Discharge Gully

Soil at the elevation of the original basin bottom (0.6 to 0.9 m [2 to 3 ft] thick interval) at a depth of 3 to 3.6 m (10 to 12 ft) is contaminated with thorium-228 and radium-228 at a 6×10^{-3} carcinogenic risk, exceeding the PTSM threshold criteria of a 1×10^{-3} risk to the industrial worker exposed to soil. Contamination within the IPSL is assumed to be PTSM.

TNX Burying Ground and Vadose Zone

There is evidence from SVE tests that a continuing source of VOC contamination to the groundwater exists in the vadose zone beneath the TBG in the vicinity of the 500 ppb groundwater isoconcentration contour. This secondary source is considered PTSM due to its leachability and presence in groundwater above MCLs.

Conclusion

Based upon RFI/RI characterization activities and BRA evaluations, contaminants that represent a risk to human health or the environment are present at all subunits in the TNX Area OU. A remedial action is warranted because of estimated risks to the future industrial worker and ecological receptors (NTSB), presence of PTSM (OTSB, TBG vadose zone), and contamination in groundwater above MCLs.

VIII. REMEDIAL ACTION OBJECTIVES AND REMEDIAL GOALS

Based on the RFI/RI/BRA and Core Team decisions, the remedial action objectives (RAOs) established for the TNX Area OU are outlined in the following sections:

New TNX Seepage Basin/Inactive Process Sewer Line

- Protect terrestrial biota (predatory animals like the heron) from exposure to chromium, lead, and mercury in the Inlet Basin sediment.
- Protect sediment-dwelling biota from exposure to arsenic, chromium, copper, lead, mercury, nickel, silver, and zinc in the Inlet Basin sediment.
- Protect future industrial workers from exposure to radium-226 in the Inlet Basin sediment.
- Protect sediment-dwelling biota from exposure to mercury and nickel in the Main Basin sediment.
- Protect aquatic biota from exposure to aluminum, barium, boron and iron in the Main Basin surface water.
- Protect aquatic biota from exposure to aluminum, barium, boron, copper, iron, lead, manganese, mercury, nickel, silver, vanadium, and zinc in the Inlet Basin surface water.
- Protect future industrial workers from exposure to radium-226 potentially present in the IPSL (1.2 to 2.4 m [4 to 8 ft] bls).

TNX Burying Ground and Vadose Zone

- Identify and reduce the secondary source of VOCs representing PTSM in the vadose zone in order to reduce the time to achieve groundwater RAOs.

Old TNX Seepage Basin/Inactive Process Sewer Line/Discharge Gully

- Remove or treat contamination exceeding PTSM criteria in subsurface soils of the OTSB/IPSL to the extent practicable.
- Prevent leaching of mercury above the MCL from deep soils of the OTSB/IPSL/DG.
- Prevent or minimize perched water contact with PTSM or mercury exceeding the CM RG.
- Prevent leaching of uranium above the MCL from soils of the LDG.
- Protect future industrial workers from exposure to contaminants exceeding RGs in soils of the LDG.

TNX Groundwater

- Protect future industrial workers and return groundwater to beneficial uses within a reasonable time period by remediating carbon tetrachloride, PCE, and TCE to applicable or relevant and appropriate requirements (ARARs) (i.e., MCLs). Note that chloroform, while a residential RCOC, does not exceed the MCL.
- Protect future industrial workers from exposure to groundwater contaminated with radiological constituents and mercury at levels exceeding MCLs.
- Prevent, minimize, or eliminate discharge of contaminated groundwater to surface water that would result in unacceptable risk to human or ecological receptors.
- Minimize adverse impact to the wetland ecosystem of the TNX Area flood plain through careful consideration and implementation of remedial actions.

The RGs for all the RCOCs included in Table 8 are based on either ARARs, human health (industrial worker) at the risk level of 1 x 10^{-6} or hazard index > 1, or ecological risk analysis. The lowest value of each unit-specific RG was selected for each specific RCOC and compared to its unit-specific average background value. Location-, chemical-, and action-specific ARARs and to-be-considered (TBC) guidance were evaluated in the CMS/FS for relevance to the TNX Area OU. These ARARs and TBCs are identified in Table 9.

Table 8. Summary of Refined COCs and Remedial Goals Associated with Contaminated Media at the TNX Area OU

Subunit	Media	Remedial Action Objectives	Refined COC	Remedial Goal	Basis
New TNX Seepage Basin (Inlet Basin)	Sediment	Protect future industrial worker from exposure to radium-226 in sediment.	Radium-226	0.16 pCi/g	1E-06 risk level
		Protect sediment-dwelling biota from exposure to arsenic, chromium, copper, lead, mercury, nickel, silver and zinc in the sediment.	Arsenic	8.2 mg/kg	HQ=1
			Chromium	80 mg/kg	HQ=1
			Copper	70 mg/kg	HQ=1
			Lead	35 mg/kg	HQ=1
			Mercury	0.15 mg/kg	HQ=1
			Nickel	30 mg/kg	HQ=1
			Silver	1.0 mg/kg	HQ=1
			Zinc	150 mg/kg	HQ=1
	Surface Water	Protect aquatic biota from exposure to aluminum, barium, boron, copper, iron, lead, manganese, mercury, nickel, silver, vanadium, and zinc in the surface water.	Aluminum	87 µg/L	HQ=1
			Barium	3.9 µg/L	HQ=1
			Boron	750 µg/L	HQ=1
			Copper	1.51 µg/L	HQ=1
			Iron	1000 µg/L	HQ=1
			Lead	0.15 µg/L	HQ=1
			Manganese	22.7 µg/L	HQ=1
			Mercury	0.012 µg/L	HQ=1
			Nickel	20.5 µg/L	HQ=1
			Silver	0.012 µg/L	HQ=1
			Vanadium	20 µg/L	HQ=1
			Zinc	13.7 µg/L	HQ=1

Table 8. Summary of Refined COCs and RGs Associated with Contaminated Media at the TNX Area OU (Continued)

Subunit	Media	Remedial Action Objectives	Refined COC	Remedial Goal	Basis
New TNX Seepage Basin (Main Basin)	Sediment	Protect sediment-dwelling biota from exposure to mercury and nickel in the sediment.	Mercury Nickel	0.15 mg/kg 30 mg/kg	HQ=1 HQ=1
	Surface Water	Protect aquatic biota from exposure to aluminum, barium, boron and iron in the surface water.	Aluminum Barium Boron Iron	87 μg/L 3.9 μg/L 750 μg/L 1000 μg/L	HQ=1 HQ=1 HQ=1 HQ=1
Old TNX Seepage Basin/ IPSL/ Discharge Gully					
OTSB/IPSL	Soil	Prevent mercury contamination to groundwater above MCL (2 μg/L).	Mercury	0.078 mg/kg	Contaminant migration soil cleanup level.
		Prevent human exposure to Radium-228 and Thorium-228 and from exceeding PTSM levels in soils at basin bottom.	Thorium-228 Radium-228	Remove or treat contaminated PTSM 23.44 pCi/g 21.75 pCi/g	Combined carcinogenic risk of 6×10^{-3}

Table 8. Summary of Refined COCs and RGs Associated with Contaminated Media at the TNX Area OU (Continued)

Subunit	Media	Remedial Action Objectives	Refined COC	Remedial Goal	Basis
UDG	Soil	Prevent mercury contamination to groundwater above MCLs (2 μg/L)	Mercury	0.13 mg/kg	Contaminant migration soil cleanup level.
LDG[1]	Soil	Prevent total uranium contamination to groundwater above MCLs (30 μg/L, respectively)	Uranium-233/234, Uranium-235, Uranium-238	1.31 pCi/g, 0.06 pCi/g, 1.31 pCi/g	
	Soil	Prevent future industrial worker exposure to Actinium-228, Cesium-137, Lead-212, Radium-228, Thorium-228, Thorium-234, Uranium-233/234, Uranium-235, and Uranium-238	Actium-228 Cesium-137 Lead-212 Radium-228 Thorium-228 Thorium-234 Uranium-233/234 Uranium-235 Uranium-238	0.07 pCi/g 0.10 pCi/g 0.73 pCi/g 0.07 pCi/g 0.04 pCi/g 45.43 pCi/g 68.80 pCi/g 0.82 pCi/g 3.13 pCi/g	

[1]WSRC 2003

Table 8. Summary of Refined COCs and RGs Associated with Contaminated Media at the TNX Area OU (Continued)

Subunit	Media	Remedial Action Objectives	Refined COC	Remedial Goal	Basis
TNX Burying Ground and Vadose Zone	Groundwater	Prevent VOCs in the deep vadose zone from contaminating groundwater above MCLs.	Carbon Tetrachloride PCE TCE	5 µg/L 5 µg/L 5 µg/L	Maximum Contaminant Level for groundwater cleanup
TNX Groundwater (Water Table Aquifer)	Groundwater	Protect the future industrial worker from exposure to carbon tetrachloride, PCE and TCE in groundwater above MCLs.	Carbon Tetrachloride PCE TCE	5 µg/L 5 µg/L 5 µg/L	Maximum Contaminant Level for groundwater cleanup
		Protect the future industrial worker from exposure to radiological constituents and mercury in groundwater above MCLs.	Gross Alpha Total Uranium Total Radium(Ra-226 and Ra-228) Mercury	15 pCi/L 30 µg/L* 5 pCi/L 2 µg/L	Maximum Contaminant Level for groundwater cleanup

*MCL effective 12/8/03

Table 9. Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Guidance

Citation (s)	Status	Requirement Summary	Reason for Inclusion
Chemical-Specific			
SC R61-68 South Carolina Water Classification and Standards	Applicable	States official classified water uses for all surface and groundwater in South Carolina. Surface water concentrations must meet the established water quality standards. Groundwater concentrations must meet MCLs unless a Mixing Zone is established for developing alternative compliance levels. Appendices incorporate numeric criteria for surface waters to protect human health and the environment.	Potentially applicable to contaminant concentrations in groundwater and will be considered for contaminants in surface water in the New TNX Seepage Basin.
National Oceanic and Atmospheric Administration Threshold Values for Potential Sediment Toxicity	TBC	Threshold values developed for predicting toxicity to organisms exposed to sediment contaminants. The ER-L is the Effects Range-Low value that predicts less than 10% mortality in organisms exposed to these sediment concentrations and the ER-M is the Effects Range-Medium value that predicts greater than 50% mortality in exposed organisms.	To be considered for contaminated sediments and soils that represent secondary sources of contamination and may be transported off-site to surface waters via surface runoff or groundwater in shallow aquifers.
SC R61-58.5(B)(2) South Carolina Drinking Water Regulations	Applicable	State regulations implementing MCLs and MCLGs for drinking water	Applicable to contaminant concentrations in groundwater.
40 CFR 141 Federal National Primary Drinking Water Regulations	Applicable	Federal regulations implementing MCLs and MCLGs for groundwater that may be a source of drinking water.	Applicable to contaminant concentrations in groundwater.
Location-Specific			
Clean Water Act, Section 404	Applicable	Federal program that regulates discharge of dredged and fill materials to surface waters and wetlands	Backfilling activities must avoid, minimize, and then mitigate any adverse effects on surface waters and wetlands.
SC R72-300 Standards for Stormwater Management and Sediment Reduction	Applicable	Stormwater management and sediment control plan for land disturbances.	Excavation activities and construction/remedial action may require an erosion control plan.
SC 61-9. Water Pollution Control Permits Section 122.26 Stormwater Discharges.	Potentially Applicable	Requires notification of intent to discharge stormwater from construction associated with industrial activity that will result in a land disturbance of 5 acres or more and/or industrial activities and sets the requirements for the control of stormwater discharges	Potentially applicable if stormwater is discharged during construction activities.

Table 9. Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered Guidance (Continued)

Citation (s)	Status	Requirement Summary	Reason for Inclusion
Action-Specific			
SC 61-62.6 Control of Fugitive Particulate Matter	Potentially Applicable	Particulate matter must be controlled in such a manner and to the degree that it does not create an undesirable level of air pollution.	Earth-moving activities have the potential to generate airborne particulate matter. Construction/ remedial action may be required for dust suppression
40 CFR 261 Identification and Listing of Hazardous Waste SC R61-79.261 Hazardous Waste Management System	Potentially Applicable	Defines criteria for determining whether a waste is RCRA hazardous waste. Any waste media that are actively managed or shipped offsite must be tested to determine if they are RCRA characteristic wastes.	Applicable for the management and transportation of RCRA hazardous waste and contaminated soils.
40 CFR 261 SC R61-79.261 Identification and Listing of RCRA Hazardous Waste	Applicable	Defines criteria for determining whether a waste is RCRA hazardous waste. Any waste media that are actively managed or shipped off site must be tested (Toxic Characteristic Leach Procedure) to determine if they are RCRA characteristic wastes.	Applicable to wastes actively managed or excavated for off-site treatment, storage, or disposal.
40 CFR 263 SC R61-79.263 Standards Applicable to Transporters of Hazardous Waste	Applicable	Identifies transporter requirements including manifests, record keeping, and actions for accidental waste discharges	Applicable to off-site transportation of RCRA hazardous waste.
40 CFR 264 Standards for Owners and Operators of Hazardous Waste TSDs	Applicable	General performance standards for TSDs	Applicable to off-site treatment, storage, or disposal of hazardous wastes
40 CFR 268 Land Disposal Restrictions (LDRs) (RCRA)	Applicable	Prohibits land disposal and specifies treatment standards for specific RCRA hazardous wastes. Movement of excavated materials from their original location triggers the RCRA LDRs.	Applicable to excavation of wastes.

Table 9. Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered Guidance (Continued)

Citation (s)	Status	Requirement Summary	Reason for Inclusion
Action-Specific (continued)			
Clean Air Act, Section 112, Subpart H National Emission Standards for Emissions of Radionuclides Other Than Radon From DOE Facilities 40 CFR 61 National Emissions Standards for Hazardous Air Pollutants (NESHAP)	Potentially Applicable	Identifies annual effective radiation dose limits for the public from US DOE activities at a particular site. For members of the public in the vicinity of a US DOE site, the maximum permissible whole body effective dose from all US DOE activities ins 25 mrem/yr, with a 75 mrem/yr effective dose limit for any critical organ.	Applicable during soil handling activities.
SC R61-62.5 South Carolina Air Pollution Control Standards	Applicable	Identifies allowable air concentrations and permit requirements for air emissions of toxic chemicals for new and existing sources	Applicable to air stripping or SVE. Would apply to air emissions of Standard 2 Toxic Air Pollutants and Standard 8 Ambient Air Quality Standards
SC 61-9.122 Water Pollution Control Permits Section 122 40 CFR 122-125	Applicable	Discharge of treated groundwater to stream must comply with the effluent limitation of the National Pollution Discharge Elimination System (NPDES) permit.	Applicable to point source discharges to surface waters including effluent water from extraction and treatment systems.
SC R61-58.2 Construction and Operation Permits – Groundwater Sources and Treatment	Applicable	Specifies requirements for well construction, operation, and abandonment.	Groundwater wells must be installed/abandoned and drilling wastes disposed in a manner to prevent cross-contamination of aquifers.
40 CFR 144-147 Underground Injection Control (UIC)	Applicable	Established minimum requirements for underground injection activities to ensure drinking water sources.	Re-injection of treated groundwater or air would require a permit.

