008017

United States Department of Energy

Savannah River Site

Record of Decision
Remedial Alternative Selection for the K-Area Burning/Rubble Pit (131-K) and Rubble Pile (631-20G) Operable Unit (U)

WSRC-RP-97-862

Rev. 1

July 2000

SAFETY · RESPONSIBILITY · SECURITY
SRS
SAVANNAH RIVER SITE

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

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

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

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RECORD OF DECISION
REMEDIAL ALTERNATIVE SELECTION (U)

K-Area Burning/Rubble Pit (131-K) and Rubble Pile (631-20G) Operable Unit (U)

WSRC-RP-97-862
Revision 1 July 2000

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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DECLARATION FOR THE RECORD OF DECISION

Site Name and Location

K-Area Burning/Rubble Pit (131-K) and Rubble Pile (631-20G) Operable Unit (U)
Savannah River Site
EPA ID#SC1890008989
Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) ID # EC-11
Aiken, South Carolina

The K-Area Burning/Rubble Pit (KBRP) (131-K) and Rubble Pile (KRP) (631-20G) 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 KBRP/KRP OU consists of two soil waste units and groundwater beneath the OU.

Statement of Basis and Purpose

This decision document presents the selected remedies for the KBRP/KRP OU, located at SRS in Barnwell County, South Carolina, which was chosen in accordance with CERCLA, as amended by Superfund Amendments and 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.

The State of South Carolina concurs with the selected remedies. In addition, the remedies have met State and Federal regulatory and community acceptance.

Assessment of the Site

The response actions selected in this Record of Decision (ROD) are 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 Remedies

Based on the identified risks, the KBRP, KRP, and groundwater pose risks to human health. Based on characterization and risk evaluations, remedial actions are appropriate for these waste units and groundwater.

A review of the final, human-health constituents of concern (COCs) present within the soils and groundwater to be remediated at the KBRP and KRP indicates that the wastes represent low-level threats. The contaminants within the soils and groundwater can be categorized as follows:

- Low concentrations of polycyclic aromatic hydrocarbons and arsenic in surface soils are considered to be a low-level threat because they represent relatively moderate risks to future, industrial workers, have a very low potential for migration, and are easily contained.

- The lack of any contaminant migration COCs or any significant contaminants within the pit debris indicates that the buried pit debris is not a principal threat source material. In addition, the plume location suggests that the original volatile organic compound source is depleted.

- The relatively low concentrations of tetrachloroethylene and trichloroethylene in the water table aquifer are above the maximum contaminant level (MCL). However, according to regulatory guidance for principal threat and low-level threat wastes (US EPA 1991), groundwater is not a source material.

The FFA identified OUs, including the KBRP/KRP OU, at SRS that require further action. The overall objective of the FFA is to protect human health and the environment at SRS. SRS's strategy to achieve this objective entails simultaneously implementing further actions at each of the OUs in accordance with the FFA requirements. These actions include (1) characterize the waste unit, delineating the nature and extent of contamination and identifying the media of concern (i.e., perform the RCRA Facility Investigation [RFI]/CERCLA Remedial Investigation [RI]); (2) perform a Baseline Risk Assessment to evaluate media of concern, COCs, and exposure pathways, and to characterize potential risks; and (3) evaluate and perform a final action to remediate, as needed, the identified media.

The KBRP/KRP OU is located in an area that has been recommended for industrial use by the SRS Citizens Advisory Board (CAB). The *Savannah River Site Future Use Report Stakeholder Recommendations for SRS Land and Facilities* (United States Department of Energy [US DOE] 1996) includes the recommendation that "residential uses of SRS land should be prohibited"; the *Federal Facility Agreement Implementation Plan* (WSRC 1996a) designated the KBRP/KRP OU as an industrial zone. The planned future use of the KBRP/KRP OU by the US DOE is continued industrial usage.

An evaluation of potential alternatives was performed in accordance with the NCP. Based on this evaluation, the selected alternatives for remediating the various waste units and media are:

K-Area Burning/Rubble Pit and Rubble Pile	<u>Soil Cover over the KBRP and KRP with Institutional Controls</u>
K-Area Water Table Aquifer	<u>Monitored Natural Attenuation</u>

The soil cover with institutional controls at the KBRP and KRP entails the following actions:

- All waste, contaminated soil, and mixed debris are left in place.
- Trees and brush are cleared.
- Large pieces of mixed debris (e.g., concrete, wood) are separated and disposed of at a sanitary landfill.
- Mounded piles and pit area are graded.
- Pit and pile are covered with soil obtained from a borrow pit at SRS; the soil cover will be sloped to provide appropriate drainage, and vegetated to prevent erosion. The cover will be maintained for its functional integrity.
- Institutional controls are implemented that consist of future deed/land-use restrictions and access controls, such as signs. A unit-specific Land-Use Control Implementation Plan (LUCIP), appended to the appropriate post-ROD document, will contain the details of institutional controls and maintenance.

The KBRP/KRP OU is located within an industrial use zone, as identified in Figure 3.3 of the SRS FFA Implementation Plan (WSRC 1996a), for both current and anticipated future land use. Although the remediation decisions for this unit were based on the industrial-use scenario, the groundwater remedy will achieve the more protective residential-use scenario. Groundwater at the unit is not used for drinking or any other purposes. It is anticipated that groundwater will not be used in the immediate future. The groundwater remedy, monitored natural attenuation, entails the following actions:

- Establish a groundwater mixing zone in accordance with South Carolina guidance (SCDHEC 1997).
- Conduct groundwater sampling and analysis throughout the process to confirm that attenuation is continuing at rates consistent with cleanup objectives. If monitored natural attenuation does not progress as expected, an active contingency measure will be considered. This contingency measure is discussed in the Conceptual Contingency Remedy Plan within the Groundwater Mixing Zone Application (WSRC 1998a)
- Implement institutional controls during the performance period to restrict groundwater use until remediation goals are achieved.
- Perform data validation if reassessment of risk becomes necessary.

Statutory Determinations

Based on the KBRP/KRP RFI/RI/BRA (WSRC 1998b), the KBRP/KRP OU does pose risk to human health. Therefore, a determination has been made that a soil cover over the KBRP and KRP and monitored natural attenuation within the water table aquifer protect human health for the KBRP/KRP OU waste units and associated environmental media.

The selected soil remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. Even though the soil remedy does not satisfy the statutory preference for treatment, it is the only practicable remedy because there is no discernible contaminant source, there is no principal threat source material, and the waste represents only a low level threat.

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

Because these remedies will result in hazardous substances remaining onsite above levels that allow for unlimited use and unrestricted exposure, a review will be conducted within five years after initiation of remedial actions to ensure that the remedies continue to provide adequate protection of human health and the environment.

Institutional controls will be an integral part of the selected remedies mentioned above. Institutional controls implemented at the site will consist of future land-use restrictions and access controls such as signs. Per the US EPA-Region IV Land-Use Controls (LUC) Policy, a LUC Assurance Plan (LUCAP) for SRS has been developed and submitted to the regulators for their approval. In addition, a LUCIP for the KBRP/KRP OU will be developed and submitted to the regulators for their approval with the post-ROD documentation. The LUCIP will detail how SRS will implement, maintain, and monitor the LUC elements of the KBRP/KRP OU preferred alternative to ensure that the remedies remain protective of human health and the environment.

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 deed notification shall, in perpetuity, notify any potential purchaser that the property has been used for the management and disposal of waste. These requirements also are 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 and groundwater use of the property. However, the need for these deed restrictions may be re-evaluated 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 deed restrictions will be done through an amended ROD with US EPA and South Carolina Department of Health and Environmental Control (SCDHEC) review and approval.

In addition, if the site is ever transferred to nonfederal ownership, a survey plat of the area will be prepared, certified by a professional land surveyor, and recorded with the appropriate county recording agency. If the KBRP/KRP is transferred to nonfederal ownership prior to remediation of the groundwater to the MCLs and the reduction of soil risks to acceptable levels for the COCs, reevaluation of the need for deed restrictions will be performed through an amended ROD, with US EPA and SCDHEC approval. The survey plat will be reviewed and updated, as necessary, at the time the site is transferred and will be recorded with the appropriate county recording agency.

Data Certification Checklist

This ROD provides the following information:

- COCs and their respective concentrations;
- Baseline risk represented by the COCs;
- Cleanup levels established for the COCs and the basis for the levels;
- Current and future land and groundwater use assumptions used in the BRA and ROD;
- Land and groundwater use that will be available at the site as a result of the Selected Remedy;
- Estimated capital, operation and maintenance (O&M), and total present worth cost; discount rate, and the number of years over which the remedy cost estimates are projected;
- Decision factor(s) that led to selecting the remedy (i.e., describe how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria); and
- How source materials constituting principal threats are addressed.

7/21/00
Date

Thomas F. Heenan
Assistant Manager for Environmental Programs
U. S. Department of Energy, Savannah River Operations Office

6/22/01
Date

James S. Kutzman for
Richard D. Green
Division Director
Waste Management Division
U. S. Environmental Protection Agency - Region IV

8/20/01
Date

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

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DECISION SUMMARY
REMEDIAL ALTERNATIVE SELECTION (U)

K-Area Burning/Rubble Pit (131-K) and
Rubble Pile (631-20G) Operable Unit (U)

WSRC-RP-97-862
Revision 1
July 2000

Savannah River Site
Aiken, South Carolina

Prepared by:

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Savannah River Operations Office
Aiken, South Carolina

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DECISION SUMMARY

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ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CAB	Citizens Advisory Board
CMCOC	contaminant migration constituent of concern
CMS	Corrective Measures Study
COC	constituent of concern
COPC	constituent of potential concern
CSM	conceptual site model
DQO	data quality objective
FFA	Federal Facility Agreement
FS	Feasibility Study
ft	feet
ha	hectare
HI	hazard index
IDW	investigation-derived waste
KBRP	K-Area Burning Rubble Pit
KRP	K-Area Rubble Pile
km	kilometers
LUC	land use control
LUCAP	land use control assurance plan
LUCIP	land use control implementation plan
MCL	maximum contaminant level
m	meters
m^3	cubic meter
mg/kg	milligrams per kilogram
mi	miles
mi^2	square miles
NCP	National Oil and Hazardous Substances Contingency Plan
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCE	tetrachloroethylene
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RGO	remedial goal option
RI	CERCLA Remedial Investigation
ROD	Record of Decision
RME	reasonable maximum exposure
SB/PP	Statement of Basis/Proposed Plan

ACRONYMS AND ABBREVIATIONS (continued)

SCDHEC	South Carolina Department of Health and Environmental Control
SCHWMR	South Carolina Hazardous Waste Management Regulation
sq km	square kilometers
SRS	Savannah River Site
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TBC	to be considered
TCE	trichloroethylene
US DOE	U.S. Department of Energy
US EPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
WSRC	Westinghouse Savannah River Company
yd^3	cubic yards

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

Savannah River Site, Location, and Brief Description

Savannah River Site, Aiken, SC
EPA ID#SC1890008989
CERCLIS ID # EC-11
United States Department of Energy (US DOE)

Savannah River Site (SRS) occupies approximately 803 km^2 (310 mi^2) of land adjacent to the Savannah River, principally in Aiken and Barnwell counties of South Carolina (see Figure 1). SRS is located approximately 40 km (25 mi) southeast of Augusta, Georgia, and 32 km (20 mi) south of Aiken, South Carolina.

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

Site Name, Location, and Brief Description

K-Area Burning/Rubble Pit (131-K) and Rubble Pile (631-20G) Operable Unit (U)
Savannah River Site
Aiken, South Carolina

The Federal Facility Agreement (FFA) for the SRS lists the K-Area Burning/Rubble Pit (KBRP) and Rubble Pile (KRP) Operable Unit (OU) as a Resource Conservation and Recovery Act (RCRA)/CERCLA unit that requires further evaluation using an investigation/assessment process that integrates and combines the RCRA Facility Investigation (RFI) process with the CERCLA Remedial Investigation (RI) to determine the actual or potential impact to human health and the environment (WSRC 1993). The KBRP/KRP OU location in relation to the major SRS facilities is shown in Figure 1.