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IX. DESCRIPTION OF ALTERNATIVES

In the CMS/FS, a total of 22 remedial action alternatives were screened for the TNX Area OU subunits with respect to effectiveness, implementability, and cost (WSRC 2002d). These alternatives are discussed below. For any remedy that includes institutional controls, the institutional controls will consist of the following: (1) industrial worker access controls via the Site Use Program, Site Clearance Program, work control, worker training, worker briefing of health and safety requirements, and identification signs located at the waste unit boundaries; (2) notification of the USEPA and SCDHEC in advance of any changes in land use or excavation of waste; and (3) access controls against trespassers such as security/surveillance, artificial or natural barriers, entry controls, and/or warning signs. Long-term institutional controls include property record notifications and restrictions.

Comparisons of the remedies, including overall protectiveness, long- and short-term effectiveness, risk reduction and residual risks, implementation, time to achieve RAOs, and costs are provided on Table 10. Additional details on the selected remedies can be found in Section XI.

New TNX Seepage Basin/Inactive Process Sewer Line

Detailed analysis was performed on three alternatives for remedial action of NTSB/IPSL. Each alternative is described below.

Alternative NB-1: No Action

Estimated Present Value Cost: $58,000

Construction Time to Complete: Immediate

Under the No Action alternative, no remedial effort to control risk, treat or remove waste, or reduce the toxicity, mobility, or volume of contaminated media will be made.

Institutional controls and actions such as groundwater monitoring do not continue. This alternative does not meet RAOs; COCs would continue to pose exposure risk to future human and ecological receptors. Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation.

Alternative NB-2a: Backfill with Institutional Controls

Estimated Present Value Cost: $639,000

Construction Time to Complete: Six months

This alternative involves backfilling the Inlet and Main Seepage Basins, and in situ grouting of the IPSL. Prior to backfilling, standing water is removed from the basins and either discharged to ground surface, discharged to a permitted outfall, or transported to an approved wastewater treatment facility. No waste is removed and disposed of offsite. Institutional controls such as the Site Use Program, facility walkdown/maintenance and property record notices and restrictions ensure that future industrial activities do not cause unit disturbance, resulting in exposure of ecological or human receptors to contaminated media. Property record restrictions will prevent residential use, and a five-year remedy review will be required. The institutional controls and property record restrictions will include the ODA, which has residential COCs only. This alternative meets RAOs. Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation.

Alternative NB-3a: Removal and Offsite Disposal

Estimated Present Value Cost: $2,592,000

Construction Time to Complete: Nine months

Standing water is removed from the basins and either discharged to ground surface, discharged to a permitted outfall, or transported to an approved wastewater treatment facility. Contaminated soil/sediment is excavated to a maximum depth of 1.2 m (4 ft) in the Inlet Basin and 0.3 m (1 ft) in the Main Basin. The IPSL is also excavated for disposal. All excavated sediment and soil is disposed of at an offsite CERCLA-approved commercial facility. After excavation, the basin is backfilled with clean soil; a vegetated cover is placed over the unit to prevent erosion. For the ODA, deed restrictions will prevent residential use, and a five-year remedy review will be required. For the Inlet Basin, Main Basin, and IPSL, institutional controls and five-year remedy reviews are not required since contaminated media are removed, making the unit suitable for unrestricted use. Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. This alternative meets RAOs.

TNX Burying Ground and Vadose Zone

Detailed analysis was performed on five alternatives for remedial action of the TBG and vadose zone. Each alternative is described below.

Alternative V-1: No Action

Estimated Present Value Cost: $0

Construction Time to Complete: Immediate

Under the No Action alternative, no remedial effort to control risk, treat or remove waste, or reduce the toxicity, mobility, or volume of contaminated media will be made. Institutional controls and actions such as groundwater monitoring do not continue. This alternative does not meet the RAO; COCs would continue to be released to groundwater, and the time to achieve the groundwater remedy would not be accelerated. No five-year remedy review is required for this alternative due to no direct exposure to hazardous substances, pollutants or contaminants in the deep vadose zone. However, five-year reviews are necessary for the TNX Area OU because of other subunits. Land use remains industrial, and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation.

Alternative V-2: Soil-Vapor Extraction

Estimated Present Value Cost: $1,184,000

Construction Time to Complete: Five months with phased implementation

This alternative entails the installation and operation of an active and passive SVE system in the TNX vadose zone. The extraction system consists of existing monitoring wells that have screened portions above the water table as well as new SVE wells in locations where existing well spacing is not sufficient. Soil vapor is actively extracted with vacuum pumps or is passively vented. System air emissions are treated if vapor concentrations exceed state regulatory limits. This alternative effectively removes CVOCs from permeable portions of the vadose zone, improves groundwater concentration, and achieves the RAO.

Phase I and Phase II SVE tests performed in the vadose zone near the TBG from 1997 through 1999 indicated that SVE was a viable remediation alternative for clean-up of the CVOC contamination present in the unsaturated sediments at TNX. Due to the encouraging results of the SVE tests, SRS requested in 2002 that limited SVE be implemented as part of the Interim Action. Several SVE wells were installed, and a SVE unit is being utilized to remove CVOCs from the vadose zone. Details of the plan are provided in the ESD to the Rev. 1.0 IROD for the TNX Area OU Groundwater (WSRC 2001) and in the Addition of SVE to the IA HGCA, Addendum for the TNX Groundwater OU RDR/RAWP, Rev. 1.7 (WSRC 2002b). The active SVE system will be replaced by a more passive SVE system when it is reasonably apparent from operational data that equivalent benefit can be achieved by a more passive system. A passive system (e.g., natural barometric pumping or solar-powered SVE) is more environmentally and financially beneficial.

Remediation effectiveness will be determined by evaluating the (1) rate of mass removal, (2) system response following restart, and (3) cost of operation. An assessment of these combined criteria will be used to determine when transition to passive remediation is appropriate. Effectiveness of the system is evaluated and reported annually in the Comprehensive TNX Area Annual Groundwater and Effectiveness Monitoring Strategy Report. Because the mass of VOC source material may be relatively small, it is anticipated that active SVE will reach this point within a 6- to 18-month period. No waste is removed and disposed of offsite. Land use remains industrial. Because this action is intended to remediate the vadose zone source material only, the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. This alternative achieves the RAO.

Alternative V-3: SVE with Electrical Resistance Heating

Estimated Present Value Cost: $4,222,000

Construction Time to Complete: Five months with phased implementation

This alternative entails placing electrodes directly into the less permeable portions of the vadose zone soils. Activated electrodes create an electrical current that passes through the soil. In turn, resistance to the current heats the soil, causing it to dry out and fracture. In addition, the heat helps to volatilize trapped, liquid-phase contaminants. The electrical resistance (ER) heating would be combined with an active and passive SVE system. System air emissions are treated if vapor concentrations exceed state regulatory limits. No waste is removed and disposed of offsite. Land use remains industrial. Because this action is intended to remediate the vadose zone source material only, the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. This alternative effectively removes CVOCs from both permeable and less permeable portions of the vadose zone and achieves the RAO.

Alternative V-4: SVE with Steam/Hot Air Injection

Estimated Present Value Cost: $4,808,000

Construction Time to Complete: Five months with phased implementation

Steam or hot air is injected into the contaminated soil through a set of injection wells. Steam and hot air raise the subsurface temperature, thereby increasing the vapor pressure of contaminants. Additionally, steam injection increases contaminant solubility and dissolves the contaminants in the condensed steam. Steam injection also enhances the natural diffusion rates of contaminants and accelerates the cleanup of diffusion-limited, low-permeability formations. Vapor is extracted through a set of SVE wells by applying vacuum. Condensate and offgas streams are treated before final disposal if contaminant concentrations exceed state regulatory limits. No waste is removed and disposed of offsite. Land use remains industrial. Because this action is intended to remediate the vadose zone source material only, the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. This alternative effectively removes CVOCs from both permeable and less permeable portions of the vadose zone and achieves the RAO.

Alternative V-5: SVE with Air Sparging

Estimated Present Value Cost: $1,554,000

Construction Time to Complete: Five months with phased implementation

Air sparging technology expands the remediation capability of SVE to the capillary and saturated zones where SVE alone is not effective. Air is injected under pressure into the saturated zone through a set of injection or sparge points. As the injected air rises through the formation, it volatilizes and removes adsorbed VOCs in soils and strips dissolved contaminants from water. The contaminant-laden air is then collected through a set of SVE wells placed in the vadose zone. Offgas is treated if contaminant concentrations exceed state regulatory limits. No waste is removed and disposed of offsite. Land use remains industrial. Because this action is intended to remediate the vadose zone source material only, the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. This alternative effectively removes CVOCs from permeable portions of both vadose and saturated zones and achieves the RAO.

Old TNX Seepage Basin/ Inactive Process Sewer Line and Discharge Gully

Detailed analysis was performed on eight alternatives for remedial action of the OTSB/IPSL and DG. Each alternative is described below.

Alternative OB-1: No Action

Estimated Present Value Cost: $58,000

Construction Time to Complete: Immediate

Under the No Action alternative, no remedial effort to control risk, treat or remove waste, or reduce the toxicity, mobility, or volume of contaminated media will be made. Institutional controls and actions such as groundwater monitoring do not continue. This alternative does not mitigate potential risks associated with mercury in the soil of the OTSB and IPSL, leaching to groundwater, or eliminate concerns associated with exposure of future land users to contaminated media at the unit. Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. This alternative does not meet RAOs.

Alternative OB-2ax: Asphalt Cover with PTSM Removal and Institutional Controls

Estimated Present Value Cost: $5,033,000

Construction Time to Complete: Twelve months

This alternative entails paving uncovered areas of the OTSB, IPSL and DG with asphalt to effectively eliminate infiltration of precipitation and prevent the leaching of mercury and uranium. Prior to paving, the PTSM layer is removed from the basin and disposed of; the basin is then backfilled with clean fill, including the current fill material where practical. If needed, sheet piling will be installed to stabilize the sides of the excavation and prevent infiltration of water. If perched water is encountered in the excavation, desiccants or soil blending may be utilized to absorb excess moisture. The IPSL, assumed to contain PTSM, is also excavated for disposal. Costs and implementability were calculated based on 2002 sampling that shows that the PTSM is radioactive waste (not mixed waste), which can be disposed of at an offsite CERCLA-approved commercial disposal facility like Envirocare. Institutional controls (Site Use Program, facility walkdown/maintenance, and property record notices/restrictions) prohibit modifying or removing the asphalt cover. Monitoring for the presence of perched water in contact with soil exceeding the mercury CM RG would be accomplished using an appropriate in situ instrument (e.g., lysimeter or tensiometer). Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. This alternative meets RAOs for industrial land use.

Alternative OB-2ay: Asphalt Cover with Soil Stabilization and Institutional Controls

Estimated Present Value Cost: $4,265,000

Construction Time to Complete: Twelve months

This alternative entails paving uncovered areas of the OTSB, IPSL and DG with asphalt to effectively eliminate infiltration of precipitation and prevent the leaching of mercury and uranium. Prior to paving, the PTSM layer with the basin is stabilized to encapsulate the PTSM. Encapsulation of the PTSM limits the leachability of the material. The encapsulating agent will be selected during the design process. The IPSL, assumed to contain PTSM, is excavated, placed into the basin, and stabilized together with basin PTSM soil. The excavation would be extended southward from the basin as necessary to provide an adequate volume to contain the stabilized PTSM and allow a minimum of 1.2 m (4 ft) of clean backfill/cover without creating an excessive crown. No waste is removed and disposed of offsite. Institutional controls (Site Use Program, facility walkdown/maintenance, and property record notices/restrictions) prohibit modifying or removing the asphalt cover. Monitoring for the presence of perched water in contact with soil exceeding the mercury CM RG would be accomplished using an appropriate in situ instrument (e.g., lysimeter or tensiometer). Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. This alternative meets RAOs for industrial land use.

Alternative OB-2bx: Engineered Cap with PTSM Removal and Institutional Controls

Estimated Present Value Cost: $5,091,000

Construction Time to Complete: Twelve months

This alternative involves placing an engineered soil cap over the area of the OTSB/IPSL and DG to effectively eliminate infiltration of precipitation and prevent the leaching of mercury and uranium. Prior to placing the cap, the PTSM layer is removed from the basin, disposed of, and the basin is backfilled with clean fill, including the current fill material where practical. If needed, sheet piling will be installed to stabilize the sides of the excavation and prevent infiltration of water. If perched water is encountered in the excavation, desiccants or soil blending may be utilized to absorb excess moisture. The IPSL, assumed to be PTSM, is also excavated for disposal, where accessible. If soil surrounding the IPSL is contaminated (radioactivity will be checked by field instruments), the soil will also be excavated for disposal. Costs and implementability were calculated based on 2002 sampling that shows that the PTSM is radioactive waste (not mixed waste), which can be disposed of at an offsite CERCLA-approved commercial disposal facility like Envirocare. A vegetated topsoil cover is placed over the cap to control erosion. An apron of asphalt or other appropriate material is placed around the natural soil cap and over the unexcavated portions of the IPSL. Institutional controls (Site Use Program, facility walkdown/maintenance, and property record notices/restrictions) prohibit modifying or removing the engineered cap. Monitoring for the presence of perched water in contact with soil exceeding the mercury CM RG would be accomplished using an appropriate in situ instrument (e.g., lysimeter or tensiometer). Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. This alternative meets RAOs for industrial land use.

Alternative OB-2by: Engineered Cap with Soil Stabilization and Institutional Controls.