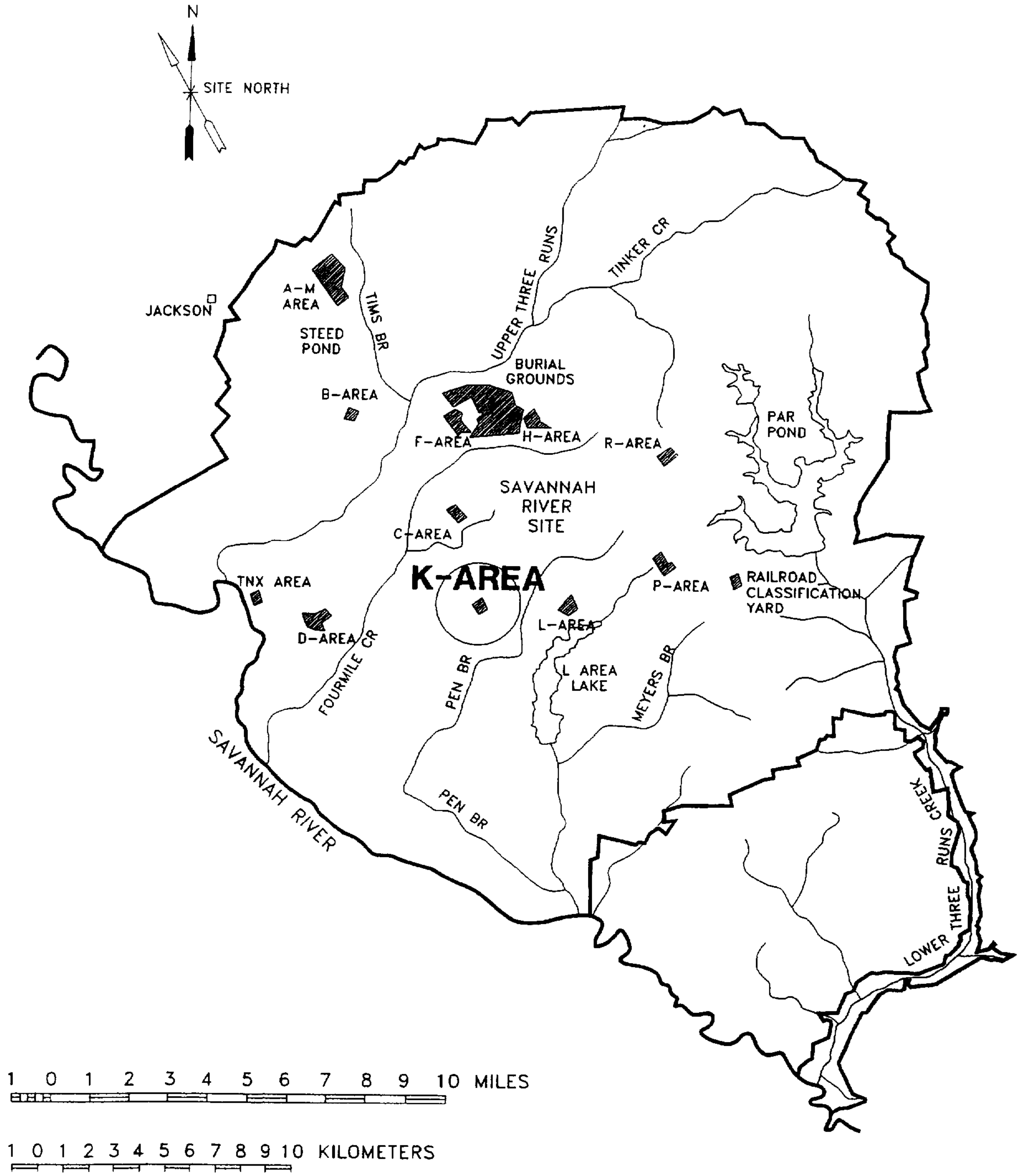

Figure 1. Location of the Savannah River Site and Major SRS Facilities

The KBRP/KRP OU is located approximately 9.5 km (5.9 mi) east of the nearest site boundary and 0.65 km (0.4 mi) east of the K-Reactor Area (see Figure 2). The KBRP/KRP OU is a permanently inactive RCRA/CERCLA unit. No removal or remedial actions have been conducted under CERCLA or other authorities at the site. A photograph of the KBRP/KRP OU is shown in Figure 3.

A complete description of the surface and subsurface features can be found in the *RCRA Facility Investigation/Remedial Investigation Report with the Baseline Risk Assessment for the K-Area Burning/Rubble Pit (131-K) and Rubble Pile (631-20G) (U)*, WSRC-RP-97-442, Rev 1.2, December 1998.

II. SITE AND OPERABLE UNIT COMPLIANCE HISTORY

SRS Operational and Compliance History

The primary mission of SRS has been to produce tritium, plutonium-239, 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 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 materials handled at SRS are managed under RCRA, a comprehensive law requiring responsible management of hazardous waste. Certain SRS activities require South Carolina Department of Health and Environmental Control (SCDHEC) operating or post-closure permits under RCRA. SRS received a hazardous waste permit from the SCDHEC, which was most recently renewed on September 5, 1995. Module IV of the Hazardous and Solid Waste Amendments portion of the RCRA permit mandates corrective action requirements for non-regulated solid waste management units subject to RCRA 3004(u).

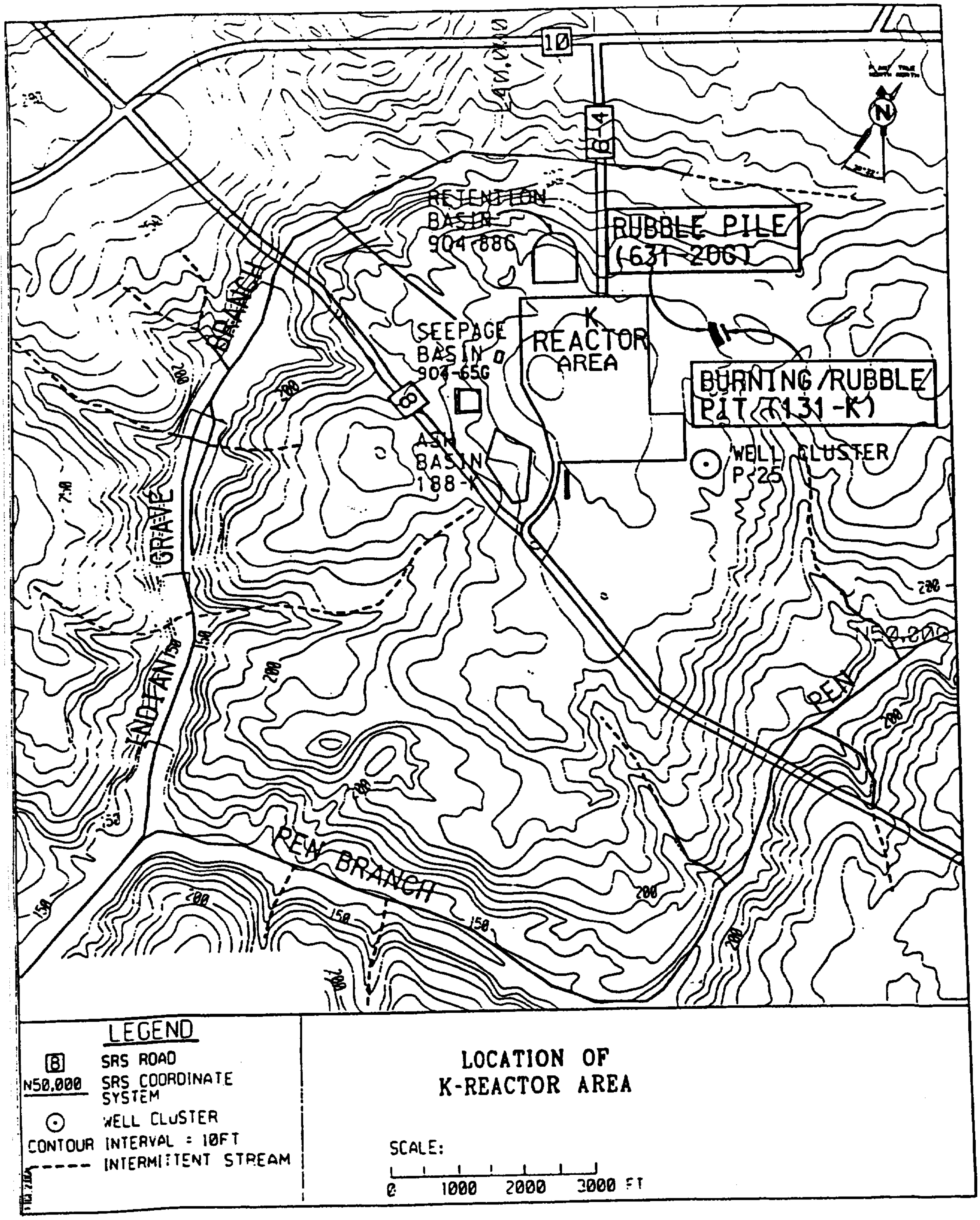

Figure 2. Topography and Location of Waste Units within K Area

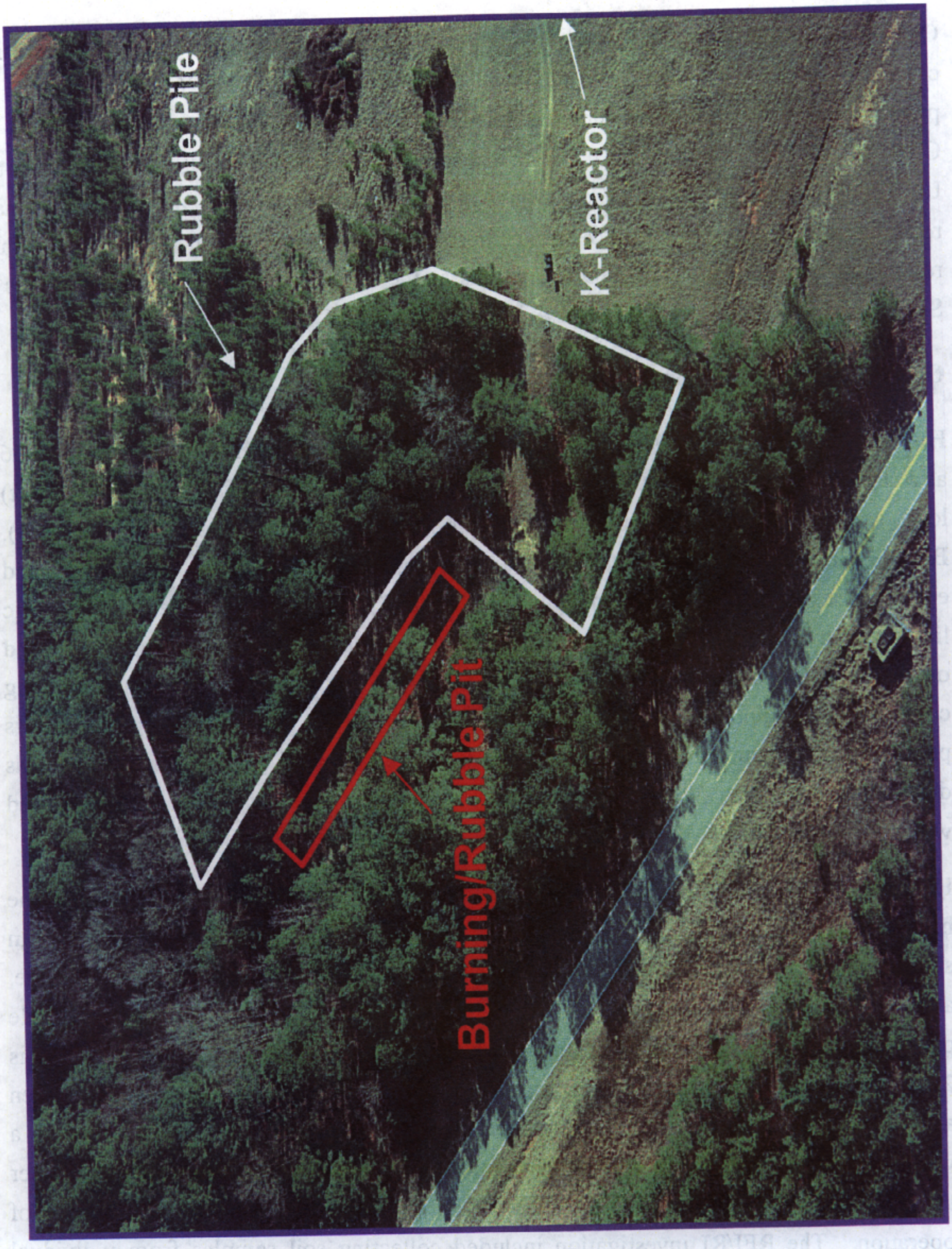

Figure 3. Photograph of KBRP/KRP OU

On December 21, 1989, SRS was included on the National Priorities List. 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 USC Section 9620, US DOE has negotiated an FFA (WSRC 1993) with the United States Environmental Protection Agency (US EPA) and SCDHEC to coordinate remedial activities at SRS into one comprehensive strategy which fulfills these dual regulatory requirements. US DOE functions as the lead agency for remedial activities at SRS, with concurrence by the US EPA-Region IV and SCDHEC.

Operable Unit Operational and Compliance History

Historical photographs of K Area indicate that the KBRP was constructed in 1955-1956 as a shallow, unlined excavation measuring approximately 9 m (30 ft) wide, 73 m (240 ft) long, and approximately 2.4 m (8 ft) deep, for waste burning and burial (see Figure 4). Based on these dimensions, total pit volume is approximately 1,640 m^3 (2,140 yd^3) and encompasses an area of approximately 0.07 ha (0.17 acres). During operation, organic liquids of unknown use and origin, waste oils, paper, plastics, and rubber were disposed of in the pit and burned periodically (WSRC 1998b). Disposal records, including composition, origin, and use of materials disposed, were not kept for this unit during its period of operation. The use of the KBRP for disposal of combustible wastes was discontinued in 1973. When the pit became full with disposed wastes, it was backfilled with soil to grade level.

Historical photographs of K Area indicate that the KRP was constructed sometime between 1956 and 1961. The KRP consists of a general disposal area, semicircular in shape, measuring approximately 91 m (300 ft) long and 15 to 41 m (50 to 135 ft) wide, and having an area of approximately 0.6 ha (1.5 acres) (see Figure 4). Individual rubble piles within the area are 1.2 to 1.8 m (4 to 6 ft) high. Total estimated waste volume is 2,140 m^3 (2,800 yd^3). The KRP is composed primarily of soil matter, with some broken asphalt, broken concrete pieces, and gravel-sized coal. The coal and asphalt exist in a wide range of particle sizes and are dispersed in a highly heterogeneous manner throughout the piles. Disposal records were not kept for this unit during its period of operation. The RFI/RI investigation included collecting soil samples from individual rubble piles as part of the pit and pile area evaluation (WSRC 1998b).

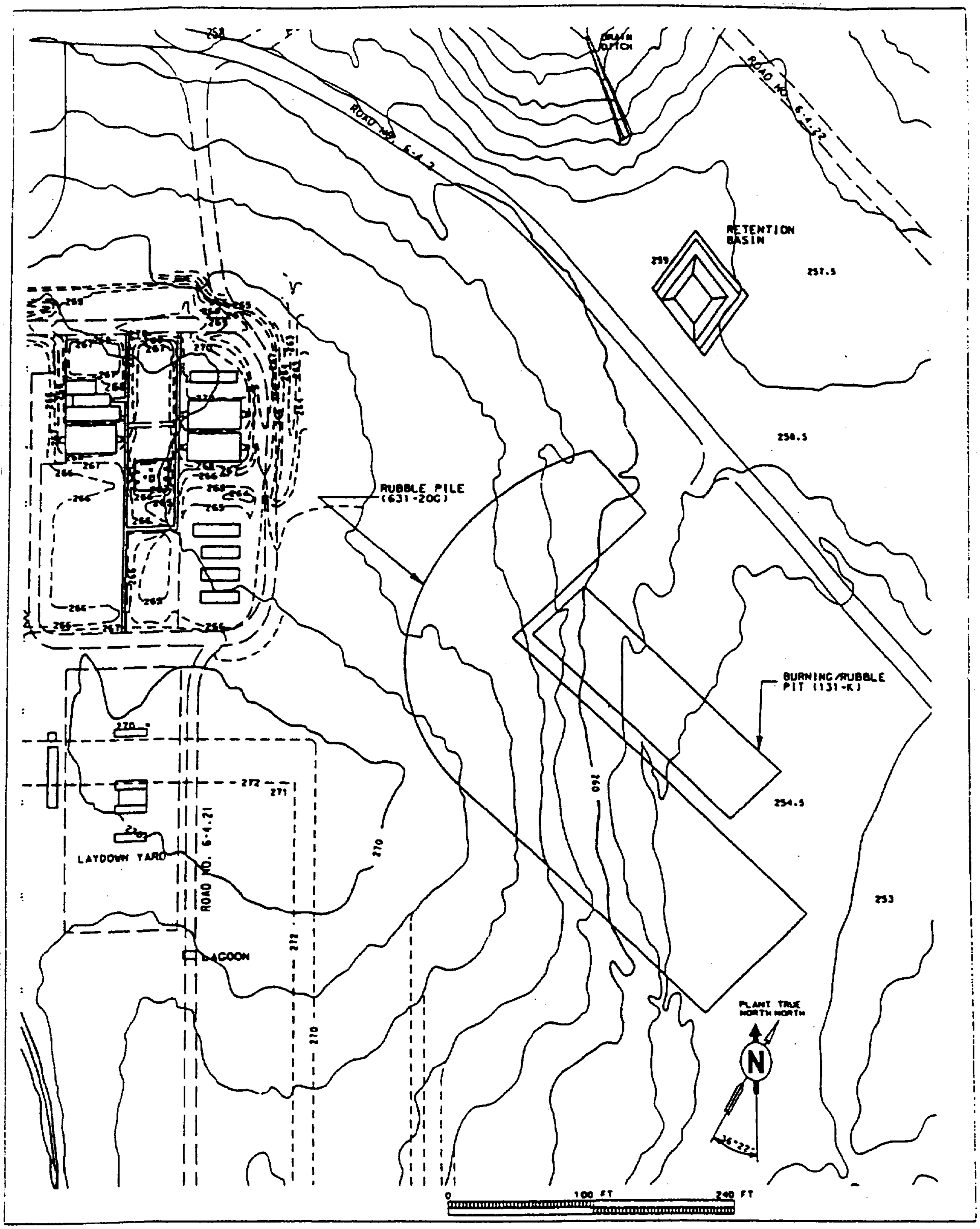

Figure 4. KBRP and KRP Unit Layout

The KBRP/KRP OU is located within the Pen Branch Watershed (see Figure 5). Surface drainage in the study area is to the east-southeast, discharging into an unnamed tributary and eventually entering Pen Branch approximately 1.6 km (1 mi) from the units. Surface water from Pen Branch ultimately discharges into the Savannah River, located approximately 11 km (7 mi) southwest of the study area.

As previously stated, the KBRP and KRP are listed in the FFA as a RCRA/CERCLA unit that requires further evaluation to determine the actual or potential impact to human health and the environment. The first site-specific investigation data for the KBRP and KRP are available from ground penetrating radar surveys conducted in 1990 and 1992 and from soil gas surveys conducted in 1985/1986, 1988, and 1991. In 1983, groundwater monitoring wells KRP-1 through KRP-4 were installed surrounding the KBRP.

An RFI/RI characterization and Baseline Risk Assessment (BRA) were conducted for the unit during 1996 and 1997. The results of the RFI/RI and BRA are presented in the RFI/RI/BRA (WSRC 1998b). The RFI/RI/BRA was submitted in accordance with the FFA and the approved implementation schedule and was approved by the US EPA and SCDHEC in December 1998. The Corrective Measures Study/Feasibility Study (CMS/FS) and Statement of Basis/Proposed Plan (SB/PP) were submitted in accordance with the FFA and the approved implementation schedule and were approved by US EPA and SCDHEC in October 1999 and January 2000, respectively (WSRC 1999 and 2000).

Prior to the submittal of the CMS/FS for the KBRP/KRP OU, the SRS Environmental Restoration Department presented a focused feasibility scoping of remedial actions for the KBRP/KRP to the Environmental Remediation and Waste Management Subcommittee of the SRS Citizens Advisory Board (CAB). This feasibility scoping was deemed necessary since the risk associated with KBRP/KRP OU requires that a remedial action be performed in a timely manner.

The purpose of this Record of Decision (ROD) is to present a decision document of the selected remedial alternatives for the KBRP/KRP OU. The selected alternatives were developed in accordance with CERCLA, as amended by the Superfund Amendments and Reauthorization Act and, to the extent practicable, the National Oil and Hazardous Substances Contingency Plan (NCP). This decision document is based on information maintained in the Administrative Record File for this specific RCRA/CERCLA unit.

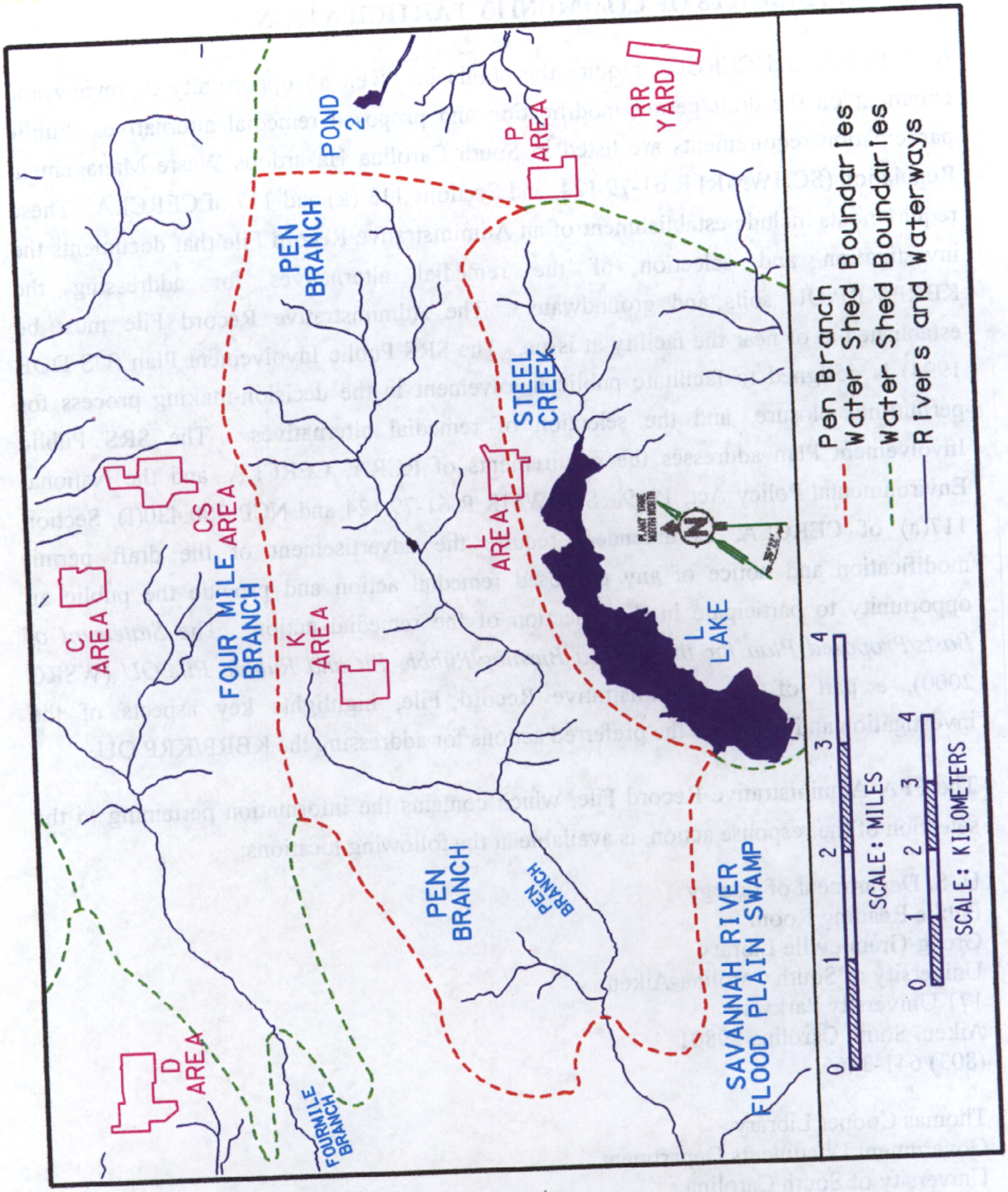

Figure 5. Pen Branch Watershed

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Both RCRA and CERCLA require the public be given an opportunity to review and comment on the draft permit modification and proposed remedial alternative. Public participation requirements are listed in South Carolina Hazardous Waste Management Regulation (SCHWMR) R.61-79.124, and Sections 113 (k) and 117 of CERCLA. These requirements include establishment of an Administrative Record File that documents the investigation and selection of the remedial alternatives for addressing the KBRP/KRP OU soils and groundwater. The Administrative Record File must be established at or near the facility at issue. The SRS Public Involvement Plan (US DOE 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. SCHWMR R.61-79.124 and NCP 300.430(f), Section 117(a) of CERCLA, as amended, require the advertisement of the draft permit modification and notice of any proposed remedial action and provide the public an opportunity to participate in the selection of the remedial action. The *Statement of Basis/Proposed Plan for the K-Area Burning/Rubble Pit and Rubble Pile OU* (WSRC 2000), a part of the Administrative Record File, highlights key aspects of the investigation and identifies the preferred actions for addressing the KBRP/KRP 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
218 Beaufort Street, Northeast
Aiken, South Carolina 29802
(803) 641-7670

The public was notified of the public comment period through mailings of the *SRS Environmental Bulletin*, a newsletter sent to citizens in South Carolina and Georgia, and through notices in the *Aiken Standard*, the *Allendale Citizen Leader*, the *Augusta Chronicle*, the *Barnwell People-Sentinel*, and *The State* newspapers. The public comment period was also announced on local radio stations. Copies of the draft RCRA permit modification/s were made available for review at SCDHEC during regular business hours.

The 45-day public comment period began on February 18, 2000, and ended on April 2, 2000. The Proposed Plan also was presented in an open public meeting to the SRS CAB Environmental Remediation Committee on March 7, 2000. A Responsiveness Summary was prepared to address any comments received during the public comment period. The Responsiveness Summary is provided in Appendix A of the ROD. It will also be available in the final RCRA Permit.