Estimated Present Value Cost: $4,542,000

Construction Time to Complete: Twelve months

This alternative entails placing an engineered soil cap over the area of the OTSB/IPSL and DG to effectively eliminate infiltration of precipitation and prevent the leaching of mercury and uranium. Prior to placing the cap, the PTSM layer within the basin is stabilized using soil mixing to encapsulate the PTSM. If needed, sheet piling will be installed to stabilize the sides of the excavation and prevent infiltration of water. Encapsulation of the PTSM limits the leachability of the material. The encapsulating agent will be selected during the design process. The IPSL, assumed to contain PTSM, is excavated, placed into the basin, and stabilized together with basin PTSM soil. The excavation would be extended southward from the basin as necessary to provide an adequate volume to contain the stabilized PTSM and allow a minimum of 1.2 m (4 ft) of clean backfill/cover without creating an excessive crown. A vegetated topsoil cover is placed over the cap to control erosion. An apron of asphalt or other appropriate material is placed around the natural soil cap and over the IPSL to accommodate ongoing operations in the TNX Area. No waste is excavated and disposed of offsite. Institutional controls (Site Use Program, facility walkdown/maintenance, and property record notices/restrictions) prohibit modifying or removing the engineered cap. Monitoring for the presence of perched water in contact with soil exceeding the mercury CM RG would be accomplished using an appropriate in situ instrument (e.g., lysimeter or tensiometer). Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. This alternative meets RAOs for industrial land use.

Alternative OB-3a: In Situ Stabilization with Institutional Controls

Estimated Present Value Cost: $6,087,000

Construction Time to Complete: Eighteen months

This alternative consists of in situ stabilization to immobilize CMCOCs in soil and PTSM in the OTSB. A stabilizer is injected into borings advanced into the contaminated zone. The interior of the IPSL is grouted in situ. No wastes are excavated and disposed of offsite. Institutional controls (Site Use Program, facility walkdown/maintenance, and property record notices/restrictions) prohibit future excavation in the remedial area. Monitoring for the presence of perched water in contact with soil exceeding the CM RG is accomplished using an appropriate in situ instrument (e.g., lysimeter or tensiometer). Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. This alternative meets RAOs for industrial land use.

Alternative OB-3b: Ex Situ Stabilization with Institutional Controls

Estimated Present Value Cost: $7,115,000

Construction Time to Complete: Eighteen months

This alternative consists of ex situ stabilization to immobilize contaminants in soil. The remedy involves excavating contaminated soil that exceeds RGs at the OTSB/IPSL and DG. Excavations deeper than 1.5 to 3.0 m (5 to 10 ft) will require side stabilization and/or shoring. Sheet piling will be driven into the ground to a depth of approximately 9 m (30 ft) prior to excavation to surround the proposed excavation area. To stabilize ex situ, contaminated soil is mixed with cement slurry. If perched water is encountered in the excavation, it will be incorporated into the cement slurry. The ex situ stabilization also addresses the PTSM soil layer within the basin and the IPSL that is assumed to contain PTSM. The excavation is backfilled with the stabilized mixture, which is then allowed to solidify. The excavation would be extended southward from the basin as necessary to provide an adequate volume to contain the stabilized PTSM and allow a minimum of 1.2 m (4 ft) of clean backfill/cover without creating an excessive crown. No waste is disposed of offsite. Institutional controls (Site Use Program, facility walkdown/maintenance, and property record notices/restrictions) prohibit future excavation in the remedial area. Monitoring for the presence of perched water in contact with soil exceeding the mercury CM RG would be accomplished using an appropriate in situ instrument (e.g., lysimeter or tensiometer). Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. This alternative meets RAOs for industrial land use.

Alternative OB-4b: Removal and Offsite Disposal

Estimated Present Value Cost: $24,095,000

Construction Time to Complete: Eighteen months

This alternative consists of excavating contaminated subsurface soil from the OTSB and the DG, including the PTSM soil layer. The IPSL, which is assumed to contain PTSM, will be excavated. Contaminated soil is disposed of at an offsite CERCLA-approved commercial disposal facility like Envirocare. Excavated areas are backfilled with clean soil, including the current fill material where practical. The backfilled areas are vegetated to control erosion. Institutional controls are not necessary for this subunit of the TNX Area OU since all contaminated media posing a CM threat is removed and disposed of. Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. This alternative meets RAOs for industrial land use.

TNX Groundwater

Detailed analysis was performed on six alternatives for remedial action of the TNX Groundwater. Each alternative is described below. All remedial alternatives except No Action include a monitoring/mixing zone and institutional controls (Site Use Program, facility walkdown/maintenance, and property record notices/restrictions) for the localized mercury and radiological contamination downgradient of the TBG and beneath the TNX Outfall Delta OU.

Alternative GW-1: No Action

Estimated Present Value Cost: $58,000

Construction Time to Complete: Immediate

Under the No Action alternative, no remedial effort to control risk, treat or remove waste, or reduce the toxicity, mobility, or volume of contaminated media will be made. Institutional controls and actions such as groundwater monitoring do not continue. Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. This alternative does not comply with ARARs and does not meet RAOs.

Alternative GW-3a: Monitoring/Mixing Zone with Institutional Controls

Estimated Present Value Cost: $2,918,000

Construction Time to Complete: Three months

This alternative entails continued monitoring of groundwater to ensure that the magnitude (concentration) or extent (location/size) of contaminants (CVOCs, mercury, and radionuclides) does not increase significantly in the future and that MCLs are not exceeded at established points of exposure. If the Core Team determines that it is necessary to quantify and document control of groundwater contamination with respect to points of exposure, a mixing zone demonstration could be implemented. No waste is excavated and disposed of offsite. Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. Institutional controls (Site Use Program, facility walkdown/maintenance, and property record notices/restrictions) are established to prohibit future residential land use and restrict access to prevent unacceptable human exposures to contaminated TNX groundwater during implementation of this alternative.

The applicability of a mixing zone will be evaluated following completion of the remedial actions of the TNX Area OU surface units and decommissioning and decontamination of TNX Area facilities. It is anticipated that these activities will be concluded by 2007. A groundwater/surface water mixing zone, if implemented, will be established in accordance with the guidance provided in the State of South Carolina Water Classifications and Standards R.61-68 (SCDHEC 2001). Prior to establishing a mixing zone, a Mixing Zone Application must be approved by SCDHEC. The application must include a detailed hydrogeologic/fate and transport assessment of the COCs and the proposed plume boundaries and associated Mixing Zone Concentration Limits (MZCLs), point of exposure boundary, monitoring well network, and a groundwater/surface water monitoring program. The mixing zone monitoring program must demonstrate attainment of RAOs and compliance with (1) the MZCLs at established monitoring well locations within the contaminant plume(s), and (2) MCLs at the established point of exposure boundary (i.e., groundwater location prior to discharge to surface water). The monitoring program continues until MCLs within the plume are achieved. Compliance with the MZCLs will be demonstrated as described in the mixing zone monitoring program. As a contingency, if the MZCLs established for plume monitoring wells are exceeded during a scheduled sampling event, the appropriate response action will be coordinated through regulatory agencies. If a subsequent technical review determines that the established mixing zone will not achieve the desired contaminant concentrations at the point of exposure, then contingency remedial techniques will be employed to achieve standards. It is recognized that additional information with respect to contaminant nature and extent may be required to implement a mixing zone.

Alternative GW-3c: GeoSiphon in Low CVOC Concentration Area with Monitoring/Mixing Zone and Institutional Controls

Estimated Present Value Cost: $6,833,000

Construction Time to Complete: Six months

This alternative involves constructing and operating a series of GeoSiphon wells in the swamp high ground area, near the leading edge of the CVOC plume. A siphon is created to withdraw groundwater by placing one end of a tube in an extraction well below the water table and the other end at a downgradient location. As water flows through the treatment cell in the annular space around the well, it comes in contact with granular zero-valent iron, and CVOCs in the groundwater are degraded by abiotic reductive dechlorination to harmless end-products. Groundwater sampling and CVOC analysis are conducted during implementation to gauge system effectiveness. No waste is excavated and disposed of offsite. Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation.

The applicability of a mixing zone will be evaluated following completion of the remedial actions of the TNX Area OU surface units and decommissioning and decontamination of TNX Area facilities. It is anticipated that these activities will be concluded by 2007. If applicable, a mixing zone will be implemented to contain/treat CVOCs in the flood plain, and monitoring of select wells will be conducted to ensure protection from dissolved mercury and radiological contaminants and to ensure achievement of RAOs. Institutional controls (Site Use Program, facility walkdown/maintenance, and property record notices/restrictions) are established to prevent human exposure to contaminated TNX groundwater during implementation of this alternative. Pilot studies conducted at the TNX Area OU demonstrate the effectiveness of this treatment system for CVOCs in groundwater.

Alternative GW-3d: Permeable Treatment Wall in Low CVOC Concentration Area with Monitoring/Mixing Zone and Institutional Controls

Estimated Present Value Cost: $4,629,000

Construction Time to Complete: Six months

This alternative involves constructing a flow-through permeable wall of zero-valent granular cast iron to provide for in situ dechlorination of CVOCs in groundwater. The wall is constructed in the swamp high ground area near the leading portion of the plume. A "hanging-type" wall is installed in the water table aquifer to a depth of 8 m (25 ft) and is not keyed into the underlying confining layer. Groundwater sampling and CVOC analysis are conducted during implementation to gauge system effectiveness. No waste is excavated and disposed of offsite.

The applicability of a mixing zone will be evaluated following completion of the remedial actions of the TNX Area OU surface units and decommissioning and decontamination of TNX Area facilities. It is anticipated that these activities will be concluded by 2007. If applicable, a mixing zone will be implemented to contain/treat CVOCs in the flood plain, and monitoring of select wells will be conducted to ensure protection from dissolved mercury and radiological contaminants. Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. Institutional controls (Site Use Program, facility walkdown/maintenance, and property record notices/restrictions) are established to prevent human exposure to contaminated TNX groundwater during implementation of this alternative. This alternative meets RAOs for CVOCs, providing contaminants do not pass under the wall at concentrations above their respective MCLs.

Alternative GW-3e: In Situ Chemical Oxidation in High CVOC Concentration Area with Monitoring/Mixing Zone and Institutional Controls

Estimated Present Value Cost: $6,392,000

Construction Time to Complete: Six months

This alternative consists of injecting Fenton's reagent (H_2O_2 and ferrous iron) into the dissolved-CVOC source zone within TNX Area. The reaction between the H_2O_2 and ferrous iron produces hydroxyl radicals (OH) that are strong, nonspecific oxidizing agents. The hydroxyl radicals quickly degrade hydrocarbons to CO_2 and water by attacking the carbon bonds. Fenton's reagent is delivered via injection wells screened across the most contaminated intervals of the saturated zone. Groundwater sampling and

CVOC analysis are conducted during implementation to gauge system effectiveness. The applicability of a mixing zone will be evaluated following completion of the remedial actions of the TNX Area OU surface units and decommissioning and decontamination of TNX Area facilities. It is anticipated that these activities will be concluded by 2007. If applicable, a mixing zone will be implemented to contain/treat CVOCs in the flood plain, and monitoring of select wells will be conducted to ensure protection from dissolved mercury and radiological contaminants. No waste is excavated and disposed of offsite. Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. Institutional controls (Site Use Program, facility walkdown/maintenance, and property record notices/restrictions) are established to prevent human exposure to contaminated TNX groundwater during implementation of this alternative. Pilot-scale treatability studies would be required to establish site-specific effectiveness at meeting RAOs.

Alternative GW-4a: Extraction in High CVOC Concentration Area with Monitoring/Mixing Zone and Institutional Controls

Estimated Present Value Cost: $7,132,000

Construction Time to Complete: Immediate

This alternative consists of operating the existing interim action extraction system. Groundwater is extracted from four recovery wells in the TNX Area, and CVOCs are removed from the extracted groundwater via an air stripper. Treated water is discharged to an SRS National Pollutant Discharge Elimination System (NPDES)-permitted outfall. Groundwater sampling and CVOC analysis are conducted during implementation to gauge system effectiveness. The applicability of a mixing zone will be evaluated following completion of the remedial actions of the TNX Area OU surface units and decommissioning and decontamination of TNX Area facilities. It is anticipated that these activities will be concluded by 2007. If applicable, a mixing zone will be implemented to contain/treat CVOCs in the flood plain, and monitoring of select wells will be conducted to ensure protection from dissolved mercury and radionuclides and to ensure achievement of RAOs. No waste is excavated and disposed of offsite. Land use remains industrial and the aquifer beneath the TNX Area OU cannot be used as a drinking water source or for irrigation. Institutional controls (Site Use Program, facility walkdown/maintenance, and property record notices/restrictions) will be established to prevent human exposure to contaminated TNX groundwater during implementation of this alternative. The existing pump-and-treat system contains the contaminant plume effectively. Eventually, CVOC contaminant levels will decline to levels consistent with this continued monitoring/mixing zone approach. The entire groundwater plume will be reassessed once SVE operation is determined to have reached diminished returns, as discussed previously for the TBG and vadose zone. This strategy will be assessed annually in the Comprehensive TNX Area Annual Groundwater and Effectiveness Monitoring Strategy Report.

X. COMPARATIVE ANALYSIS OF ALTERNATIVES

Each of the remedial alternatives for the source unit was evaluated using the nine criteria established by the National Oil and Hazardous Substances Contingency Plan (NCP) 40 Code of Federal Regulations (CFR) 300. The criteria were derived from the statutory requirements of CERCLA Section 121.

Threshold Criteria:

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

Balancing Criteria:

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment

- Short-term effectiveness

- Implementability

- Cost

Modifying Criteria:

- State acceptance

- Community acceptance

This evaluation identifies the advantages and disadvantages of the alternatives when compared to each other. The comparative analysis identifies the key tradeoffs to be balanced during the selection of a final preferred alternative. Table 10 provides the comparative analysis of alternatives.

New TNX Seepage Basin/ Inactive Process Sewer Line

Overall Protection of Human Health and the Environment

Both action alternatives (NB-2a and NB-3a) protect human health and the environment by eliminating the Inlet and Main Basins as aquatic habitats and preventing exposure of industrial workers (either through removal or backfilling) and future residents (through institutional controls and deed restrictions). The No Action alternative (NB-1) does not protect human health or the environment.

Compliance with ARARs

Chemical-Specific ARARs: Both action alternatives meet these criteria by eliminating the basins as aquatic environments. The No Action alternative does not meet TBC criteria for metals in surface water and sediment.

Location-Specific ARARs: There are no location-specific ARARs applicable to the No Action alternative. The action alternatives will be implemented in a manner that is protective of nearby wetlands to comply with ARARs.

Action-Specific ARARs: There are no action-specific ARARs applicable to the No Action alternative. Compliance with RCRA and South Carolina regulations for the management of solid and hazardous wastes is required for removal alternative NB-3a.

Table 10. Comparative Analysis of Alternatives

Criterion	Alternative NB-1 No Action	Alternative NB-2a Backfill with Institutional Controls	Alternative NB-3a Excavation & Offsite Disposal
Overall Protectiveness			
Human Health	Not Protective	Protective of future industrial workers; institutional controls prohibit future residential land usage.	Protective of future industrial workers; institutional controls prohibit future residential land usage.
Environment	Not protective	Protective	Protective
Compliance with ARARs			
Chemical-Specific	Would not meet TBC (ambient water quality criteria [AWQC])	Would meet criteria	Would meet criteria
Location-Specific	Not applicable	Must comply with erosion and runoff control requirements and must be protective of wetlands	Must comply with erosion and runoff control requirements and must be protective of wetlands
Action-Specific	Not applicable	Must comply with fugitive dust emission requirements	Must comply with fugitive dust emission requirements
Long-Term Effectiveness and Permanence			
Magnitude of Residual Risks	Risk not reduced	In the basins, remaining contaminants would be at a depth greater than 4 ft bls; no Human Health concerns. Residential risk at ODA managed by Institutional Controls	Risk to industrial worker in the basins would be eliminated. Residential risk at ODA managed by Institutional Controls
Permanence	Not permanent	Permanent	Permanent
Reduction of Toxicity, Mobility or Volume			
Degree of Expected Reduction in Toxicity, Mobility or Volume	None	None	None
Short-Term Effectiveness			
Risks to Remedial Workers	None	Negligible	Negligible
Risks to Community	None	Negligible	Negligible
Time to Achieve Remedial Action Objectives	No time	6 months	9 months
Implementability			
Availability of Materials, Equipment, Contractors	Not applicable	Readily available	Readily available
Administrative Feasibility/Regulatory Requirements	Readily implemented; 5-year remedy review	Permits not required; 5-year remedy review	Permits not required; 5-year remedy review
Technical Feasibility	Readily implementable	Readily Implementable	Readily Implementable
Monitoring Considerations	Not applicable	No monitoring required	No monitoring required
Time to Implement	No time	6 months	9 months
Cost			
Present Worth Capital Cost	$0	$507,434	$2,591,751
Present Worth O&M Cost	$58,176	$131,397	$0
Total Present Worth Cost	$58,176	$638,831	$2,591,751

Table 10. Comparative Analysis of Alternatives (Continued)

Criterion	Alternative OB-1 No Action	Alternative OB-2ax Asphalt Cover with PTSM Removal and Institutional Controls	Alternative OB-2ay Asphalt Cover with Soil Stabilization and Institutional Controls	Alternative OB-2bx Engineered Cap with PTSM Removal and Institutional Controls	Alternative OB-2by Engineered Cap with Soil Stabilization and Institutional Controls	Alternative OB-3a In Situ Stabilization with Institutional Controls	Alternative OB-3b Ex Situ Stabilization with Institutional Controls	Alternative OB-4b Removal and Offsite Disposal
Overall Protectiveness								
Human Health	Not protective because of resulting groundwater contamination and risk associated with subsurface wastes	Protective of groundwater and industrial workers. Institutional controls prohibit future residential land usage.	Protective of groundwater and industrial workers. Institutional controls prohibit future residential land usage.	Protective of groundwater and industrial workers. Institutional controls prohibit future residential land usage.	Protective of groundwater and industrial workers. Institutional controls prohibit future residential land usage.	Protective of groundwater and industrial workers. Institutional controls prohibit future residential land usage.	Protective of groundwater and industrial workers. Institutional controls prohibit future residential land usage.	Protective of groundwater, industrial workers, and future residents.
Environment	Not protective because of resulting groundwater contamination and risk associated with subsurface wastes	Protective	Protective	Protective	Protective	Protective	Protective	Protective
Compliance with ARARs								
Chemical-Specific	Not applicable	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location-Specific	Not applicable	Require erosion controls, transportation	Require erosion controls	Require erosion controls, transportation	Require erosion controls	Require erosion controls	Require erosion controls, transportation	Require erosion controls, transportation
Action-Specific	Not applicable	Require air monitoring	Require air monitoring	Require air monitoring	Require air monitoring	Require air monitoring	Require air monitoring	Require air monitoring
Long-Term Effectiveness and Permanence								
Magnitude of Residual Risks	PTSM COCs left in place; remaining contaminants more than 4 ft bls so no human health risk	PTSM removed; remaining contaminants more than 4 ft bls so no human health risk. Asphalt cover would prevent CM RCOCs from leaching to groundwater.	PTSM COCs left in place; remaining contaminants more than 4 ft bls so no human health risk. Asphalt cover would prevent CM RCOCs from leaching to groundwater.	PTSM removed; remaining contaminants more than 4 ft bls so no human health risk. Engineered cap would prevent CM RCOCs from leaching to groundwater.	PTSM COCs left in place; remaining contaminants more than 4 ft bls so no human health risk. Engineered cap would prevent CM RCOCs from leaching to groundwater.	PTSM COCs left in place; remaining contaminants more than 4 ft bls so no human health risk. Grouting would prevent CM RCOCs from leaching to groundwater.	PTSM COCs left in place; remaining contaminants more than 4 ft bls so no human health risk. Grouting would prevent CM RCOCs from leaching to groundwater.	Risk eliminated
Permanence	Not Permanent	Permanent	Permanent	Permanent	Permanent	Permanent	Permanent	Permanent
Reduction of Toxicity, Mobility or Volume								
Degree of Expected Reduction in Toxicity, Mobility or Volume	None	Mobility reduced. Volume reduced at SRS but not overall. PTSM removed	Reduce mobility but toxicity unchanged and volume increased	Mobility reduced. Volume reduced at SRS but not overall. PTSM removed	Reduce mobility but toxicity unchanged and volume increased	Reduce mobility but toxicity unchanged and volume increased	Reduce mobility but toxicity unchanged and volume increased	Volume reduced at SRS but not overall.
Short-Term Effectiveness								
Risks to Remedial Workers	None	Potential exposure to contaminants during excavation	Negligible	Potential exposure to contaminants during excavation	Negligible	Negligible	Potential exposure to contaminants during excavation	Potential exposure to contaminants during excavation

Table 10. Comparative Analysis of Alternatives (Continued)

Criterion	Alternative OB-1 No Action	Alternative OB-2ax Asphalt Cover with PTSM Removal and Institutional Controls	Alternative OB-2ay Asphalt Cover with Soil Stabilization and Institutional Controls	Alternative OB-2bx Engineered Cap with PTSM Removal and Institutional Controls	Alternative OB-2by Engineered Cap with Soil Stabilization and Institutional Controls	Alternative OB-3a In Situ Stabilization with Institutional Controls	Alternative OB-3b Ex Situ Stabilization with Institutional Controls	Alternative OB-4b Removal and Offsite Disposal
Risks to Community	None	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Time to Achieve Remedial Action Objectives	No time	Three years	Three years	Three years	Three years	Three years	Three years	Three years
Implementability								
Availability of Materials, Equipment, Contractors	Not applicable	Readily available	Readily available	Readily available	Readily available	Readily available	Readily available	Readily available
Technical Feasibility	Not applicable	Qualified contractor available	Qualified contractor available	Qualified contractor available	Qualified contractor available	Qualified contractor available	Qualified contractor available	Qualified contractor available
Administrative Feasibility/Regulatory Requirements	Readily implemented - 5-year remedy review	Readily implemented - 5-year remedy review	Readily implemented - 5-year remedy review	Readily implemented - 5-year remedy review	Readily implemented - 5-year remedy review	Readily implemented - 5-year remedy review	Readily implemented - 5-year remedy review	Readily implemented
Monitoring Considerations	Not applicable	Monitoring easily accomplished	Monitoring easily accomplished	Monitoring easily accomplished	Monitoring easily accomplished	Monitoring easily accomplished	Monitoring easily accomplished	Monitoring not required
Time to Implement	No time	Twelve months	Twelve months	Twelve months	Twelve months	Eighteen months	Eighteen months	Eighteen months
Cost								
Present Worth Capital Cost	$0	$4,832,915	$4,064,915	$4,928,766	$4,314,809	$6,012,257	$7,040,257	$24,094,582
Present Worth O&M Cost	$58,176	$199,849	$199,849	$199,494	$226,968	$75,176	$7,576	$0
Total Present Worth Cost	$58,176	$5,032,764	$4,264,794	$5,128,259	$4,541,777	$6,087,433	$7,155,433	$24,094,582

Table 10. Comparative Analysis of Alternatives (Continued)

Criterion	Alternative GW-1 No Action	Alternative GW-3a Monitoring/Mixing Zone with Institutional Controls	Alternative GW-3c GeoSiphon in Low CVOC Area with Monitoring/Mixing Zone and Institutional Controls	Alternative GW-3d Permeable Treatment Wall in Low CVOC Area with Monitoring/Mixing Zone and Inst. Controls	Alternative GW-3e In Situ Chemical Oxidation in High CVOC Area with Monitoring/Mixing Zone and Institutional Controls	Alternative GW-4a Extraction in High CVOC Area with Monitoring/Mixing Zone and Institutional Controls
Overall Protectiveness						
Human Health	Not protective	Protective for all possible future uses of groundwater	Protective for all possible future uses of groundwater	Protective for all possible future uses of groundwater	Protective for all possible future uses of groundwater	Protective for all possible future uses of groundwater
Environment	Protective	Protective	Protective	Protective	Protective	Protective
Compliance with ARARs						
Chemical-Specific	Would not meet MCLs	Would meet MCLs for CVOCs, meets MCL for mercury except in one well	Would meet MCLs for CVOCs, meets MCL for mercury except in one well	Would meet MCLs for CVOCs, meets MCL for mercury except in one well	Would meet MCLs for CVOCs and mercury	Would meet MCLs for CVOCs and mercury
Location-Specific	Not applicable	Not applicable	Requires measures to protect wetlands	Requires measures to protect wetlands	Requires measures to protect wetlands	Requires measures to protect wetlands
Action-Specific	Not applicable	Mixing Zone should be implemented in accordance with the SCDHEC mixing zone criteria	System construction must comply with fugitive dust and solid waste management; system operation must comply with effluent discharge requirements	System construction must comply with fugitive dust and solid waste management regulations	System construction must comply with fugitive dust and solid waste management regulations; chemical injection must comply with UIC and OSHA worker protection requirements	Must comply with requirements related to fugitive dust, NESHAPS, hazardous waste management, effluent discharges
Long-Term Effectiveness and Permanence						
Magnitude of Residual Risks	Risk not reduced	Risk reduced, eventually to levels allowing unrestricted usage	Risk reduced, eventually to levels allowing unrestricted usage	Risk reduced, eventually to levels allowing unrestricted usage	Risk reduced, eventually to levels allowing unrestricted usage	Risk reduced, eventually to levels allowing unrestricted usage
Permanence	Not permanent	Permanent	Permanent	Permanent	Permanent	Permanent

Table 10. Comparative Analysis of Alternatives (Continued)

Criterion	Alternative GW-1 No Action	Alternative GW-3a Monitoring/Mixing Zone with Institutional Controls	Alternative GW-3c GeoSiphon in Low CVOC Area with Monitoring/Mixing Zone and Institutional Controls	Alternative GW-3d Permeable Treatment Wall in Low CVOC Area with Monitoring/Mixing Zone and Inst. Controls	Alternative GW-3e In Situ Chemical Oxidation in High CVOC Area with Monitoring/Mixing Zone and Institutional Controls	Alternative GW-4a Extraction in High CVOC Area with Monitoring/Mixing Zone and Institutional Controls
Reduction of Toxicity, Mobility or Volume						
Degree of Expected Reduction in Toxicity, Mobility or Volume	None	Natural attenuation eventually reduces CVOC volume, toxicity, and mobility in groundwater; natural attenuation of acidic conditions reduce mercury and radionuclide mobility and concentration in groundwater	In situ destruction of CVOCs reduces volume, toxicity, and mobility in groundwater; natural attenuation of acidic conditions reduce mercury and radionuclide mobility and concentration in groundwater	In situ destruction of CVOCs reduces volume, toxicity, and mobility in groundwater; natural attenuation of acidic conditions reduces mercury and radionuclide mobility and concentration in groundwater	In situ chemical oxidation reduces CVOC volume; natural attenuation of acidic conditions reduces mercury and radionuclide mobility and concentration in groundwater	Ex situ stripping of organics reduces CVOC mobility and contaminated groundwater volume; natural attenuation of acidic conditions reduces mercury and radionuclide mobility and concentration in groundwater
Short-Term Effectiveness						
Risks to Remedial Workers	None	Minor; contact with contaminated groundwater during monitoring	Minor; potential risk from airborne particulates and contact with contaminated soil during construction.	Minor; potential risk from airborne particulates and contact with contaminated soil during construction.	Minor; potential risk from airborne particulates and contact with contaminated soil during construction.	Minor; potential risk from airborne particulates and contact with contaminated soil during construction.
Risks to Community	None	None	Negligible	Negligible	Negligible	Negligible
Time to Achieve Remedial Action Objectives	No time	Greater than 30 years for CVOCs; greater than 100 years for mercury and radionuclides	Greater than 30 years for CVOCs; greater than 100 years for mercury and radionuclides	Greater than 30 years for CVOCs; greater than 100 years for mercury and radionuclides	Five years for CVOCs, assuming 100% source removal and operation of IRA P&T system; greater than 100 years for mercury and radionuclides	Greater than 30 years for CVOCs; greater than 100 years for mercury and radionuclides

Table 10. Comparative Analysis of Alternatives (Continued)

Criterion	**Alternative GW-1 No Action**	**Alternative GW-3a Monitoring/Mixing Zone with Institutional Controls**	**Alternative GW-3c GeoSiphon in Low CVOC Area with Monitoring/Mixing Zone and Institutional Controls**	**Alternative GW-3d Permeable Treatment Wall in Low CVOC Area with Monitoring/Mixing Zone and Institutional Controls**	**Alternative GW-3e In Situ Chemical Oxidation in High CVOC Area with Monitoring/Mixing Zone and Institutional Controls**	**Alternative GW-4a Extraction in High CVOC Area with Monitoring/Mixing Zone and Institutional Controls**
Implementability						
Availability of Materials, Equipment, Contractors	Not applicable	Readily available	Readily available	Readily available	Readily available	Readily available
Technical Feasibility	Not applicable	Requires computer modeling	New technology, but application demonstrated.	Requires computer modeling	Requires short pilot test and exclusion zone during injection	Straightforward
Administrative Feasibility/Regulatory Requirements	Readily implemented – 5-year remedy review	Readily implemented for the low concentration area; five-year remedy reviews required until MCLs achieved	Readily implemented – 5-year remedy review required until MCLs achieved	Readily implemented – 5-year remedy review required until MCLs achieved	Could require a UIC permit; five-year remedy reviews required until MCLs achieved	Readily implemented – 5-year remedy review required until MCLs achieved
Monitoring Considerations	Not applicable	Groundwater monitoring readily accomplished	Groundwater monitoring readily accomplished.	Groundwater monitoring readily accomplished.	Groundwater monitoring readily accomplished.	Groundwater and effluent monitoring readily accomplished.
Time to Implement	No time	Three months	Six months to construct	Six months to construct	Six months, including pilot testing	IRA system currently operating
Cost						
Present Worth Capital Cost	$0	$78,900	$1,900,739	$1,572,207	$2,262,230	$100,700
Present Worth O&M Cost	$58,176	$2,839,292	$4,932,540	$3,057,058	$4,129,275	$7,031,674
Total Present Worth Cost	$58,176	$2,918,192	$6,833,279	$4,629,265	$6,391,505	$7,132,374