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

RCRA/CERCLA Programs at SRS

RCRA/CERCLA units, including the KBRP/KRP OU, at SRS are subject to a multi-stage remedial investigation process that integrates the requirements of RCRA and CERCLA as outlined in the FFA. The RCRA/CERCLA processes are summarized below:

- Investigate and characterize potentially impacted environmental media, such as soil, groundwater, and surface water, comprising the waste site and surrounding areas.
- Evaluate risk to human health and the local ecological community.
- Screen possible remedial actions to identify the selected technology which will protect human health and the environment.
- Implement the selected alternative.
- Document that the remediation has been performed competently.
- Evaluate the effectiveness of the technology.

The steps of this process are iterative in nature and include decision points which require concurrence between US DOE, as owner/manager; US EPA and SCDHEC, as regulatory oversight agencies; and the public (see Figure 6).

Operable Unit Remedial Strategy

The overall strategy for addressing SRS OUs, including the KBRP/KRP OU, is as follows: (1) characterize the waste unit, delineating the nature and extent of contamination and identifying the media of concern (i.e., perform the RFI/RI); (2) perform a BRA to evaluate media of concern, constituents of concern (COCs), and exposure pathways and to characterize potential risks; and (3) evaluate and perform a final action to remediate, as needed, the identified media.

Based on characterization and risk assessment information, the KBRP/KRP OU does not significantly impact the Pen Branch Watershed (see Figure 5). Upon disposition of all OUs within this watershed, a final, comprehensive evaluation will be conducted to determine whether any additional actions are necessary. The RFI/RI considered all unit-specific groundwater. Based on the groundwater investigation, the contamination in the water table aquifer apparently is attributable to the KBRP/KRP OU wastes.

The proposed action for the KBRP/KRP OU soil and groundwater is a final action. Several OUs within this watershed will be evaluated to determine future impact, if any, to associated streams and wetlands. It is the intent of SRS, US EPA, and SCDHEC to manage these sources of contamination to minimize impact on the watershed.

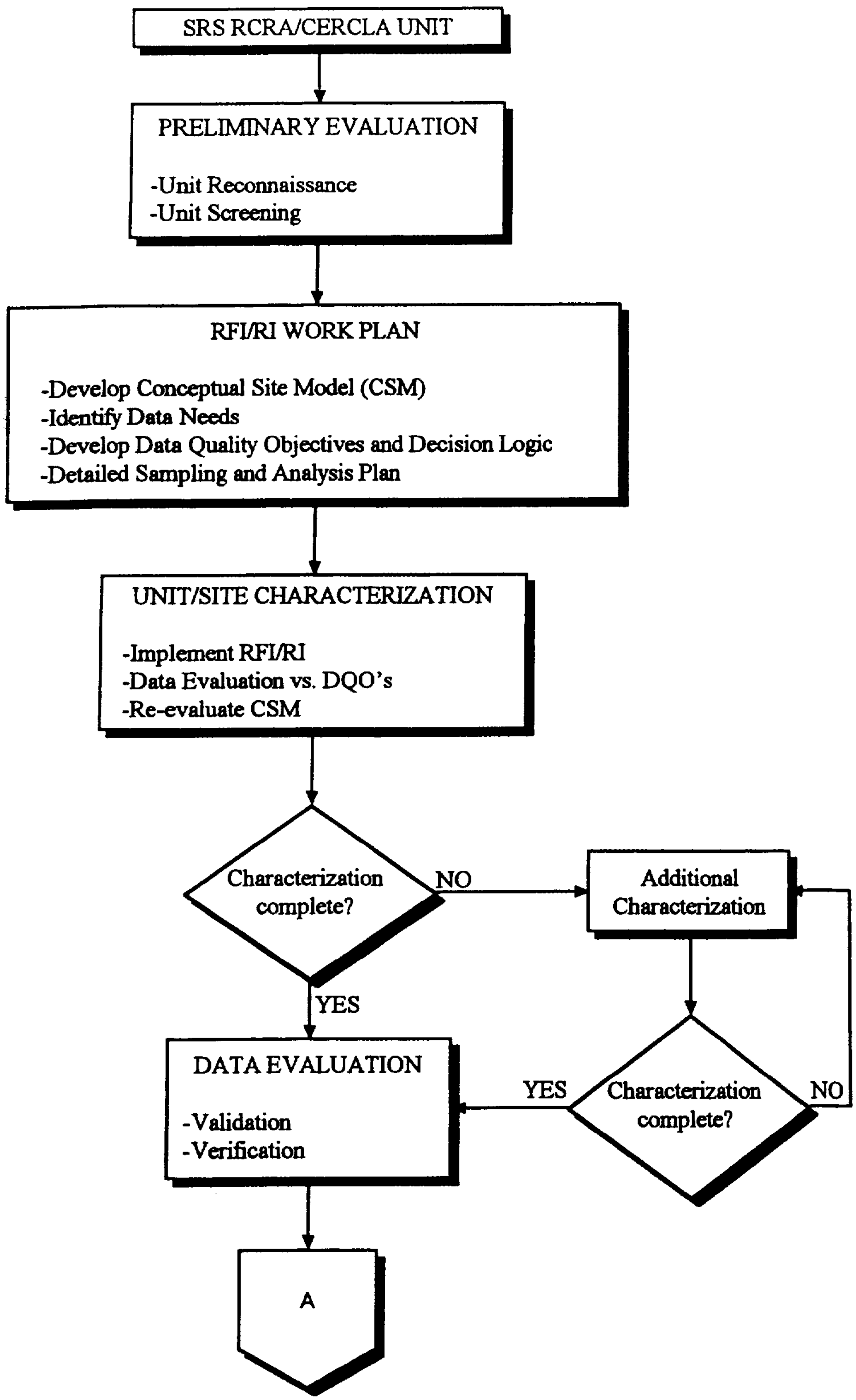

Figure 6. RCRA/CERCLA Logic and Documentation

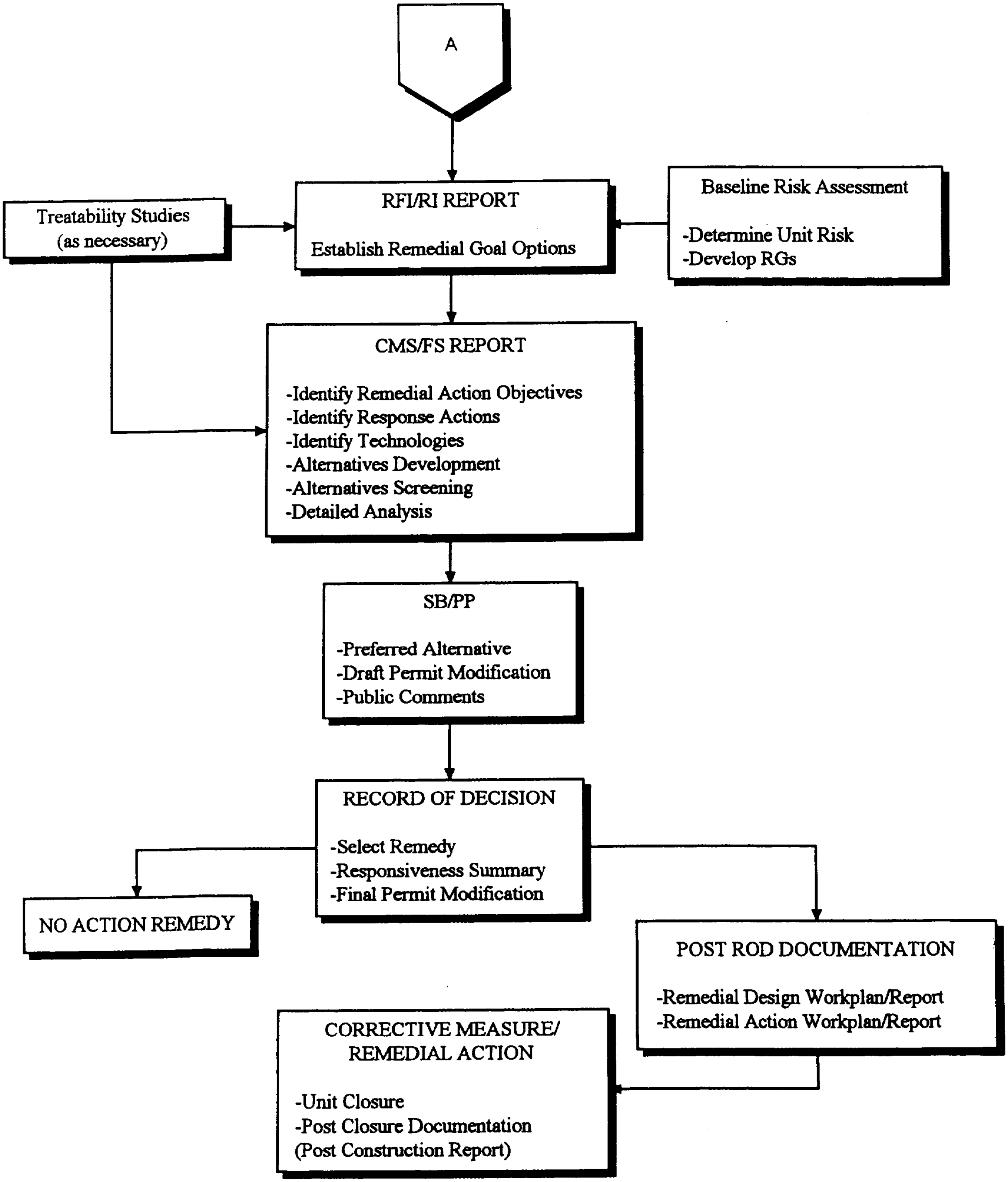

Figure 6. RCRA/CERCLA Logic and Documentation (continued)

Based on the data reviewed and collected during the unit preliminary screening and process knowledge, conceptual site models (CSMs) were developed to determine the source, primary contaminated media, migration pathways, exposure pathways, and potential human and ecological receptors. Section V provides the unit-specific CSMs for the KBRP/KRP OU and a summary of the characteristics of the primary and secondary sources and release mechanisms for the units, as determined in the RFI/RI.

Development of the CSM facilitates the initial step of determining the nature and extent of unit contamination through the identification of data gaps using the data quality objectives (DQO) process. DQOs are useful in identifying data needs associated with the sources and exposure media, and in developing a sampling and analytical plan that describes the procedures for collecting sufficient data of known and defensible quality. The unit disposal and monitoring history indicated that the KBRP/KRP OU waste units are a probable contamination source that could represent unacceptable risk to human health and the environment.

Multiple data needs were identified to reduce the uncertainty associated with the contamination of the KBRP/KRP OU. Data needs included the nature and extent of contamination in surface and subsurface soils and groundwater beneath and downgradient of the KBRP/KRP. A work plan that satisfies these data needs was developed to determine the associated risk to human and ecological receptors. The approved RFI/RI work plan for the KBRP/KRP OU (WSRC 1996b), and subsequent revisions, outlined the specific characterization activities that were necessary to meet the DQOs for the KBRP/KRP OU.

V. OPERABLE UNIT CHARACTERISTICS

Conceptual Site Model for KBRP/KRP OU

A CSM was developed to characterize the sources, potential exposure pathways, and exposure media relevant to the KBRP/KRP OU. The CSM is based on the data that are presented in the RCRA/CERCLA documentation and is shown in Figure 7.