Table 10. Comparative Analysis of Alternatives (Continued)

Criterion	Alternative V-1 No Action	Alternative V-2 Soil Vapor Extraction	Alternative V-3 SVE with ER Heating	Alternative V-4 SVE with Steam/Hot Air Injection	Alternative V-5 SVE with Air Sparging
Overall Protectiveness					
Human Health	Does not support actions to protect future receptors	Protective	Protective	Protective	Protective
Environment	Not protective	Protective	Protective	Protective	Protective
Compliance with ARARs					
Chemical-Specific	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Location-Specific	Not applicable	Complies with erosion and runoff control requirements to protect wetlands and surface water	Complies with erosion and runoff control requirements to protect wetlands and surface water	Complies with erosion and runoff control requirements to protect wetlands and surface water	Complies with erosion and runoff control requirements to protect wetlands and surface water
Action-Specific	Not applicable	Sampling performed to ensure compliance with air emissions requirements; complies with hazardous waste management requirements	Sampling performed to ensure compliance with air emissions requirements; complies with hazardous waste management requirements	Sampling performed to ensure compliance with air emissions requirements; complies with hazardous waste management requirements	Sampling performed to ensure compliance with air emissions requirements; complies with hazardous waste management requirements
Long-Term Effectiveness and Permanence					
Magnitude of Residual Risks	Residual risk may exist if groundwater remedy does not address contaminants in Water Table Aquifer	No residual risk	No residual risk	No residual risk	No residual risk
Permanence	Not permanent	Permanent	Permanent	Permanent	Permanent
Reduction of Toxicity, Mobility or Volume					
Degree of Expected Reduction in Toxicity, Mobility or Volume	None	Contaminant mobility is reduced by fixing CVOCs to carbon; toxicity not reduced; contaminants destroyed when carbon is regenerated; contaminant volume in source material is reduced	Contaminant mobility is reduced by fixing CVOCs to carbon; toxicity not reduced; contaminants destroyed when carbon is regenerated; contaminant volume in source material is reduced	Contaminant mobility is reduced by fixing CVOCs to carbon; toxicity not reduced; contaminants destroyed when carbon is regenerated; contaminant volume in source material is reduced	Contaminant mobility is reduced by fixing CVOCs to carbon; toxicity not reduced; contaminants destroyed when carbon is regenerated; contaminant volume in source material is reduced

Table 10. Comparative Analysis of Alternatives (Continued)

Criterion	Alternative V-1 No Action	Alternative V-2 Soil Vapor Extraction	Alternative V-3 SVE with ER Heating	Alternative V-4 SVE with Steam/Hot Air Injection	Alternative V-5 SVE with Air Sparging
Short-Term Effectiveness					
Risks to Remedial Workers	None	Minor; potential risk from airborne particulates and contact with contaminated soil during construction.	Minor; potential risk from airborne particulates and contact with contaminated soil during construction.	Minor; potential risk from airborne particulates and contact with contaminated soil during construction.	Minor; potential risk from airborne particulates and contact with contaminated soil during construction.
Risks to Community	None	Negligible	Negligible	Negligible	Negligible
Time to Achieve Remedial Action Objectives	No time	Estimated 3 to 5 years	Estimated 3 to 5 years	Estimated 3 to 5 years	Estimated 3 to 5 years
Implementability					
Availability of Materials, Equipment, Contractors	Not applicable	Readily available	Available from specialty vendors/subcontractors	Readily available	Readily available
Technical Feasibility	Not applicable	Common technology that is easily implemented	Easily implemented	Common technology that is easily implemented	Common technology that is easily implemented
Administrative Feasibility/Regulatory Requirements	Readily implemented – 5-year remedy review	Readily implemented – 5-year remedy review	Readily implemented – 5-year remedy review	Readily implemented – 5-year remedy review	Readily implemented – 5-year remedy review
Monitoring Considerations	Not applicable	Easily monitored through vacuum and flow measurements and sampling	Easily monitored through vacuum and flow measurements and sampling	Easily monitored through vacuum and flow measurements and sampling	Easily monitored through vacuum and flow measurements and sampling
Time to Implement	No time	Five months with phased implementation	Five months with phased implementation	Five months with phased implementation	Five months with phased implementation
Cost					
Present Worth Capital Cost	$0	$492,884	$3,530,885	$748,413	$632,745
Present Worth O&M Cost	$0	$690,698	$690,694	$4,059,723	$921,313
Total Present Worth Cost	$0	$1,183,582	$4,221,583	$4,808,136	$1,554,058

Long-Term Effectiveness and Permanence

Both action alternatives are permanent and long term in nature. Alternative NB-3a (excavation and disposal) is superior in long-term effectiveness and permanence since the contaminated soil is permanently removed from the basins, but it will still require permanent institutional controls in the ODA due to remaining residential risk. Alternative NB-2a (backfilling) requires permanent institutional controls in the basin areas and the ODA to effectively achieve RAOs. The No Action alternative provides no long-term protection of human health or the environment.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative NB-3a reduces the volume of contaminated media at the OU, but not the total volume, since no treatment is involved. None of the alternatives reduce the toxicity or mobility of contaminants or contaminated media. There are no CM RCOCs at this subunit, and no PTSM.

Short-Term Effectiveness

Alternative NB-2a poses no short-term risk to the community or the environment during implementation. Alternative NB-3a poses a small, but manageable, short-term risk to the community during implementation due to the transportation of contaminated soil. Both action alternatives pose small, but manageable, short-term risk to remedial workers during implementation. Alternative NB-2a achieves RAOs in six months, while Alternative NB-3a would take nine months. The No Action alternative never achieves RAOs.

Implementability

The containment and removal alternatives are easily implemented using conventional construction techniques and equipment. The No Action alternative requires no effort to implement.

Cost

Alternative NB-2a ($639,000) is cost-effective at approximately one-fourth the cost of Alternative NB-3a ($2,592,000).

Old TNX Seepage Basin/ Inactive Process Sewer Line and Discharge Gully

Overall Protection of Human Health and the Environment

All action alternatives are protective of human health and the environment. Alternative OB-4b protects groundwater by removing contaminated soil from the unit. The Asphalt Cap alternatives (OB-2ax and OB-2ay) and the Engineered Cap alternatives (OB-2bx, OB-3a and OB-3b) provide protection of groundwater by limiting infiltration, but require institutional controls to ensure long-term integrity of the cap to prevent exposure to deep soil. Alternatives OB-3a and OB-3b protect groundwater by reducing contaminant mobility through treatment. Alternative OB-1 (No Action) is not protective.

Although the contamination in the basin is not a human health RCOC, it is considered PTSM, and the Core Team has decided that it should be removed from the OTSB, since it is close to the SRS boundary. Alternatives OB-2ax, OB-2bx, and OB-4b remove the PTSM, while the other alternatives do not.

Compliance with ARARs

There are no chemical-specific ARARs for this subunit. All action alternatives need to be implemented in a manner protective of nearby wetlands to comply with location-specific ARARs. General remedial construction ARARs apply to all action alternatives.

These ARARs include South Carolina regulations for fugitive dust emissions, National Emissions Standards for Hazardous Air Pollutants (NESHAPs) for radionuclides and RCRA hazardous waste management requirements.

Long-Term Effectiveness and Permanence

All action alternatives are permanent and long term in nature. Alternative OB-4b is the only alternative that does not require institutional controls, because all PTSM and soil above the CM RG are removed from the OU. The asphalt cover and engineered cap reduce the mobility of subsurface contaminants. Alternatives that require institutional controls achieve less permanent protection if controls/restrictions are not adhered to.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative OB-4b reduces the volume of contaminants (both PTSM and contaminated deep soils) at SRS through offsite disposal, but the overall volume is not reduced because no treatment is involved. All other action alternatives reduce the mobility of the contaminants; however, toxicity is not reduced. Although Alternatives OB-2ay and OB-2by include stabilization (which reduces mobility through treatment, but increases volume slightly), this is for the PTSM only, not the contaminated deep soils, so a cover system would still be needed for contaminated deep soils. Alternatives OB-3a and OB-3b include stabilization of both the PTSM and the contaminated deep soils, which would reduce mobility; both alternatives would increase the volume of contaminated media (OB-3b increases the volume of contaminated media by approximately 25% if cement is used as the stabilizer). Alternatives OB-2ax and OB-2bx reduce the volume of PTSM at SRS, but not overall because no treatment is involved. The remaining contaminated deep soils would be covered to reduce mobility.

Short-Term Effectiveness

Alternatives involving excavation require the most handling of contaminated soil and pose a greater short-term risk to the environment, community, and remedial workers.

These risks are manageable with appropriate procedures to protect remedial workers and the environment. Alternatives OB-2ay and OB-2by require the least handling of contaminated soil; Alternatives OB-2ax and OB-2bx require handling more contaminated soil; and Alternatives OB-3a, OB-3b and OB-4b require the most handling. Alternative OB-4b involves the most short-term risk to community during transportation of contaminated media, but this risk is manageable. All action alternatives require the same time frame to achieve RAOs (three years), but Alternatives OB-2ax, OB-2ay, OB-2bx, and OB-2by require less construction time in the field than the other action alternatives (twelve months compared to eighteen months).

Implementability

The asphalt cover alternatives are easily implemented with little disruption of TNX activities. The engineered cap alternatives are also easy to implement since they involve the use of an asphalt apron in the area near buildings, accommodating ongoing TNX decontamination and decommissioning. The alternatives requiring a greater amount of soil handling (OB-3a, OB-3b and OB-4b) would be the most disruptive to TNX activities, requiring movement or interruption of utilities and restricting access to work areas. In addition, these alternatives involve a much higher level of effort, requiring extensive unit work, dewatering, and transportation of contaminated soil.

Cost

The total present worth costs of the remedial alternatives are included in Table 10. Costs range from $59,000 (OB-1, No Action) to $24,095,000 (OB-4b, Removal and Offsite Disposal). The alternatives (OB-2ax, OB-2ay, OB-2bx, and OB-2by) that include treatment or removal for the PTSM only, with a cover system for the remaining contaminated soils, are more cost-effective than the alternatives (OB-3a, OB-3b, and OB-4b) that remove or treat all contaminated soil, including the contaminated soils at the DG.

TNX Burying Ground and Vadose Zone

Overall Protection of Human Health and the Environment

All action alternatives help protect human health by reducing the time necessary to achieve groundwater RAOs. None is more protective than any other action alternative. Alternative V-1 (No Action) does not support actions to protect future receptors.

Compliance with ARARs

Chemical-Specific ARARs: There are no chemical-specific ARARs for CVOCs in the TNX vadose zone.

Location-Specific ARARs: There are no location-specific ARARs applicable to the No Action and monitoring/mixing zone alternatives. Since construction activities for the action alternatives are limited to well and electrode installation and small-system setup, they will easily comply with ARARs.

Action-Specific ARARs: There are no action-specific ARARs applicable to the No Action alternative. Offgas emissions from the SVE systems in Alternatives V-2 through V-5 will be treated in accordance with South Carolina Air Pollution Controls Standards if necessary.

Long-Term Effectiveness and Permanence

All action alternatives permanently remove contaminants from the vadose zone and are long term in nature. None is more protective in the long term than any other.

Reduction of Toxicity, Mobility, or Volume through Treatment

All action alternatives reduce mobility and volume by removing CVOCs from the vadose zone. The same amount of reduction in secondary source material (PTSM) is expected from all action alternatives.

Short-Term Effectiveness

The action alternatives require handling relatively small volumes of contaminated soil and will pose minimal short-term risks that are easily managed. Alternative V-2 requires the least handling of contaminated soil.

All the action alternatives achieve substantial source removal in three to five years. There is no difference in the amount of time to achieve RAOs between the action alternatives.

Implementability

SVE is a well-established remediation technology that is easily implemented. Alternative V-2 is the most easily implemented (an interim action is already in place). Steam/hot air injection (Alternative V-4) and air sparging enhancements (Alternative V-5) are established technologies and are readily implementable. The design and/or installation of a more innovative ER heating system for Alternative V-3 could require a specialty vendor.

Cost

The total present worth costs of the remedial alternatives are included in Table 10. Costs range from $0 (V-1, No Action) to $4,808,000 (V-4, SVE with Steam/Hot Air Injection). The least expensive action alternative is V-2, at $1,184,000.

TNX Groundwater

Overall Protection of Human Health and the Environment

All action alternatives actively or passively treat CVOCs, and modeling indicates contaminant concentrations eventually decrease to below MCLs. All action alternatives would be protective of human health and the environment. Alternative GW-1 (No Action) is not protective.

Compliance with ARARs

Chemical-Specific ARARs: All action alternatives remove/treat CVOCs to achieve ARARs for VOCs. In addition, concentrations of mercury and radiological constituents naturally attenuate to the MCL as acidic conditions decrease in groundwater.

Location-Specific ARARs: There are no location-specific ARARs applicable to the No Action and monitoring/mixing zone alternatives. The action alternatives will be implemented in a manner that is protective of nearby wetlands to comply with ARARs.

Action-Specific ARARs: There are no action-specific ARARs applicable to the No Action alternative. ARARs applicable to other alternatives include NESHAPs, RCRA waste management requirements, and SCDHEC mixing zone criteria. Substantive requirements of South Carolina Air Pollution Control Standards apply to emissions of VOCs in alternative GW-4a. Effluent from treated groundwater will meet NPDES discharge requirements.

Long-Term Effectiveness and Permanence

All action alternatives implemented in the CVOC-source area either remove contaminants from the groundwater or destroy them in situ and are, therefore, long term, permanent remedies. Groundwater remedial alternatives implemented near the low-concentration plume also remove CVOCs from groundwater or destroy them in situ. The long-term effectiveness and permanence of all alternatives is dependent on continued operating and maintenance (O&M) and institutional controls until RAOs are achieved.

Reduction of Toxicity, Mobility, or Volume through Treatment

GeoSiphon (GW-3c), permeable treatment wall (GW-3d), and chemical oxidation (GW-3e) reduce CVOC toxicity and volume by destroying/degrading contaminants in situ. Groundwater extraction (GW-4a) reduces CVOC-contaminated groundwater volume. In all action alternatives, natural attenuation reduces CVOC mobility through degradation and reduces contaminant toxicity through dispersion and dilution. Less acidic conditions in groundwater reduce the mobility and volume of mercury and radiological constituents in groundwater.

Short-Term Effectiveness

Implementation of the No Action and monitoring/mixing zone alternatives poses no short-term risk to the community, remedial workers, or the environment. Direct contact with contaminated soil and/or groundwater and inhalation of fugitive dust are potential short-term hazards to remedial workers during implementation of all action alternatives. Potential contact with chemicals presents an additional hazard during implementation of in situ chemical oxidation (GW-3e).

Alternatives GW-1 and GW-3a never achieve RAOs since contaminant migration to the Savannah River is not prevented. GeoSiphon (GW-3c), permeable treatment wall (GW-3d), and groundwater extraction (GW-4a) all rely on advective transport to remove CVOCs and require greater than 100 years to reach MCLs sitewide. Therefore, all remedial action alternatives require extended treatment times to achieve groundwater RAOs.

Upon implementation, all action alternatives (except GW-3a) achieve protection of the Savannah River.

Implementability

Alternative GW-4a is the most easily implemented, since an interim action is already in place. Alternative GW-3a would be easy to implement, but does not achieve RAOs. Alternative GW-3c is readily implementable. Some treatability and pilot testing is required for chemical oxidation (GW-3e), and computer modeling would be required for Alternative GW-3d. System installation for all action alternatives is achieved using conventional construction equipment, materials, and methods that are readily available.

However, TNX Area decontamination and decommissioning and the existence of numerous subsurface utilities could complicate the construction planning.

Cost

The total present worth costs of the remedial alternatives are included in Table 10. Costs range from $58,000 (GW-1, No Action) to $7,132,000 (GW-4a, Extraction in High CVOC Area).

XI. THE SELECTED REMEDY

Detailed Description of the Selected Remedy

New TNX Seepage Basin/Inactive Process Sewer Line

Alternative NB-2a is the preferred alternative for the NTSB/IPSL.

- In situ grouting of the IPSL
- Discharge of surface water in the NTSB to an approved location (ground surface, permitted outfall, or wastewater treatment facility)
- Backfill of the Main Basin and Inlet Basin with clean soil
- Long-term management under institutional controls, including deed restrictions preventing residential use at the ODA

The remedial action is designed to minimize the exposure of the industrial worker and ecological receptors to contaminated sediments and standing water in the Inlet Basin and Main Basin. Although Alternative NB-3a (excavation with offsite disposal) is superior in long-term effectiveness and permanence since the contaminated soil would be permanently removed from the OU, this additional increase in long-term effectiveness and permanence is not justified over that attained using Alternative NB-2a (backfilling) for the following reasons: (1) Alternative NB-2a is still fully protective of human health and the environment, (2) the contaminated soil will not be readily accessible by future intruders, and (3) Alternative NB-2a has a cost of approximately one-fourth that of Alternative NB-3a. In addition, Alternative NB-2a is more effective in the short term because it does not risk exposing the public to contaminated material during transportation, and it achieves RAOs three months faster than Alternative NB-3a. Backfilling has been used previously at SRS for similar waste and has been accepted by both the state and the public as a safe, cost-effective, long-term method for treating this type of contaminated soil (LLTSM).

TNX Burying Ground and Vadose Zone

Alternative V-2 is the preferred alternative for the vadose zone.

- Installation and operation of an active and passive SVE system in the TNX vadose zone

Alternative V-2 is protective of human health and the environment, and has long-term effectiveness and permanence. SVE meets the preference for treatment of PTSM, and this alternative is readily implementable. Although other alternatives that included and supplemented SVE were evaluated, all were more expensive than Alternative V-2, with no additional benefits. The time to achieve RAOs is the same for all alternatives (estimated 3 to 5 years), and Alternative V-2 is the most cost-effective. SVE has been used previously at SRS for similar waste and is currently being used at the TNX Area OU as an interim action. SVE has been accepted by both the state and the public as a safe and cost-effective method for treatment.

The Core Team has agreed to deploy simple SVE in the vadose zone at the TBG as a component of the current groundwater interim action. The existing IROD for the TNX groundwater has been revised to incorporate SVE. If it is determined in the future that improvements to the SVE are needed, they will be considered. This remedial action effectively removes CVOCs from permeable portions of the vadose zone and achieves the RAO. The SVE system will operate until an assessment determines that a transition to a passive remediation technique (e.g., natural barometric pumping or solar-powered mini-blowers) is appropriate.

For TBG areas that were characterized during the RFI/RI, no COCs were identified in surface or shallow subsurface soils. Consequently, these areas do not require remedial action and will be left intact with limited disturbance to the aboveground paved surfaces.

Due to numerous underground and aboveground obstructions, several TBG areas were not thoroughly investigated during RFI/RI characterization activities. These areas include previously excavated areas located beneath buildings and five unexcavated TBG areas. At this time, no action will be taken for the TBG areas not investigated during the RFI/RI. The unexcavated areas may contain buried contaminated materials, but these materials are not expected to be contaminated at concentrations that would pose a risk to human health or the environment based on an industrial land use scenario. Once decontamination and decommissioning of the obstructing facilities and utilities are completed, sampling will be conducted to confirm this assumption. If post-decommissioning characterization reveals contamination requiring remediation, then an appropriate action will be added to the remedy through an ESD or ROD.

Old TNX Seepage Basin/Inactive Process Sewer Line/ Discharge Gully

Alternative OB-2bx is the preferred alternative for the OTSB/IPSL/DG and entails the following actions:

- Removal of existing OTSB backfill
- Excavation of IPSL (where accessible) and associated radiologically contaminated soils
- Plugging ends of any IPSL sections not excavated during this action with grout
- Excavation of the PTSM layer in the OTSB (2- to 3-ft soil interval at the bottom of the inlet and main basins)
- Backfill of IPSL excavation and replacement of asphalt

- Disposal of PTSM-contaminated soils and pipeline (estimated 2,180 yd^3 total) at an approved off-SRS disposal facility
- Backfill of the OTSB and DG using the current backfill material where practical
- Placement of engineered cap (and associated institutional controls) over the OTSB and DG (from the facility to the base of the slope at the TNX Outfall Delta)
- Monitoring of the subsurface for the presence of perched water in contact with waste exceeding CM RGs under the soil cover
- Implementation of institutional controls to ensure the integrity of the engineered cap and prevent the future industrial worker from excavating contaminated media via access controls and field walkdown/maintenance and to prevent residential use through property notices/restrictions.

Presently, the buildings and laboratories located in the TNX area are being readied for decontamination and decommissioning. This work is currently scheduled for completion by September 30, 2004. Following decontamination and decommissioning of the buildings in the TNX Area, the remaining sections of OTSB IPSL will be further investigated as part of the TNX Area IPSL site evaluation characterization activities.

This remedial action meets RAOs for industrial land use. Alternative OB-2bx meets the CERCLA preference for treatment or removal of PTSM by removing it from the OU. The Core Team has decided that removing PTSM at this subunit is an important goal, so the long-term effectiveness and permanence of excavation and disposal of PTSM was chosen over grouting because the OTSB is near the SRS boundary. The engineered cap will meet the RAO of preventing leaching of contaminants from deep soils at the OTSB/ DG. Although the engineered cap will require O&M, it will provide long-term effectiveness and permanence at less than one-third of the cost of Alternative OB-4b, which would excavate both the PTSM and CM RCOCs. Engineered caps have been used previously at SRS for similar waste and have been accepted by both the state and the public as a safe, cost-effective, long-term method for preventing leaching of contaminants to groundwater.

TNX Groundwater

Alternative GW-4a is the preferred alternative for the TNX groundwater and entails the following:

- Extraction of VOCs from the vadose zone in the high concentration areas of the vadose zone identified as secondary source areas (i.e., SVE)
- Continued operation of the existing pump-and-treat system until groundwater monitoring determines that passive remediation (mixing zone) is appropriate
- Use of monitoring/mixing zone, if applicable, and institutional controls. Institutional controls will consist of deed restrictions and/or administrative directives, such as the Site Use Program, prohibiting installation of drinking water wells and preventing use of groundwater beneath TNX with concentrations of contaminants above MCLs. These controls will remain in effect until Core Team concurrence that COC concentrations in groundwater do not present unacceptable risk to receptors.

Alternative GW-4a is more easily implementable than the other alternatives considered because the system is currently operating under an interim action. Other technologies were evaluated, but none were more protective of human health and the environment or had a shorter time to achieve RAOs than Alternative GW-4a. This alternative reduces the volume of CVOCs in groundwater through treatment of source material and the contaminated medium. This type of pump-and-treat groundwater system, in combination with SVE and monitoring/mixing zone, has been used previously at SRS and has been accepted by both the state and the public as a safe and cost-effective method for protecting groundwater.

The installation of monitoring systems that are a part of a mixing zone will be very difficult while active decontamination and decommissioning and remediation is ongoing.

The applicability of a mixing zone will, therefore, be evaluated following completion of the remedial actions of the TNX Area OU surface units and decommissioning and decontamination of TNX Area facilities. It is anticipated that these activities will be concluded by 2007. If a monitoring/mixing zone can be implemented in the TNX groundwater, the following separate mixing zones will be established: (1) mercury- and radium-contaminated groundwater downgradient of the TBG; (2) mercury- and uranium-contaminated groundwater beneath the TNXOD OU; and (3) CVOC-contaminated groundwater beneath the TNX Area OU and TNXOD OU. These mixing zones may be implemented in phases as sufficient data becomes available and remedial actions are implemented.

This alternative will achieve the RAOs to return groundwater to beneficial use within a reasonable time period by remediating carbon tetrachloride, PCE and TCE to MCLs and to protect the industrial worker from exposure to groundwater contaminated with radiological constituents and mercury at levels exceeding the MCLs.

Groundwater - Mercury and Radium downgradient of TBG

Groundwater from isolated wells downgradient of the TBG exceeds the MCL for total radium and mercury. The Groundwater BRA Addendum (WSRC 2002c) identifies total radium and mercury as RCOCs. No radium or mercury contaminant plumes are discernable, and these constituents do not present a problem warranting action at this time.

Lower groundwater pH occurs in areas of TNX where higher levels of radium and mercury are present. Acidic conditions increase the mobility of metals and radionuclides through leaching. Because pH conditions can vary widely due to environmental (e.g., wetland and/or recharge rates) or anthropogenic (e.g., disposal of nitric acid) sources, it is uncertain whether the source of mercury and radium in groundwater is process-related or natural and whether low pH conditions are responsible for the elevated concentrations. It is also uncertain whether the magnitude (concentration) or extent (location/size) of the isolated areas of contamination will increase with time. It is likely groundwater pH will gradually increase due to natural processes, and the contaminants will adsorb to the sediments or precipitate, thereby reducing contaminant concentrations in groundwater. Although these constituents do not present a problem warranting action, their presence in groundwater will continue to be monitored and reported annually in the Comprehensive TNX Area Annual Groundwater and Effectiveness Monitoring Strategy Report. Institutional and land use controls as described in Section VI will be utilized to prevent the use of potentially contaminated groundwater.

The installation of monitoring systems that are a part of a mixing zone will be very difficult while active decontamination and decommissioning and remediation is ongoing. Therefore, the applicability of a mixing zone for mercury- and radium-contaminated groundwater downgradient of the TBG will be evaluated following completion of the remedial actions at the TNX Area OU surface units and decommissioning and decontamination of the TNX Area facilities. It is anticipated that these activities will be concluded by 2007. If feasible, SRS will provide a mixing zone demonstration for mercury- and radium-contaminated groundwater downgradient of the TBG. SRS believes the contaminated groundwater is caused by acid-leaching of naturally-occurring mercury and radium from soils. In addition, it is thought that groundwater pH will increase with time, and concentrations of mercury and radium in groundwater will decrease due to their subsequent adsorption/precipitation to soils. In the near term, additional data collection and a technical assessment will be performed. The technical assessment will be included in the Mixing Zone Application. If a significant increase in the magnitude (concentration) or extent (location/size) of mercury or radium contamination is identified before submission of the Mixing Zone Application, the appropriate response action will be coordinated through the Core Team.

<u>Groundwater – Mercury and Uranium beneath the TNX Outfall Delta OU</u>

Uncertainties exist concerning the source and future extent and magnitude of the mercury and uranium contamination in groundwater beneath the TNXOD OU. To address these uncertainties, additional monitoring and data collection will be performed. Following the conclusion of TNX Area OU surface unit remedial actions and decontamination and decommissioning of TNX Area facilities in 2007 and a technical review of the additional data, a separate mixing zone may be proposed for mercury- and uranium-contaminated groundwater beneath the TNXOD OU.

<u>Groundwater - CVOCs</u>

SRS will provide a mixing zone demonstration for CVOC-contaminated groundwater after sufficient remediation has been achieved by the groundwater interim action. In the near term, effectiveness of the interim action (i.e., air stripper and SVE) will continue to be evaluated as part of the monitoring program as required by the TNX Effectiveness Monitoring Strategy of the *TNX Groundwater Operable Unit Remedial Design Report/Remedial Action Work Plan* (WSRC 1999b).

TNX Area OU (all subunits)

The proposed action for the TNX Area OU may change as a result of the remedial design or construction process. Changes to the remedy described in the ROD will be documented in the Administrative Record File with a memo, an Explanation of Significant Difference, or ROD Amendment.

Institutional controls will be implemented through the following:

- Providing access controls for on-site workers via the Site Use Program, Site Clearance Program, work control, worker training, worker briefing of health and safety requirements and identification signs located at the waste unit boundaries.

- Notifying the USEPA and SCDHEC in advance of any changes in land use or excavation of waste.

- Providing access controls against trespassers as described in the 1992 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.