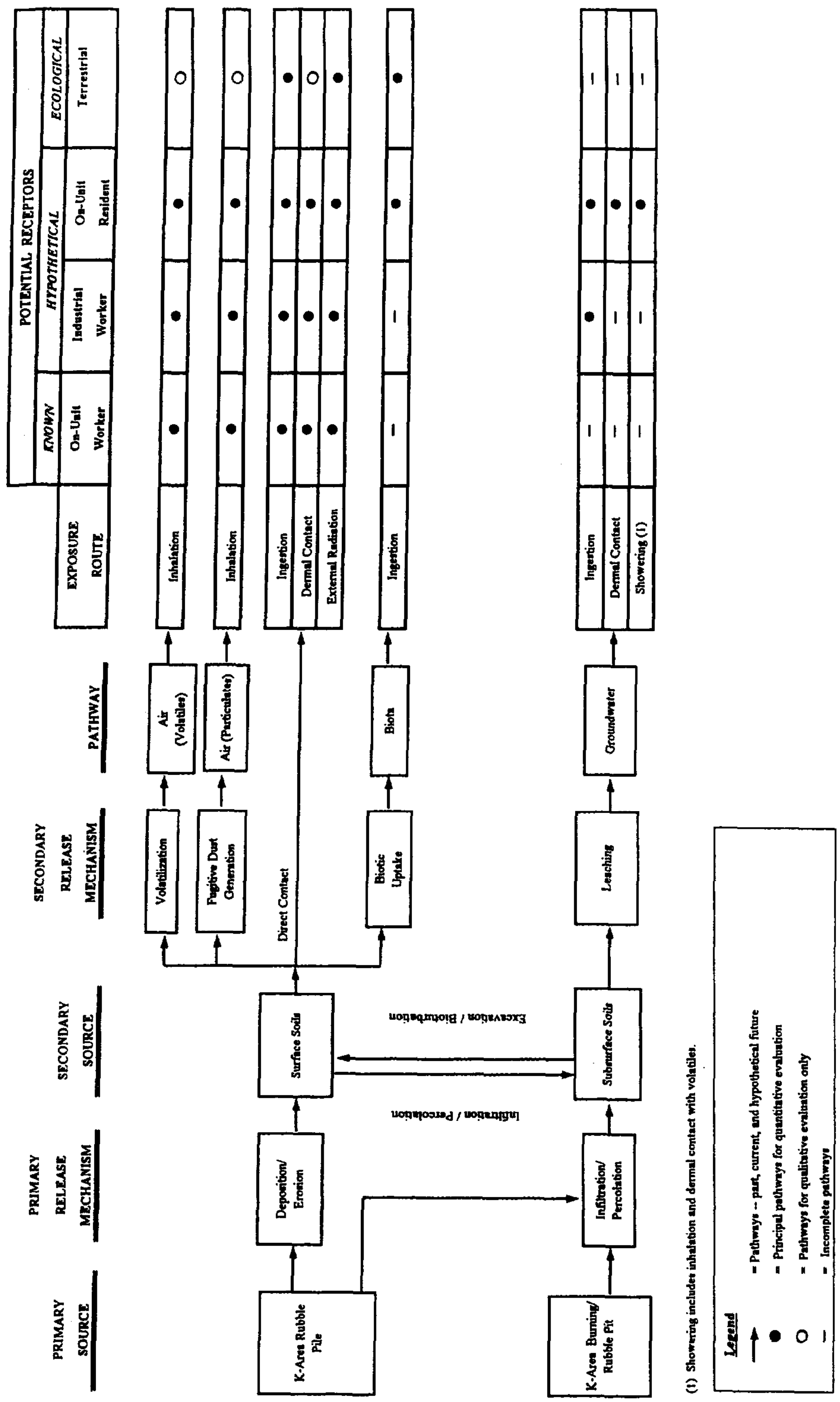

Figure 7. Conceptual Site Model of the K-Area Burning/Rubble Pit and Rubble Pile

The primary contaminant source at the KBRP was the waste placed into the pit for burning, the residue from waste burning, and the waste fill placed into the pit after waste burning was discontinued. Erosion/deposition and infiltration/percolation of rainwater and surface runoff are the two primary release mechanisms that potentially impact the surface and subsurface soil. Potentially impacted secondary media include the groundwater downgradient of the pit. Surface and subsurface soil samples collected at KBRP and KRP provide information for evaluating the quantity of constituents transported to the groundwater.

At the KRP, the primary contaminant source was mixed construction debris and soil that was disposed of in piles. The primary release mechanisms are deposition and erosion, resulting in release of contaminants to surface soil, which is the secondary source material at the site. Potential secondary release mechanisms are leaching, biotic uptake, fugitive dust generation, and volatilization.

Exposure pathways identified in the CSM for the KBRP and KRP include the following:

- Inhalation of vapor or dust associated with KBRP and/or KRP surface soil
- Ingestion of, dermal contact with, and/or external radiation by contaminants in KBRP and/or KRP surface soil
- Ingestion of contaminated biota associated with KBRP and/or KRP surface soil
- Ingestion of, dermal contact with, or showering with contaminated groundwater from the immediate vicinity of the KBRP and/or KRP, assuming use of groundwater as a drinking water source and showering includes inhalation and dermal contact with volatiles

Media Assessment

The RFI/RI/BRA (WSRC 1998b) and the CMS/FS (WSRC 1999) contain detailed, analytical data for all of the environmental media samples collected for the KBRP and KRP characterization. These documents are available in the Administrative Record File (see Section III).

During the RFI/RI, the following areas were investigated at the KBRP and KRP OU:

- Soil within the pit, from the surface to a maximum depth of 11.3 m (37 ft)
- Soil within the rubble piles and native soil beneath the piles to a maximum depth of 1.2 m (4 ft)
- Upper Three Runs Aquifer, "upper" aquifer zone

The soil and groundwater sampling activities conducted at the KBRP and KRP provided data on the nature and extent of constituents. Background locations also were sampled as part of the unit investigation. These data were used to evaluate the contaminant fate and transport as well as human-health and ecological risks associated with these exposure units.

The remedial investigation of the source materials and soil at the KBRP and KRP included six soil borings, 27 hand-auger borings, and two trenches to obtain surface and subsurface samples and observations (see Figure 8). Background soil samples also were collected at seven locations.

The wastes within the KBRP and KRP are low-level threat wastes under US EPA Principal Threat and Low-Level Threat Wastes Guidance (US EPA 1991). The source material within the wastes is considered nonmobile, with low toxicity. Risks related to low-level threat wastes normally can be safely mitigated through containment and institutional controls and do not necessarily require treatment. There are no principal threat source materials.

KBRP Soil

The KBRP was a shallow, unlined excavation measuring 9 m (30 ft) wide, 73 m (240 ft) long, and approximately 2.4 m (8 ft) deep (WSRC 1998b). Based on these dimensions, the total pit volume is approximately 1,640 m^3 (2,140 yd^3). The total volume of waste material (1,640 m^3 [2,140 yd^3]) and underlying contaminated soil 2,330 m^3 [3,050 yd^3]) at the KBRP is approximately 3,970 m^3 (5,190 yd^3).

At the KBRP, the primary organic contaminants detected in soil were semivolatile organic compounds (SVOCs), including 17 polycyclic aromatic hydrocarbons (PAHs). The pervasive nature of PAH contamination indicates that the KBRP is a source of PAHs.

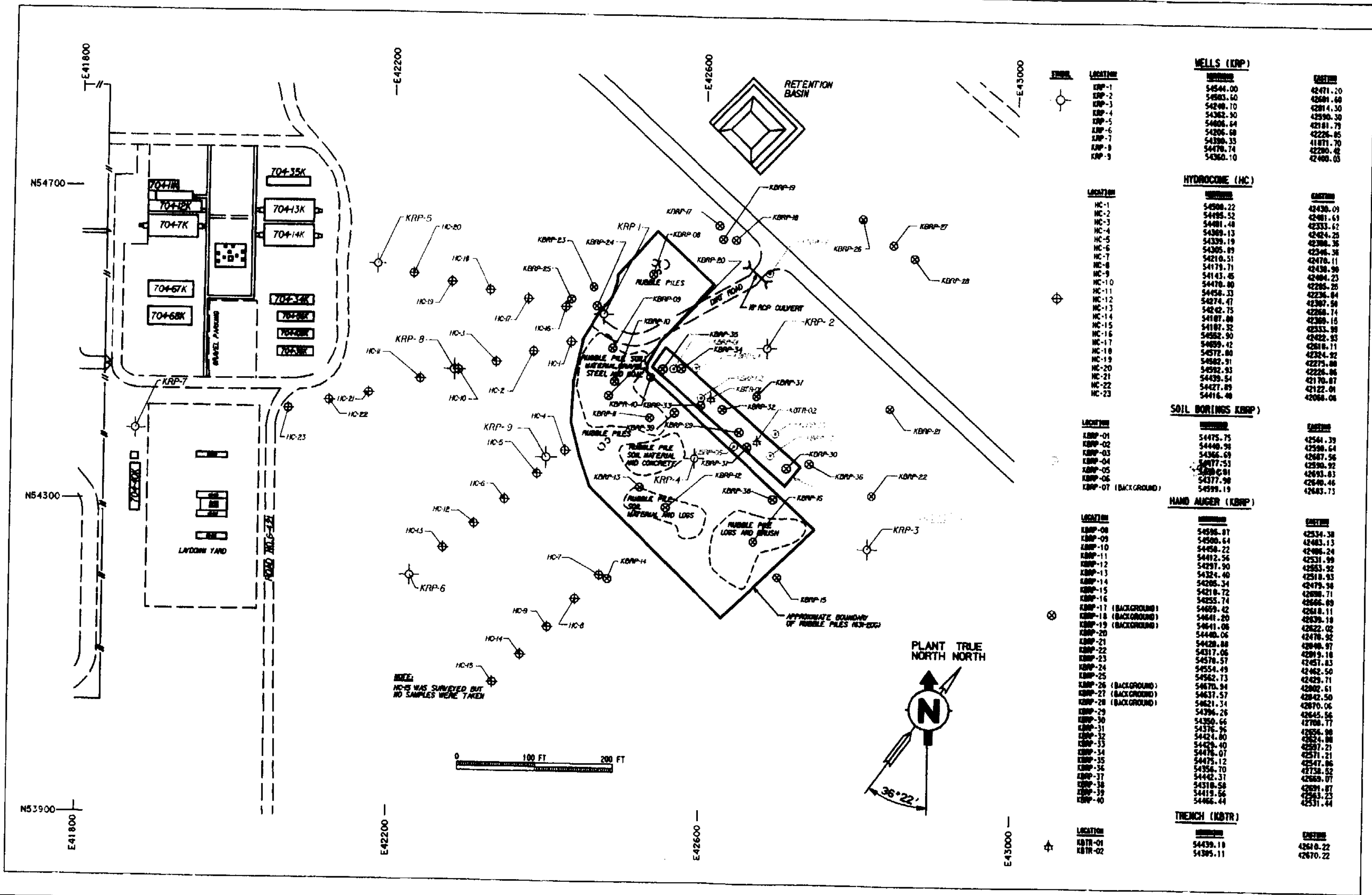

Figure 8. RFI/RI Sampling Locations for the K-Area Burning/Rubble Pit, Rubble Pile and Groundwater

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PAHs are a group of semivolatiles that are formed by incomplete burning of organic materials (e.g., coal, oil, gas, garbage, wood, and leaves). PAHs also are common in substances such as crude oil, coal, and coal tar pitch and in coal tar emulsions such as asphalt sealant, creosote, asphalt cements, road asphalt, roofing tar, and roofing shingles. PAHs are ubiquitous environmental pollutants since they are created from the burning of fossil fuels, are contained in common construction products, and also are created from atmospheric deposition from natural sources. In addition, PAHs that were rapidly buried and preserved are known to be present in the geologic record in lacustrine and coastal marine sediments that are millions of years old (WSRC 1998b).

PAHs usually do not occur as single compounds at waste sites but as groups of compounds. The presence of 17 PAHs in the KBRP soils is a very common situation in soils where incomplete burning of organics has occurred. Considering that the waste unit consisted of a burning pit, it is very likely that ashes from the burning process were blown from the pit onto nearby surface soils.

The presence of many of the 23 inorganics detected in the KBRP above twice the average background level can be explained in terms of varying lithology and weathering characteristics. The metals arsenic, cadmium, copper, lead, mercury, and zinc could be the result of unit-derived contamination. Barium, chromium, thallium, and silver most likely are limited to small areas within the KBRP. Barium, chromium, and thallium are naturally occurring in SRS soils.

Eleven radionuclides were detected above twice the average background at the KBRP. All detections, except cobalt-60, represented either uncommon or single occurrences or laboratory artifacts. Additional sampling was done to verify the presence of cobalt-60. Since it was not detected in the 27 additional samples, previous detects of cobalt-60 likely were isolated occurrences.

Other constituents were detected at low concentrations in KBRP soil. Groundwater data have indicated that tetrachloroethylene (PCE) and trichloroethylene (TCE) were released from the KBRP to groundwater. Recent groundwater and RFI/RI soil data indicate that the KBRP volatile organic compound (VOC) source no longer is a source of groundwater contamination.

KRP Soil

The KRP consists of a general disposal area semicircular in shape, measuring approximately 91 m (300 ft) long, 15 to 41 m (50 to 135 ft) wide, and having an area of approximately 0.6 ha (1.5 acres) (see Figure 8). Individual rubble piles within the area are 1.2 to 1.8 m (4 to 6 ft) high (WSRC 1998b). The total KRP waste volume is approximately 2,140 m^3 (2,800 yd^3). The total volume of mixed, piled waste, plus one additional foot below the pile at the KRP, is approximately 4,050 m^3 (5,300 yd^3). While only a portion of the piled waste (i.e., mixed soil and debris) is contaminated at levels exceeding remedial goals, the alternatives evaluated assume remediation of the complete volume/area of piled waste. Remediation of the complete volume/area of piled waste is appropriate since it results in an approach that is effective, or more conservative, more easily implemented, and less costly than attempting to better define the distribution of COCs.

Twenty-eight soil samples were used to characterize KRP surface and subsurface soils as a secondary source of contamination. The primary SVOCs detected in KRP soils were PAHs, likely the result of leaching and runoff from asphalt and coal materials within some of the piles.

The metals arsenic, copper, mercury, and zinc occur in the KRP at concentrations more than an order of magnitude above their respective background levels. This could be the result of unit-derived contamination. However, the isolated occurrences suggest that these metals, except arsenic, are limited to small areas within the KRP and are not widespread.

Six radionuclides (e.g., americium-241, barium-133, cerium-144, cesium-134, cesium-137, and potassium-40) were detected above twice the average background at the KRP. All detections represent either uncommon or single occurrences, or laboratory artifacts.