In the long term, if the property is ever transferred to nonfederal ownership, the U.S. 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, in perpetuity, 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 under industrial land use for TNX Area OU leaves hazardous substances in place that pose a potential future risk and will require land use restrictions for an indefinite period of time. As negotiated with USEPA, and in accordance with USEPA - Region IV Policy (*Assuring Land Use Controls at Federal Facilities*, April 21, 1998), SRS has developed a Land Use Control Assurance Plan (LUCAP) to ensure that land use restrictions are maintained and periodically verified. The unit-specific Land Use Control Implementation Plan (LUCIP) referenced in this ROD will provide details and specific measures required for the land use controls (LUCs) selected as part of this remedy. USDOE is responsible for implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs selected under this ROD. The LUCIP, developed as part of this action, will be submitted concurrently with the CMI/RAIP, as required in the FFA for review and approval by USEPA and SCDHEC. Upon final approval, the LUCIP will be appended to the LUCAP and is considered incorporated by reference into the TNX Area OU 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 until modified as needed to be protective of human health and the environment. LUCIP modification will only occur through another CERCLA document.

Cost Estimate for the Selected Remedy

The total present worth cost of the remedy for the TNX Area OU is \$14,083,000. The present value is based primarily on a discount rate of 3.9% and a thirty-year time period. However, for shorter term operation and maintenance costs discount rates of 2.1% (for a two year time period) and 2.8% (for years three and four) were used (see Tables 12 through 15). A summary of the subunit costs is shown in Table 11. A detailed activity-based breakdown of the estimated costs associated with implementing and maintaining the remedy for each subunit is shown in Tables 12 through 15.

The information in the cost-estimate summary tables is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the 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.

Estimated Outcomes of Selected Remedy

The results of the BRA summarized in the RFI/RI/BRA Report (WSRC 1999a) and Groundwater BRA Addendum (WSRC 2002c) indicate that the existing conditions at the NTSB pose an excess lifetime cancer risk of 1.1 x 10^{-6} for the future industrial worker from exposure to radium-226 present in the Inlet Basin sediment. Existing conditions also pose a cancer risk for a hypothetical future resident in the Inlet Basin and a noncancer hazard in the ODA. Additionally, metals are present in the sediments of the Inlet and Main Basins at concentration levels that present an ecological risk to sediment-dwelling biota. Lead, mercury, and chromium concentration levels in the Inlet Basin also pose a risk to predatory animals such as the heron. The standing surface water which collects in the Inlet and Main Basins as a result of rainfall can be contaminated with metals at concentration levels that present a risk to aquatic biota.

At the TBG, the SVE tests reveal evidence of a continuing source of VOC contamination to the groundwater in the vadose zone beneath the TBG. The secondary source is in the vicinity of the 500 ppb groundwater isoconcentration contour and is considered PTSM.

At the OTSB, soil at the elevation of the original basin bottom (a 0.6 to 0.9 m [2 to 3 ft] thick interval) is contaminated with thorium-228 and radium-228 at an approximately 6 x 10^{-3} carcinogenic risk, exceeding the PTSM threshold criteria of a 1 x 10^{-3} risk to the industrial worker exposed to soil. Contamination within the OTSB IPSL is assumed to be PTSM. Additionally, deep soils at the OTSB/IPSL/DG (approximately 1.2 to 8.2 m [4 to 27 ft] bls) are contaminated with constituents at concentrations that could result in levels in the groundwater in excess of the MCL (WSRC 1999a, WSRC 2002e). Exposure to soils in the LDG may also result in up to 2 x 10^{-4} risk to the future industrial worker (WSRC 2002e, WSRC 2003).

Table 11. Cost Estimate for the Selected Remedy by Subunit

	NTSB: NB-2a	OTSB: OB-2bx	Groundwater: GW-4a	TBG/Vadose Zone: V-2
Present Worth Capital Cost	$507,000	$4,929,000	$101,000	$493,000
Present Worth O&M Cost	$131,000	$199,000	$7,032,000	$691,000
Total Present Worth Cost	$639,000	$5,128,000	$7,132,000	$1,184,000

Table 12. Cost Estimate for Alternative NB-2a

Table 12. Cost Estimate for Alternative NB-2a

	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
Soil Erosion & Sediment Control Plan	1	ea	$15,000	$15,000
Site Topographic Survey	2.3	acre	$3,777	$8,705
Erosion & Sediment Control Measures	1	ea	$15,000	$15,000
Dewatering and Construction				
In situ grout the IPSL	1	ea	$10,000	$10,000
Pump Water from Inlet and Main Basins	513000	gal	$0.03	$15,390
Backfill Basins	4900	cy	$15.46	$75,754
Soil Cover (minimum 1-ft thickness, graded, vegetated)	0.8	acre	$71,276	$56,310
Institutional Controls				
Land Use Implementation Plan	1	ea	$5,000	$5,000
Deed Restrictions	1	ea	$5,000	$5,000
Access Controls (Signs)	6	ea	$50	$300
Subtotal - Direct Capital Cost				$206,459
Mobilization/Demobilization		4% of subtotal DCC		$8,258
Site Preparation		6% of subtotal DCC		$12,388
Total Direct Capital Cost				**$227,105**
Indirect Capital Costs				
Engineering & Design				$110,000
Project/Construction Management		25% of DCC		$56,776
Health & Safety		5% of DCC		$11,355
Overhead & Profit		30% of DCC		$68,132
Contingency		15% of DCC		$34,066
Total Indirect Capital Cost				**$280,329**
Total Estimated Capital Cost				**$507,434**
Direct O&M Costs		3.9% discount rate		
Annual Costs		30 year O&M period		
Access Controls	1	ea	$500	$500
Cover Repair	1	acre	$2,400	$2,400
Subtotal - Annual Costs				$2,900
Present Worth Annual Costs				$50,761
Five Year Costs				
Remedy Review	1	ea	$13,308	$13,308
Subtotal - Five Year O&M Costs				$13,308
Present Worth Five Year Costs				$43,094
Total Present Worth Direct O&M Cost				**$93,855**
Indirect O&M Costs				
Project/Admin Management		5% of DOM		$4,693
Health & Safety		5% of DOM		$4,693
Overhead & Profit		30% of DOM		$28,157
Total Present Worth Indirect O&M Cost				**$37,542**
Total Estimated Present Worth O&M Cost				**$131,397**
TOTAL ESTIMATED COST				**$638,831**

Table 13. Cost Estimate for Alternative OB-2bx

Table 13. Cost Estimate for Alternative OB-2bx

	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
Soil Erosion & Sediment Control Plan	1	ea	$16,000	$16,000
Site Topographic Survey	1.2	acre	$4,957	$5,948
Erosion & Sediment Control Measures	1	ea	$15,000	$15,000
Excavate PTSM at Bottom of Former Basin				
Excavate and Stockpile Overlying Clean Soil	4703	cy	$20	$94,060
Temporary Soil Storage (Onsite)	5409	cy	$7	$36,240
Excavate PTSM (Basin & IPSL)	2740	cy	$30	$82,200
Backfill Excavation and Grade Site with Clean Soil	7139	cy	$15	$107,085
IPSL - Excavation, replacement of concrete and asphalt	390	cy	$200	$78,000
Storm Drain System Replacement	1	ea	$9,642	$9,642
Waste Soil Management				
Waste Characterization (Rads, PCBs, no RCRA-hazardous)	20	samples	$1,000	$20,000
Rad Waste Packaging (Lift Liners)	440	ea	$561	$246,770
Transportation to Envirocare (Clive, UT)	3653	cy	$150	$547,950
Disposal at Envirocare (Rad and PCB waste)	285	cy	$425	$121,125
Disposal at Envirocare (Rad waste with no PCBs)	3368	cy	$150	$505,200
Transportation to Solid Waste Landfill	190	cy	$5	$950
Disposal of Excavated Asphalt/Concrete in Solid Waste Landfill	190	cy	$25	$4,750
Engineered Cap Construction	1	ea	$300,894	$300,894
Institutional Controls				
Land Use Implementation Plan	1	ea	$5,000	$5,000
Deed Restrictions	1	ea	$5,000	$5,000
Access Controls (Signs)	21	ea	$50	$1,050
Subtotal - Direct Capital Cost				$2,202,864
Mobilization/Demobilization		5% of subtotal DCC		$110,143
Site Preparation		20% of subtotal DCC		$440,573
Total Direct Capital Cost				**$2,753,580**
Indirect Capital Costs				
Engineering & Design				$110,000
Project/Construction Management		25% of DCC		$688,395
Health & Safety		5% of DCC		$137,679
Overhead & Profit		30% of DCC		$826,074
Contingency		15% of DCC		$413,037
Total Indirect Capital Cost				**$2,175,185**
Total Estimated Capital Cost				**$4,928,766**
Direct O&M Costs		3.9% discount rate		
Annual Costs	30	) year O&M period		
Access Controls	1	ea	$500	$500
Engineered Cover Repair	1.21	acre	$4,280	$5,179
Subtotal - Annual Costs				$5,679
Present Worth Annual Costs				$99,401
Five Year Costs	1			
Remedy Review		ea	$13,308	$13,308
Subtotal - Five Year O&M Costs				$13,308
Present Worth Five Year Costs				$43,094
Total Present Worth Direct O&M Cost				**$142,495**
Indirect O&M Costs				
Project/Admin Management		5% of DOM		$7,125
Health & Safety		5% of DOM		$7,125
Overhead & Profit		30% of DOM		$42,749
Total Present Worth Indirect O&M Cost				**$56,998**
Total Estimated Present Worth O&M Cost				**$199,494**
TOTAL ESTIMATED COST				**$5,128,259**

Table 14. Cost Estimate for Alternative V-2

Table 14. Cost Estimate for Alternative V-2

	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
Air Emissions Permit	1	ea	$15,000	$15,000
Active SVE System Equipment & Construction				
Install SVE Wells	8	ea	$7,200	$57,600
Install Vapor Manifold System	1	ea	$33,785	$33,785
Overhead Electrical Distribution to SVE Wells	200	lin ft	$92	$18,392
Trailer-Mounted Blowers	1	ea	$19,178	$19,178
Passive SVE E Excavate PTSM (Basin & IPSL)				
Passive Pressure Check Valve System	11	ea	$500	$5,500
Offgass Treatment System				
Vapor Phase Carbon System (trailer mounted)	1	ea	$37,256	$37,256
Subtotal - Direct Capital Cost				$186,711
Mobilization/Demobilization		3% of subtotal DCC		$5,601
Site Preparation		5% of subtotal DCC		$9,336
Total Direct Capital Cost				**$201,648**
Indirect Capital Costs				
Engineering & Design				$140,000
Project/Construction Management		25% of DCC		$50,411.97
Health & Safety		5% of DCC		$10,082
Overhead & Profit		30% of DCC		$60,494
Contingency		15% of DCC		$30,247
Total Indirect Capital Cost				**$291,236**
Total Estimated Capital Cost				**$492,884**
Direct O&M Costs		2.1% discount rate		
Annual Costs (Active SVE Operations)		2 year O&M period		
Air Emissions Monitoring	1	ea	$16,400	$16,400
SVE System Operation	1	ea	$121,000	$121,000
Offgas Treatment (Media Changeout)	1	ea	$14,651	$14,651
SVE System Performance Reporting	1	ea	$25,000	$25,000
Subtotal - Annual Costs				$177,051
Present Worth Annual Costs				$343,252
		2.8% discount rate		
Annual Costs (Passive SVE Operations)		2 year O&M period		
Air Emissions Monitoring	1	ea	$16,400	$16,400
SVE System Operation	1	ea	$10,000	$10,000
SVE System Performance Reporting	1	ea	$25,000	$25,000
Subtotal - Annual Costs				$51,400
Present Worth Annual Costs				$138,109
Five Year Costs				
Remedy Review	1	ea	$13,308	$13,308
Subtotal - Five Year O&M Costs				$13,308
Present Worth Five Year Costs				$11,995
Total Present Worth Direct O&M Cost				**$493,356**
Indirect O&M Costs				
Project/Admin Management				
Health & Safety		5% of DOM		$24,668
Overhead & Profit		5% of DOM		$24,668
		30% of DOM		$148,007
Total Present Worth Indirect O&M Cost				**$197,342**
Total Estimated Present Worth O&M Cost				**$690,698**
TOTAL ESTIMATED COST				**$1,183,582**

Table 15. Cost Estimate for Alternative GW-4a

Table 15. Cost Estimate for Alternative GW-4a

	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
NPDES Discharge Permit Modification	1	ea	$10,000	$10,000
Install Monitoring System				
Install Monitoring Wells	0	ea	$7,200	$0
Institutional Controls				
Land Use Implementation Plan	1	ea	$5,000	$5,000
Deed Restrictions	1	ea	$5,000	$5,000
Subtotal - Direct Capital Cost				$20,000
Mobilization/Demobilization		5% of subtotal DCC		$1,000
Site Preparation		5% of subtotal DCC		$1,000
Total Direct Capital Cost				**$22,000**
Indirect Capital Costs				$60,000
Engineering & Design		40% of DCC		$8,800
Project/Construction Management		0% of DCC		$0
Health & Safety		30% of DCC		$6,600
Overhead & Profit		15% of DCC		$3,300
Contingency — **Total Indirect Capital Cost**				**$78,700**
Total Estimated Capital Cost				**$100,700**
Direct O&M Costs		2.1% discount rate		
Annual Costs (Existing System during post-ROD Design & Const.)		2 year O&M		
Access Controls	1	ea	$500	$500
NPDES Monitoring	1	ea	$6,000	$6,000
Extraction System & Air Stripper Operations	1	ea	$161,000	$161,000
Monitoring System Maintenance	16	well	$1,200	$19,200
Groundwater (VOCs and Hg) & Surface Waste (VOCs) Monitoring	4	event	$9,983	$39,932
Mixing Zone Performance Analysis Report	1	ea	$30,000	$30,000
Subtotal - Annual Costs				$256,632
Present Worth Annual Costs				$497,540
		3.9% discout rate		
Annual Costs (Plant Area Extraction w/Existing System & Treatment)		28 years O&M		
Access Controls	1	ea	$500	$500
NPDES Monitoring	1	ea	$6,000	$6,000
Extraction System & Air Stripper Operations	1	ea	$161,000	$161,000
Monitoring System Maintenance	16	well	$800	$12,800
Groundwater (VOCs and Hg) & Surface Waste (VOCs) Monitoring	2	event	$9,983	$19,966
Mixing Zone Performance Analysis Report	1	ea	$30,000	$30,000
Subtotal - Annual Costs				$230,266
Present Worth Annual Costs				$3,595,645
Five Year Costs				
Remedy Review	1	ea	$13,308	$13,308
Subtotal - Five Year O&M Costs				$13,308
Present Worth Five Year Costs				$43,094
Total Present Worth Direct O&M Cost				**$4,136,279**
Indirect O&M Costs				
Project/Admin Management		35% of DOM		$1,447,698
Health & Safety		5% of DOM		$206,814
Overhead & Profit		30% of DOM		$1,240,884
Total Present Worth Indirect O&M Cost				**$2,895,395**
Total Estimated Present Worth O&M Cost				**$7,031,674**
TOTAL ESTIMATED COST				**$7,132,374**

Groundwater at the TNX Area OU is contaminated with carbon tetrachloride, PCE, and TCE above MCLs with a potential to discharge to surface water above MCLs. Chloroform is a groundwater RCOC for the future resident but does not exceed the MCL. Gross alpha, total radium, uranium, and mercury were identified as RCOCs in the Groundwater BRA Addendum (WSRC 2002c). Uranium and mercury were identified as CM RCOCs in the TNXOD BRA (WSRC 2002e). These constituents have been detected in groundwater above their respective MCLs in localized areas of TNX. There are no discernable radionuclide or mercury plumes in groundwater. Although these constituents do not present a problem warranting action at this time, their presence in groundwater will continue to be monitored and reported annually in the Comprehensive TNX Area Annual Groundwater and Effectiveness Monitoring Strategy Report. Institutional and land use controls described in Section VI will be utilized to prevent the use of potentially contaminated groundwater.

When implemented, the selected remedy will result in the following major outcomes:

- PTSM will be removed at the OTSB/IPSL.

- PTSM will be treated at the TBG.

- The ecological risk and the risk to the industrial worker will be eliminated at the NTSB. Institutional controls will be implemented to eliminate the risk to the future resident at the NTSB and ODA.

- The engineered cap at the OTSB/IPSL/DG will mitigate leaching of mercury and uranium to groundwater and prevent future industrial worker exposure to contaminants presenting risk greater than 10^{-6}

- The existing active groundwater remediation system will continue until a groundwater assessment determines that passive remediation (mixing zone) is appropriate. Institutional controls will be established to prevent human exposure to contaminated TNX groundwater during implementation of this alternative.

- Remediation activities at TNX are expected to be completed approximately 18 months after construction start. The general area will then be available for industrial land use with restrictions (e.g., signs, fences, etc.) in place to preclude disturbance of any waste left in place.

XII. STATUTORY DETERMINATIONS

Based on the *RCRA Facility Investigation/Remedial Investigation/Baseline Risk Assessment for the TNX Area Operable Unit* (WSRC 1999a) and the *Addendum to the RCRA Facility Investigation/ Remedial Investigation Report/ Baseline Risk Assessment for the TNX Area Operable Unit, Groundwater Radiological Characterization* (WSRC 2002c), the unit poses a risk to human health and the environment under an industrial land use scenario. Therefore, Alternatives NB-2a, V-2, OB-2bx, and GW-4a have been selected as the remedies for the TNX Area OU subunits.

The future land use of the TNX Area OU 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 within five years after initiation of remedial action to ensure that the remedy is protective of human health and the environment.

The selected remedies are protective of human health and the environment, satisfy the requirement of CERCLA Section 121, comply with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, are cost-effective, and utilize permanent solutions and alternative treatment technologies to the maximum extent practicable. The remedy for TBG also satisfies the statutory preference for treatment as a principal element (i.e., reduce the toxicity, mobility, or volume of materials comprising principal threats through treatment). The Core Team has decided that removal and off-site disposal of the PTSM at the OTSB is preferable to treatment, since the OTSB is close to the SRS boundary. The remaining CM COC at the OTSB will be managed by an engineered cap.

The selected remedies include removal and off-site disposal of the PTSM at the OTSB and treatment for the PTSM at the TBG/Vadose Zone.

XIII. EXPLANATION OF SIGNIFICANT CHANGES

No significant changes were made to the ROD based on the comments received during the public comment period for the SB/PP. No comments were received during the public comment period. Cost estimates were revised from the proposed plan to reflect a 3.9% discount rate in the percent work calculations.

TNX LDG is associated with the OTSB and was originally part of the TNX Area OU (WSRC 1999a). However, USDOE, SCDHEC and USEPA Region IV agreed in March 1998 that this subunit, along with others in the TNX swamp, would be separated from the TNX Area OU and become the TNXOD OU. This separation allowed necessary characterization activities within the newly formed TNXOD OU to continue without impacting the remainder of the TNX Area OU. In previous documents, a distinction has been made between the LDG and the UDG.

Subsequent characterization has been performed to scope the remedial actions for the TNXOD OU in the CMS/FS for that OU (WSRC 2003). During preparation of the TNXOD OU CMS/FS (WSRC 2003), it became evident that the LDG (evaluated as a subunit of the TNXOD OU) should receive the same remedy as the UDG (evaluated as part of the OTSB of the TNX Area OU). The USDOE, SCDHEC and USEPA have agreed that to execute the remedial work for the OTSB and LDG (i.e., rerouting of the stormwater discharge, capping and infill of the DG), it will be necessary and more cost effective to combine remediation of the LDG with that of the OTSB/IPSL/UDG.

The remedy changes affect only the OTSB subunit of the TNX Area OU. The original alternative, as described in the SB/PP for the TNX Area OU, involved placing an engineered cap over the area of the OTSB and UDG. Prior to placing the cap, the PTSM (at the basin bottom and accessible IPSL) was to be excavated and disposed of offsite. The excavations would then be backfilled, and the engineered cap would be constructed over the area of the OTSB and UDG. Stormwater runoff would be rerouted, and a vegetated topsoil cover would be placed over the cap to control erosion.

The remedial action at the LDG would entail clearing/grubbing vegetation, backfill of the DG and extension of the engineered cap over the LDG. The area of the DG would also require recontouring and extension of the vegetated topsoil cover for erosion control.

The cost change required by the addition of the LDG to the remedy for the OTSB/IPSL/UDG would be $258,000 for capital cost and $32,000 for long-term operations and maintenance (all values are present worth). This represents an increase of approximately 6% more than the cost associated with the scope presented in the SB/PP (WSRC 2002f).

XIV. RESPONSIVENESS SUMMARY

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

XV. POST-ROD DOCUMENT SCHEDULE AND DESCRIPTION

A schedule for post-ROD cleanup activities is provided in Figure 12. Post-ROD documentation is as follows:

- Corrective Measures Implementation/Remedial Action Implementation Plan (CMI/RAIP) Rev. 0 for the TNX Area OU will be developed and submitted for USEPA/SCDHEC review 100 working days after submittal of the signed ROD (ROD approval and signature expected June 23, 2003). SRS submittal of Rev. 0 CMI/RAIP, November 12, 2003.

- USEPA/SCDHEC review of Rev. 0 CMI/RAIP – 90 calendar days (February 10, 2004)

- SRS revision of the CMI/RAIP will be completed 60 calendar days after receipt of all regulatory comments (April 10, 2004)

- USEPA/SCDHEC final review and approval of CMI/RAIP – May 10, 2004

- Remedial Action start date – September 3, 2004

- Post-Construction Report (PCR), Rev. 0 will be submitted to USEPA/SCDHEC 90 days after completion of the remedial action and a joint walkdown by the regulators.

- The Comprehensive TNX Area Annual Groundwater and Effectiveness Monitoring Strategy Report will be submitted to USEPA and SCDHEC within six months after the yearly fourth quarter sampling is completed. Annual submittals will continue until target groundwater levels are achieved or the Core Team concurs that no significant risk to receptors is present.

For more details, refer to Figure 12.

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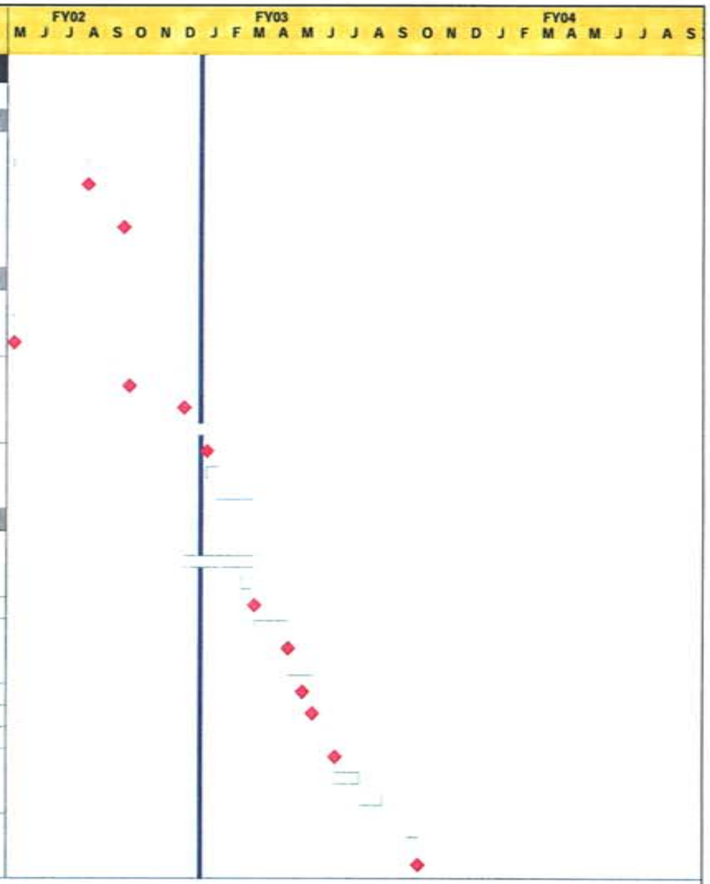
Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
CA 1109 TNX OPERABLE UNIT				
LCS 7 - RFI/RI/BRA				
RIBR/RI/BRA				
RFI/RI/BRA GROUNDWATER ADDENDUM				
AHP0109030	SRS incorp EPA/SCDHEC comments RFI/RI/BRA Rev.	90*	10MAY02A	09AUG02A
AHP0109035	SRS submittal of Rev. 1 RFI/RI/BRA Addendum	0		09AUG02A
AHP0109040	EPA/SCDHEC Review and Approval	30	12AUG02A	24SEP02A
AHP0109045	Receipt of EPA/SCDHEC Approval	0		25SEP02A
LCS 14 - REGULATORY REQUIREMENTS				
PROPOSED PLAN				
PROPOSED PLAN				
AHP01PD360	EPA/SCDHEC review Rev. 0 Proposed Plan	1		09MAY02A
AHP01PD365	EPA/SCDHEC returns Rev. 0 comments on PP	0		09MAY02A
AHP01PD370	SRS incorporates EPA/SCDHEC comments on SB/PP	122	23AUG02A	09DEC02A
AHP01PD372	Proposed Plan comment resolution meeting	0	02OCT02A	
AHP01PD375	SRS submittal of Rev. 1 SB/PP	0		09DEC02A
AHP01PD380	EPA/SCDHEC final review and approval /SB/PP	30	10DEC02A	08JAN03A
AHP01PD385	Receipt of EPA/SCDHEC Rev. 1 SB/PP approval	0		08JAN03A
AHP01PD390	Notification of Public Comment	22	09JAN03A	22JAN03
AHP01PD395	Public Comment Period	45	22JAN03	07MAR03
RECORD OF DECISION				
RECORD OF DECISION				
AHP01PD402	Develop Rev. 0 ROD	91	10DEC02A	10MAR03
AHP01PD410	Responsiveness Summary and Approval	14	24FEB03	09MAR03
AHP01PD415	SUBMIT Rev. 0 ROD	0		10MAR03
AHP01PD420	EPA / SCDHEC review of Rev. 0 ROD	45	11MAR03	24APR03
AHP01PD422	EPA/SCDHEC returns Rev. 0 comments for ROD	0		24APR03
AHP01PD425	SRS incorporates EPA/SCDHEC comments ROD	30	25APR03	24MAY03
AHP01PD426	ROD comment resolution meeting	0	12MAY03	
AHP01PD430	SRS submittal of Rev. 1 ROD	0		24MAY03
AHP01PD435	EPA/SCDHEC final review and approval of ROD	30	25MAY03	23JUN03
AHP01PD445	Receipt of ROD Approval	0		23JUN03
AHP01PD455	DOE obtain Signature on ROD	30	24JUN03	23JUL03
AHP01PD465	EPA obtain signature on ROD	30	24JUL03	22AUG03
AHP01PD475	SCDHEC obtain signature on ROD	30	23AUG03	21SEP03
AHP01PD485	Prepare Public Notice	14	22SEP03	05OCT03
AHP01PD495	Issue ROD	0		05OCT03



Start Date	01OCT92
Finish Date	30SEP27
Data Date	01JAN03
Run Date	22JAN03 09:29

Early Bar
Progress Bar

LEVL - AHPC
Sheet 1 of 2

Environmental Restoration
CA 1109 TNX AREA OPERABLE UNIT
Implementation Schedule

Date	Revision	Checked	Approved

Figure 12. TNX Area OU Implementation Schedule

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Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
LCS 15 - DETAILED ENG & PRECONST ACTIVITIES				
POST ROD DOCUMENTS				
CMI/RAIP				
AHP01FD830	Develop Rev. 0 RAIP- (Surf & GW Units)	100	24JUN03	12NOV03
AHP01PD850	SRS submittal of Rev. 0 RAIP	0		12NOV03
AHP01PD870	EPA/SCDHEC review of Rev. 0 RAIP	90	13NOV03	10FEB04
AHP01PD880	EPA/SCDHEC returns Rev. 0 comments for RAIP	0		10FEB04
AHP01PD890	SRS incorporate comments RAIP	60	11FEB04	10APR04
AHP01PD900	SRS submittal of Rev. 1 RAIP	0		10APR04
AHP01PD905	EPA/SCDHEC final review and approval RAIP	30	11APR04	10MAY04
AHP01PD910	Submit signed RAIP to EPA/SCDHEC	0		10MAY04
LCS 16 - CONSTRUCTION				
AHP0101103	REMEDIAL ACTION (RA) START	0	03SEP04	

FY02 FY03 FY04
M J J A S O N D J F M A M J J A S O N D J F M A M J J A S

Start Date	01OCT92	Early Bar	LEVL - AHPC
Finish Date	30SEP27	Progress Bar	Sheet 2 of 2
Data Date	01JAN03		Environmental Restoration
Run Date	22JAN03 09:29		CA 1109 TNX AREA OPERABLE UNIT
			Implementation Schedule

Date	Revision	Checked	Approved

Figure 12. TNX Area OU Implementation Schedule (Continued)

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XVII. APPENDICES

Appendix A Responsiveness Summary

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Appendix A

Responsiveness Summary

Responsiveness Summary

The 45-day public comment period for the Statement of Basis/Proposed Plan for TNX Area Operable Unit began on January 22, 2003 and ended on March 7, 2003. No comments were received from the public.