Groundwater

The water table aquifer is at a depth of approximately 13.7 m (45 ft) below land surface, with flow to the west-southwest toward Indian Grave Branch. The RFI/RI study addressing groundwater included groundwater sampling at seven monitoring wells and 23 hydrocone sampling locations.

Groundwater samples were collected from seven monitoring wells during the second and third quarters of 1996. Results from two upgradient monitoring wells were used to establish groundwater, unit-specific, background conditions.

A PCE- and TCE-contaminant plume was traced to the KBRP using cone penetrometer technology and hydrocone groundwater sampling just below the water table. PCE was the primary contaminant detected. Those analytical results defined the edge of the downgradient contaminant plume.

Contaminant Transport Analysis

No final contaminant migration (CM) COCs were identified for the KBRP or KRP from soil leachability models. The results of the contaminant fate and transport analysis did not indicate any constituents with the potential to leach to groundwater in concentrations above the maximum acceptable limits.

PCE and TCE currently are present in the groundwater at concentrations above the maximum contaminant level (MCL), which is the Applicable, or Relevant and Appropriate Requirement (ARAR) for groundwater. Groundwater monitoring has shown the KBRP to be depleted as a source of PCE and TCE. During the past 10 years of data collected in the KBRP area, groundwater contaminant concentrations have been reduced significantly, and there has been relatively little downgradient movement of the plume. Monitoring results show PCE and TCE values in groundwater at the KBRP are decreasing, indicating the source is no longer migrating to groundwater.

A numerical groundwater flow model calibration and solute transport model was performed to examine the fate and transport of dissolved PCE and TCE at the KBRP/KRP OU (WSRC 1998c). The three-dimensional, finite element groundwater modeling code, Flow and Contaminant Transport, described in detail in Hamm et al, 1997, was used in this study. Due to observed decreasing concentrations of PCE and TCE, additional releases are unlikely. The model assumed no additional releases and focused on currently observed concentrations. Initial model concentrations were assumed to be uniform throughout the Upper Zone of Upper Three Runs Aquifer, likely overestimating the TCE and PCE mass in groundwater. The model does not account for first order decay processes that are applicable to PCE and TCE. Based on site-specific hydrostratigraphy, more layers of discretization were used to simulate flow in the aquifer system. The model results indicate that monitored natural attenuation is a viable groundwater remedy for impacted groundwater at the KBRP/KRP OU.

VI. CURRENT AND POTENTIAL, FUTURE SITE AND RESOURCE USES

Land Uses

The only current exposure was considered to be an industrial worker who could be occasionally in the area. Groundwater exposures were not evaluated since the KBRP and KRP are undeveloped, and there are no drinking water wells currently located in the surrounding area. Therefore, the risk assessment for current land use focused only on soil at the pit and rubble pile areas.

For future land use, two receptors were evaluated, the hypothetical industrial worker and the hypothetical resident. The resident scenario is the most sensitive land use. The KBRP and KRP are located in an area that has been recommended for future industrial (nuclear) use by the SRS CAB and US DOE (US DOE 1996). Groundwater was included as part of the risk assessment for the future, land-use scenario.

Groundwater/Surface Water Uses

There currently are no drinking water wells in the area, and it is anticipated that groundwater will not be used in the future. Institutional controls will prevent the installation of drinking water wells and ensure that there is no future usage of groundwater until remedial action objectives (RAOs) are achieved. There is no surface water within the boundaries of the KBRP/KRP OU. However, as shown in Figure 2, the headwaters of Pen Branch lie approximately 1,220 m (4,000 ft) south of the unit. Pen Branch currently is not used as a source of drinking water or for industrial applications. It is not likely that Pen Branch ever will be used for these applications.

VII. SUMMARY OF OPERABLE UNIT RISKS

As part of the investigation/assessment process for the KBRP/KRP OU, a BRA was performed using data generated during the assessment phase. Detailed information regarding the development of constituents of potential concern (COPCs), the fate and transport of contaminants, and the risk assessment can be found in the RFI/RI/BRA Report (WSRC 1998b). The human-health and ecological risks for current and future land-use scenarios for each of the two exposure units were evaluated. The results of the BRA identify the COCs and characterize the associated risks to both human health and the environment.

An exposure assessment was performed to provide an indication of the potential exposures that could occur based on the chemical concentrations detected during sampling activities. The only current exposure scenario identified for the KBRP/KRP OU was for the known, on-unit worker. The hypothetical receptors under the future land use include the on-unit,industrial worker and on-unit resident. A CSM that includes the calculated risk/hazard indices associated with the potential receptors is shown in Figure 9. The preferred alternative represents an effective response action that will eliminate exposure to COCs by breaching the pathways. Final human-health COCs are listed in Table 1. The risk/hazard results are based on the larger risk estimates of the KBRP and KRP. The risks are briefly summarized in the following paragraphs.

Contaminant Migration COCs

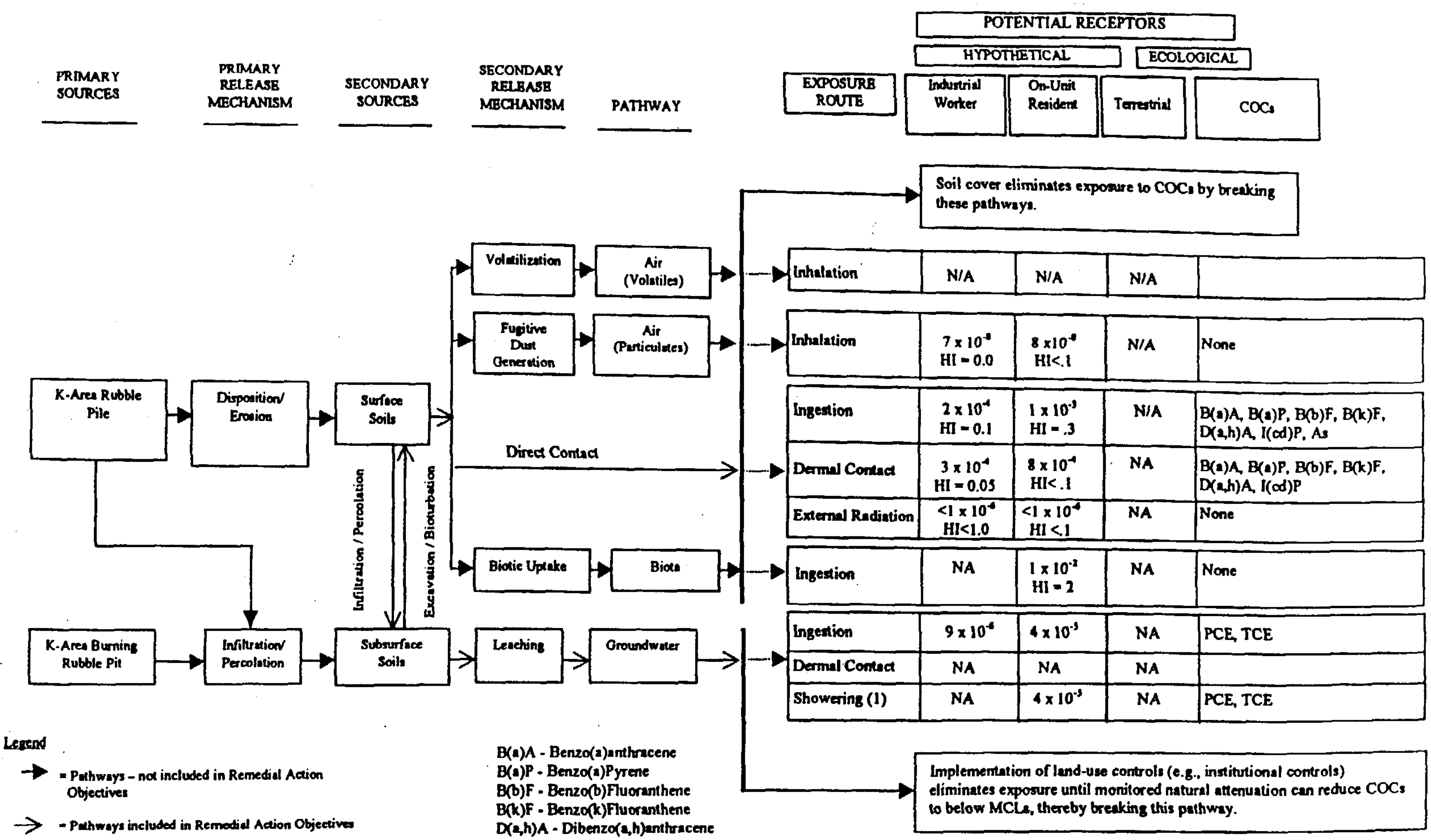
There are no final CMCOCs for the KBRP/KRP OU.

Human-Health Risk Assessment

Primary COCs in the human-health risk assessment are defined as constituents that significantly contribute to risk estimates exceeding a 1×10^{-4} excess cancer risk or a hazard index (HI) of 3.0 for a media total from all relevant pathways (US EPA 1995). These are the constituents upon which remediation may be focused. Constituents are not considered significant risk contributors if their individual excess cancer risk estimate is less than 1×10^{-6} and their noncarcinogenic hazard quotient is less than 0.1. COPCs exceeding these levels but not designated as COCs since total media risk does not exceed 1×10^{-4} or total HI falls between 1 and 3 are termed secondary COCs.

Risk Uncertainty

Human-health risk for the KBRP/KRP OU is driven by PAHs in the soil. The primary pathways for human-health exposure are through ingestion and dermal contact. Thorough characterization of the soil contamination ensures that minimal uncertainty exists for the soil. As a result, no additional contingencies will be required to manage any uncertainty.



Legend

- ➞ = Pathways – not included in Remedial Action Objectives
- → = Pathways included in Remedial Action Objectives
- --➞ = No longer a concern after completion of remedial action

(1) Showering includes inhalation and dermal contact with volatiles.

B(a)A - Benzo(a)anthracene
B(a)P - Benzo(a)Pyrene
B(b)F - Benzo(b)Fluoranthene
B(k)F - Benzo(k)Fluoranthene
D(a,h)A - Dibenzo(a,h)anthracene
I(cd)P - Indeno(P,2,3-cd)Pyrene
As - Arsenic

Footnote

The above risk/hazard results are based on the larger risk estimates of the KBRP and KRP.

Figure 9. Conceptual Site Model Showing Risk/Hazard Indices Values

Table 1. Final Human Health COCs for KBRP and KRP Soil and Groundwater

KBRP		KRP	
Human Health*	**Ecological**	**Human Health**	**Ecological**
Soils	Soils	Soils	Soils
Benzo(a)anthracene⁺ Benzo(a)pyrene⁺ Benzo(b)fluoranthene⁺ Benzo(k)fluoranthene⁺ Chrysene⁺ Dibenzo(a,h)anthracene⁺ Fluoranthene⁺ Indeno(1,2,3-c,d)pyrene⁺ Pyrene⁺	None	Benzo(a)anthracene⁺ Benzo(a)pyrene⁺ Benzo(b)fluoranthene⁺ Chrysene⁺ Dibenzo(a,h)anthracene⁺ Indeno(1,2,3-c,d)pyrene⁺ Arsenic	None
Groundwater	Groundwater	Groundwater	Groundwater
PCE TCE	Not applicable	PCE TCE	Not applicable

*Human health COCs are based on the future residential and industrial land-use scenarios

⁺Member of the PAH group of compounds.

Note: There are no CMCOCs.

Groundwater remediation is driven by the presence of VOC contamination in the aquifer and the need to meet South Carolina drinking water regulations. Some uncertainty exists associated with the migration behavior of groundwater contamination. Groundwater remedial action contingencies will be in place to manage uncertainty with groundwater contamination. Further discussion will be included with the Selected Remedial Alternative.

Current Land Use

Under current conditions, carcinogenic risks from radionuclides are insignificant at the KBRP and KRP. Carcinogenic risks to the known, on-unit worker from nonradionuclides are insignificant at the KRP and are 3×10^{-6} at the KBRP from exposure to surface soil.

Noncarcinogenic constituents at the KBRP and KRP pose no hazards for the known, on-unit worker, under the assumed conditions.

The final COC for known, on-unit workers is benzo(a)pyrene in KBRP surface soil.

Future Land Use

Under future, KBRP land-use conditions, the carcinogenic risk to hypothetical, industrial workers and residents from radionuclides is 3×10^{-5} and 1×10^{-4}, respectively. Carcinogenic risk to hypothetical, industrial workers and hypothetical residents from nonradionuclides is 6×10^{-4} and 1×10^{-2}, respectively. The HI for exposure to noncarcinogens is 3 for hypothetical industrial workers and 30 for hypothetical residents. Most of the carcinogenic risk is from PAHs in KBRP soil. There were no CMCOCs.

Under future, KRP land-use conditions, the carcinogenic risk to hypothetical industrial workers and residents from radionuclides is 1×10^{-5} and 4×10^{-5}, respectively. Carcinogenic risk to hypothetical industrial workers and hypothetical residents from nonradionuclides is 3×10^{-4} and 4×10^{-3}, respectively. The HI for exposure to noncarcinogens is 4 for hypothetical industrial workers and 30 for hypothetical residents. Most of the carcinogenic risk is from PAHs and arsenic in soil at the KRP. There were no CMCOCs.

The final human-health COCs for hypothetical, future land use are PAHs and arsenic in soil, and PCE and TCE in groundwater (see Table 1).

Ecological Risk Assessment

The baseline ecological risk assessment defined the likelihood of harmful effects, or the risk to ecological receptors, from exposure to contaminants at the KBRP/KRP OU. Receptors include both terrestrial plants and animals and their habitats. No final ecological COCs were identified at the KBRP/KRP OU (see Table 1). Therefore, KBRP/KRP OU soil and groundwater presents no risk to the environment. The ecological setting of the unit is neither unique nor significant. There are no endangered, threatened, or special concern species in the vicinity likely to be dependent on or affected by the habitat at the unit.

Summary

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present a current or potential threat to public health, welfare, or the environment.

Remedial Goal Options

Remedial goal options (RGOs) are risk-based, chemical, concentration ranges that are used as target cleanup criteria for consideration in the CMS/FS process during development and selection of remedial action alternatives. RGOs address the specific COCs, media of concern, and potential exposure pathways associated with the unit. RGOs use the same exposure and toxicity parameters used during the BRA. General sources for chemical-specific RGOs include concentrations based on ARARs and concentrations based on risk values from the risk assessment. The RGOs for the KBRP/KRP OU were developed in the RFI/RI/BRA and are listed in Table 2.

VIII. REMEDIAL ACTION OBJECTIVES AND REMEDIAL GOALS

Remedial Action Objectives

RAOs specify the potential receptors and exposure pathways, the COCs and associated remediation goal concentrations, and the objectives of remediation for each contaminated environmental media. RAOs are based on the nature and extent of contamination, threatened resources, and the potential for human and environmental exposure. Preliminary remediation goals are developed based upon RGOs identified in Table 2.

Table 2. Remedial Goal Options

K-Area Burning/Rubble Pit Surface and Subsurface Soils

Medium or Receptor	Constituent of Concern (1)	RME EP Conc. (2) (mg/kg)	Concentration at Target Cancer Risk (mg/kg)			Concentration at Target Hazard Quotient (mg/kg)		
			1E-04	1E-05	1E-06	3	1	0.1
Hypothetical Resident	Benzo(a)anthracene	126	143	14.3	1.43	--	--	--
	Benzo(a)pyrene	127	14.3	1.43	0.143	--	--	--
	Benzo(b)fluoranthene	171	143	14.3	1.43	--	--	--
	Benzo(k)fluoranthene	84.1	1,430	143	14.3	--	--	--
	Chrysene	126	14,300	1,430	143	--	--	--
	Dibenzo(a,h)anthracene	18.6	14.3	1.43	0.143	--	--	--
	Fluoranthene	411	--	--	--	9,410	3,140	314
	Indeno(1,2,3-c,d)pyrene	73.7	143	14.3	1.43	--	--	--
	Pyrene	332	--	--	--	7,060	2,350	235

Medium or Receptor	Constituent of Concern (1)	RME EP Conc. (2) (mg/kg)	Concentration at Target Cancer Risk (mg/kg)			Concentration at Target Hazard Quotient (mg/kg)		
			1E-04	1E-05	1E-06	3	1	0.1
Hypothetical Industrial Worker	Benzo(a)anthracene	126	624	62.4	6.24	--	--	--
	Benzo(a)pyrene	127	62.4	6.24	0.624	--	--	--
	Benzo(b)fluoranthene	171	624	62.4	6.24	--	--	--
	Benzo(k)fluoranthene	84.1	6,240	624	62.4	--	--	--
	Dibenzo(a,h)anthracene	18.6	62.4	6.24	0.624	--	--	--
	Indeno(1,2,3-c,d)pyrene	73.7	624	62.4	6.24	--	--	--

Medium or Receptor	Constituent of Concern (1)	RME EP Conc (2) (mg/kg)	Concentration at Target Cancer Risk (mg/kg)			Concentration at Target Hazard Quotient (mg/kg)		
			1E-04	1E-05	1E-06	3	1	0.1
Known On-Unit Worker (Surface soil only)	Benzo(a)pyrene	127	62.4	6.24	0.624	--	--	--

Table 2. Remedial Goal Options (continued)

K-Area Rubble Pile Surface and Subsurface Soils

Medium or Receptor	Constituent of Concern (1)	RME EP Conc (2) (mg/kg)	Concentration at Target Cancer Risk (mg/kg)			Concentration at Target Hazard Quotient (mg/kg)		
			1E-04	1E-05	1E-06	3	1	0.1
Hypothetical Resident	Benzo(a)anthracene	63.8	143	14.3	1.43	--	--	--
	Benzo(a)pyrene	49.9	14.3	1.43	0.143	--	--	--
	Benzo(b)fluoranthene	80.6	143	14.3	1.43	--	--	--
	Chrysene	51.3	14,300	1,430	143	--	--	--
	Dibenzo(a,h)anthracene	0.056	14.3	1.43	0.143	--	--	--
	Indeno(1,2,3-c,d)pyrene	30.1	143	14.3	1.43	--	--	--
	Arsenic	120	79	7.9	0.79	70.4	23.5	2.35

Medium or Receptor	Constituent of Concern (1)	RME EP Conc (2) (mg/kg)	Concentration at Target Cancer Risk (mg/kg)			Concentration at Target Hazard Quotient (mg/kg)		
			1E-04	1E-05	1E-06	3	1	0.1
Hypothetical Industrial Worker	Benzo(a)anthracene	63.8	624	62.4	6.24	--	--	--
	Benzo(a)pyrene	49.9	62.4	6.24	0.624	--	--	--
	Benzo(b)fluoranthene	80.6	624	62.4	6.24	--	--	--
	Indeno(1,2,3-c,d)pyrene	30.1	624	62.4	6.24	--	--	--
	Arsenic	120	374	37.4	3.74	1703.0	567.7	56.8

K-Area Burning/Rubble Pit and Rubble Pile Area Groundwater

Medium or Receptor	Constituent of Concern (1)	RME EP Conc (2) (ug/L)	Concentration at Target Cancer Risk (ug/L)			Concentration at Target Hazard Quotient (ug/L)			MCL (ug/L)
			1E-04	1E-05	1E-06	3	1	0.1	
Hypothetical Resident	Tetrachloroethylene	9.86	76.7	7.67	0.767	--	--	--	5
	Trichloroethylene	3.32	363	36.3	3.63	--	--	--	5

Medium or Receptor	Constituent of Concern (1)	RME EP Conc (2) (ug/L)	Concentration at Target Cancer Risk (ug/L)			Concentration at Target Hazard Quotient (ug/L)			MCL (ug/L)
			1E-04	1E-05	1E-06	3	1	0.1	
Hypothetical Industrial Worker	Tetrachloroethylene	9.86	550	55.0	5.50	--	--	--	5
	Trichloroethylene	3.32	2,960	296	29.6	--	--	--	5

1. RGOs are calculated for the final COCs.
2. Reasonable maximal exposure (RME) concentration currently estimated for this medium.

Each alternative presented in the CMS/FS was evaluated with respect to achieving the selected RAOs and remediation goals.

At the KBRP/KRP OU, remediation goals were established at the ARAR concentrations for groundwater COCs (i.e., MCLs), and at the 10^{-6} risk level for hypothetical, future, industrial workers for all soil COCs, except arsenic. The risk-based RGO for a 10^{-6} cancer risk to industrial workers is 3.74 mg/kg for arsenic in soil. Since this risk-based RGO for arsenic in soil is within the range of naturally occurring arsenic concentrations in SRS soil, it is not a practical remediation goal. The remediation goal for arsenic was set at the unit-specific, background screening level of 7.96 mg/kg, which is two times mean background concentration.

ARARs are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal, State, or local environmental law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Action-, chemical-, and location-specific ARARs are considered when identifying compliance requirements. Action-specific requirements set controls on the design, performance, and other aspects of implementation of specific remedial activities. Chemical-specific requirements are media-specific and health-based concentration limits developed for site-specific levels of constituents in specific media. Location-specific ARARs must consider Federal, State, and local requirements that reflect the physiographic and environmental characteristics of the unit or the immediate area. There were no action- or location-specific ARARs relevant to establishing RAOs for the KBRP/KRP OU. However, chemical-specific ARARs do exist (e.g., MCLs for groundwater) and were used in place of risk-based RGO concentrations, when appropriate.

The RFI/RI and BRA indicate that the soil and groundwater at the KBRP/KRP OU pose risk to human health. The RAOs are as follows:

K-Area Burning/Rubble Pit Soil

- Protect future, industrial workers from unacceptable exposures to PAHs in soil at the KBRP.

K-Area Rubble Pile Soil

- Protect future, industrial workers from unacceptable exposures to PAHs and arsenic in soil at the KRP.

Water Table Aquifer Groundwater

- Protect future, industrial workers from unacceptable exposures to PCE and TCE in groundwater.
- Prevent further degradation of groundwater and return it to below MCLs to allow beneficial uses.

The wastes within the KBRP and KRP are low-level threat wastes under US EPA Principal Threat and Low-Level Threat Wastes Guidance (US EPA 1991). Risks related to low-level threat wastes normally can be safely mitigated through containment and institutional controls and do not necessarily require treatment.

Remedial Goals

The RGOs for KBRP/KRP OU COCs provide the basis for selection of remedial goals. Remedial goals are selected to be protective of both human-health and ecological receptors, as well as comply with Federal and State ARARs.

The KBRP/KRP OU is located in an area that has been recommended for future, industrial (i.e., nuclear) use by the SRS CAB and US DOE (US DOE 1996). The *Federal Facility Agreement Implementation Plan* (WSRC 1996a) designated the KBRP as an industrial zone. The planned future use of the KBRP/KRP OU by US DOE is continued industrial usage. Therefore, the remediation goals identified for the KBRP/KRP OU are based on protection of future, industrial workers, and achieving ARARs, or MCLs, for groundwater. The remediation goals for the KBRP/KRP OU are presented in Table 3.

Table 3. Constituents of Concern to be Remediated, Risk to Future Industrial Workers, and Remediation Goals for K-Area Burning/Rubble Pit and Rubble Pile

Media	Unit	COCs	Basis/Receptor	Baseline Risk	Remediation Goals (for 10^{-6} or HQ=0.1)
Soil	Pit Area (KBRP)	Benzo(a)anthracene	Future Industrial Worker	3.70×10^{-5}*	6.24 mg/kg[a]
		Benzo(a)pyrene		3.70×10^{-4}*	0.624 mg/kg[a]
		Benzo(b)fluoranthene		5.00×10^{-5}*	6.24 mg/kg[a]
		Benzo(k)fluoranthene		2.50×10^{-6}*	62.4 mg/kg[a]
		Dibenzo(a,h)anthracene		5.40×10^{-5}*	0.624 mg/kg[a]
		Indeno(1,2,3-c,d)pyrene		2.14×10^{-5}*	6.24 mg/kg[a]
	Rubble Pile Area (KRP)	Benzo(a)anthracene	Future Industrial Worker	1.81×10^{-5}*	6.24 mg/kg[a]
		Benzo(a)pyrene		1.45×10^{-4}*	0.624 mg/kg[a]
		Benzo(b)fluoranthene		2.30×10^{-5}*	6.24 mg/kg[a]
		Indeno(1,2,3-c,d)pyrene		8.70×10^{-6}*	6.24 mg/kg[a]
		Arsenic		3.35×10^{-5}*	7.96 mg/kg[c]
Groundwater	KBRP and KRP OU	Tetrachloroethylene	Future Industrial Worker and Exceedance of MCL	1.6×10^{-6}**	5.0 ug/L[b]
		Trichloroethylene		1.10×10^{-7}**	5.0 ug/L[b]

*Combines ingestion, inhalation, and dermal contact based on potential exposure to soil in the 0 to 1 foot interval.
**Risk based on potential exposure (ingestion) of groundwater.
a The remediation goal is based on the 1×10^{-6} target cancer risk to the hypothetical, future, industrial worker.
b The remediation goal is based on the MCL.
c The remediation goal is based on two times the mean concentration of arsenic in background soil at the KBRP and KRP.
mg/kg = milligrams per kilogram
ug/L = micrograms per liter
mg/L = milligrams per liter

The lateral and vertical extent of PAHs exceeding remedial goals in waste and soil at the KBRP are shown in Figures 10 through 12. The lateral and vertical extent of PAHs and arsenic exceeding remedial goals in waste of the KRP are shown in Figures 13 and 14. The lateral extent of PCE and TCE exceeding MCL levels in groundwater and groundwater flow direction are shown in Figures 15 and 16. Each of these figures present the nature and extent of contamination and associated risks for the industrial worker, consistent with the future land use for the OU.

IX. DESCRIPTION OF ALTERNATIVES

This section provides a brief description of the remedial alternatives developed for the site. The alternatives described in the following paragraphs are those that were retained in the CMS/FS for detailed analysis. (Note: Alternatives BRP-2, RP-2 were eliminated in the CMS/FS and not retained in further documents.) A more detailed cost analysis is presented in Appendix A of the CMS/FS.

K-Area Burning/Rubble Pit

Alternative BRP-1: No Action at KBRP

Estimated Cost - $52,000
Construction Time to Complete – 0 months

- For the No Action alternative for KBRP soil, no remedial efforts are made to control risk; treat or remove waste; or reduce the toxicity, mobility, or volume of contaminated media. Institutional controls and actions such as land-use restrictions do not continue.

- The No Action alternative requires no construction and could be implemented immediately. No ARARs are associated with the No Action alternative.

There are no capital, construction, or system operation and maintenance (O&M) costs for the No Action alternative. However, a review of the remedy at five-year intervals, for a period of 30 years, is required by the NCP for remedial actions that result in hazardous substances, pollutants, or contaminants remaining at a waste unit above levels that allow for unlimited use and unrestricted exposure.

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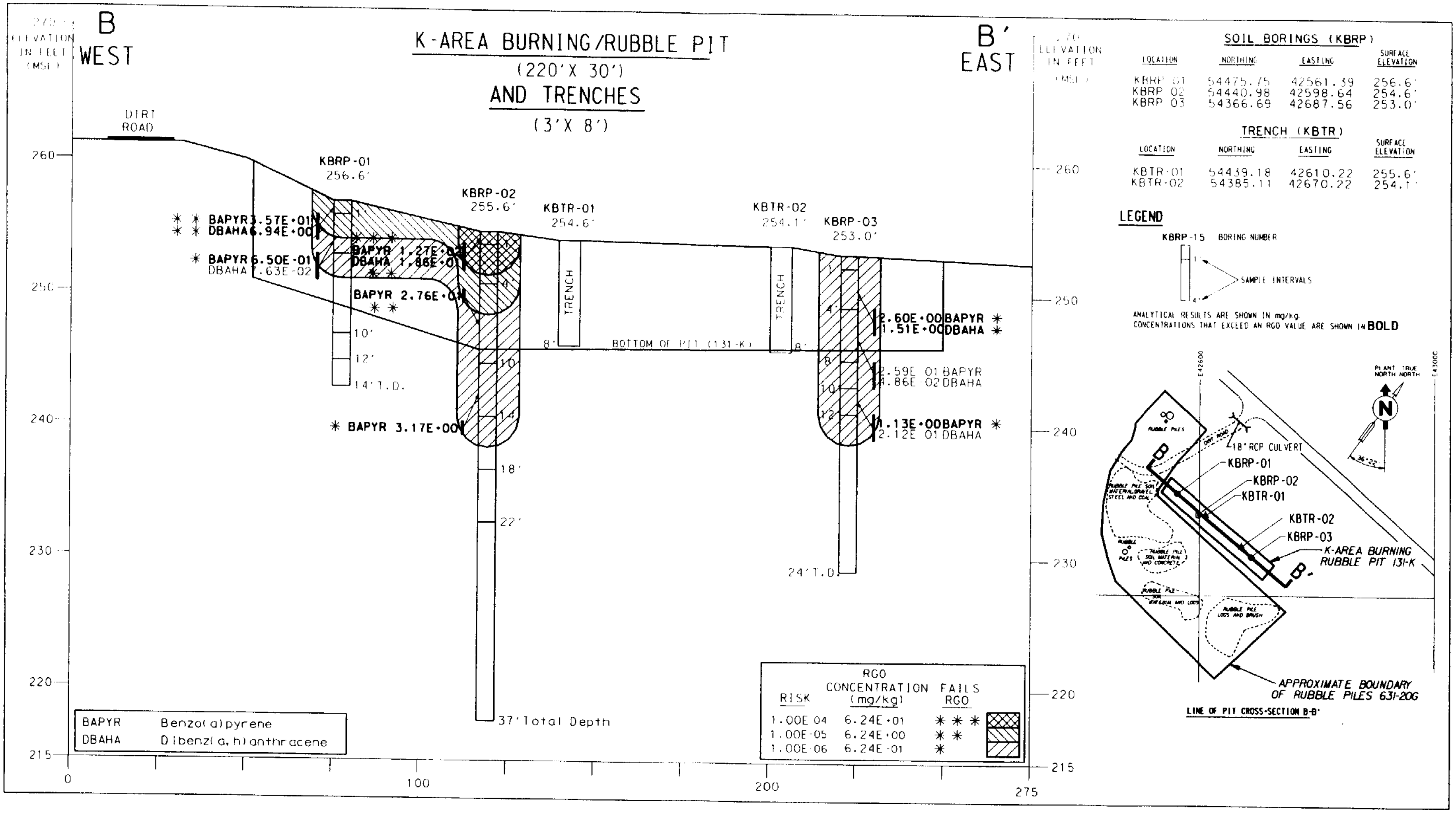

Figure 10. Cross Section of K-Area Burning/Rubble Pit Showing Lateral and Vertical Extent of PAHs Exceeding RGOs for Future Industrial Worker

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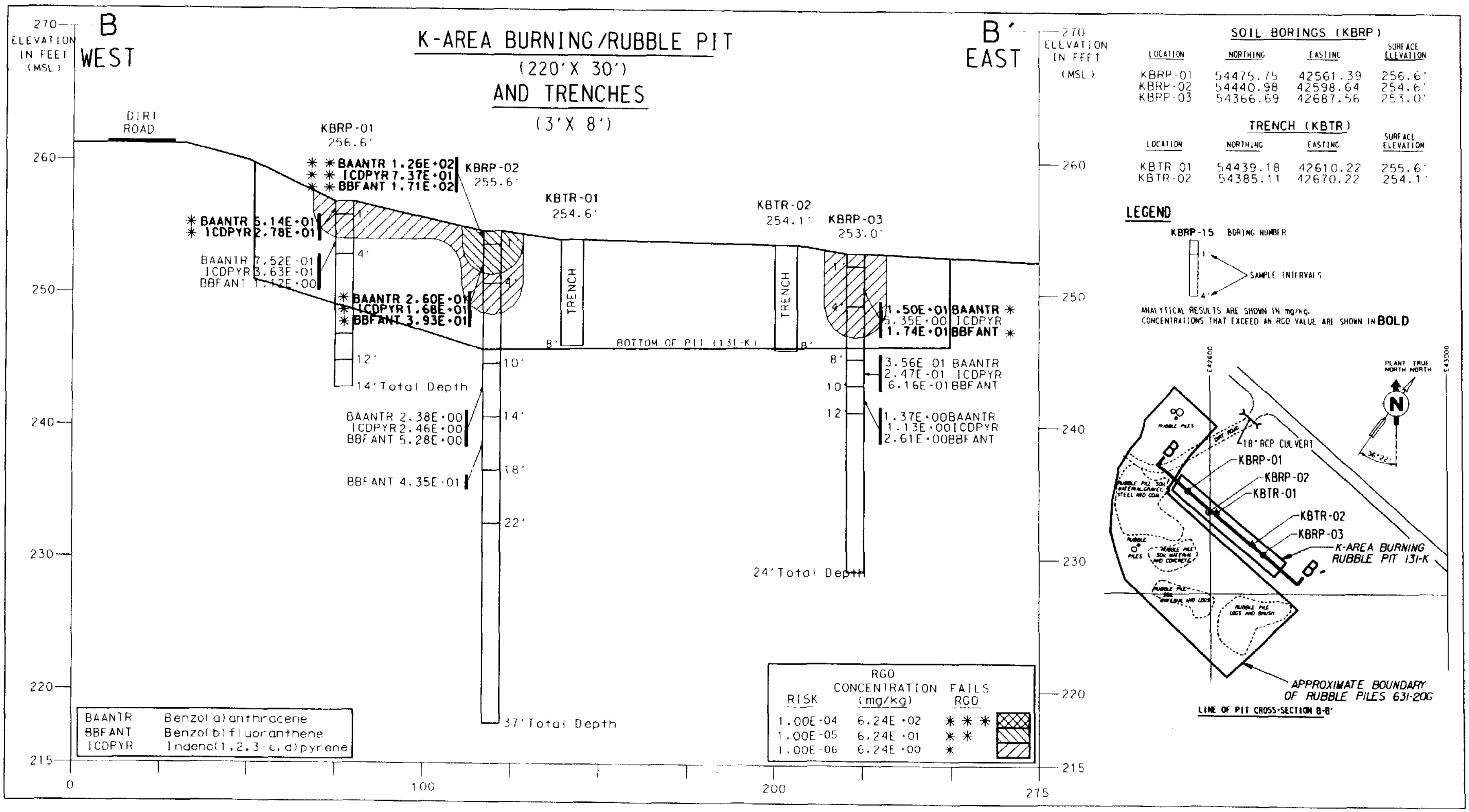

Figure 11. Cross Section of K-Area Burning/Rubble Pit Showing Lateral and Vertical Extent of PAHs Exceeding RGOs for Future Industrial Worker

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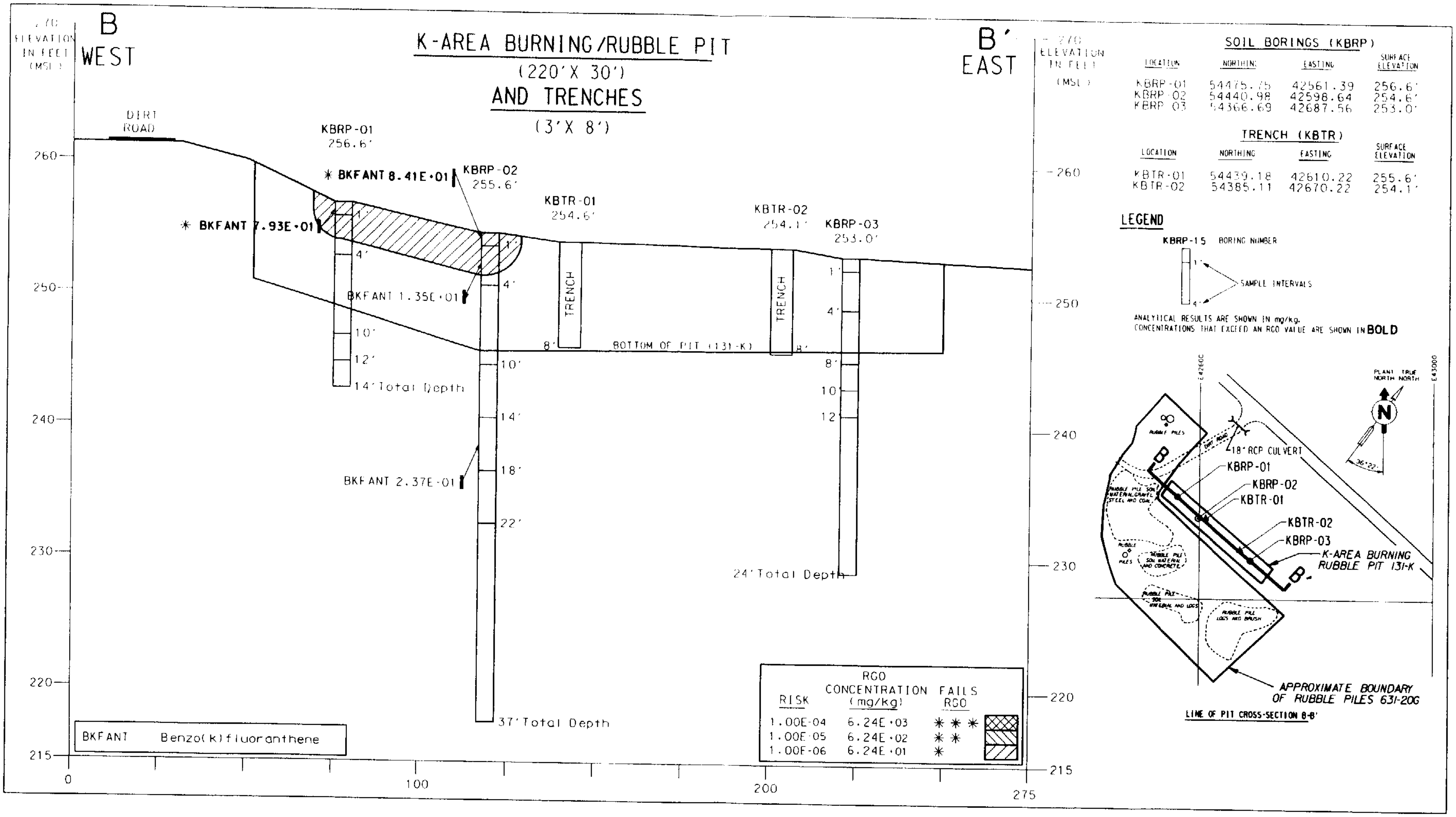

Figure 12. Cross Section of K-Area Burning/Rubble Pit Showing Lateral and Vertical Extent of PAHs Exceeding RGOs for Future Industrial Worker

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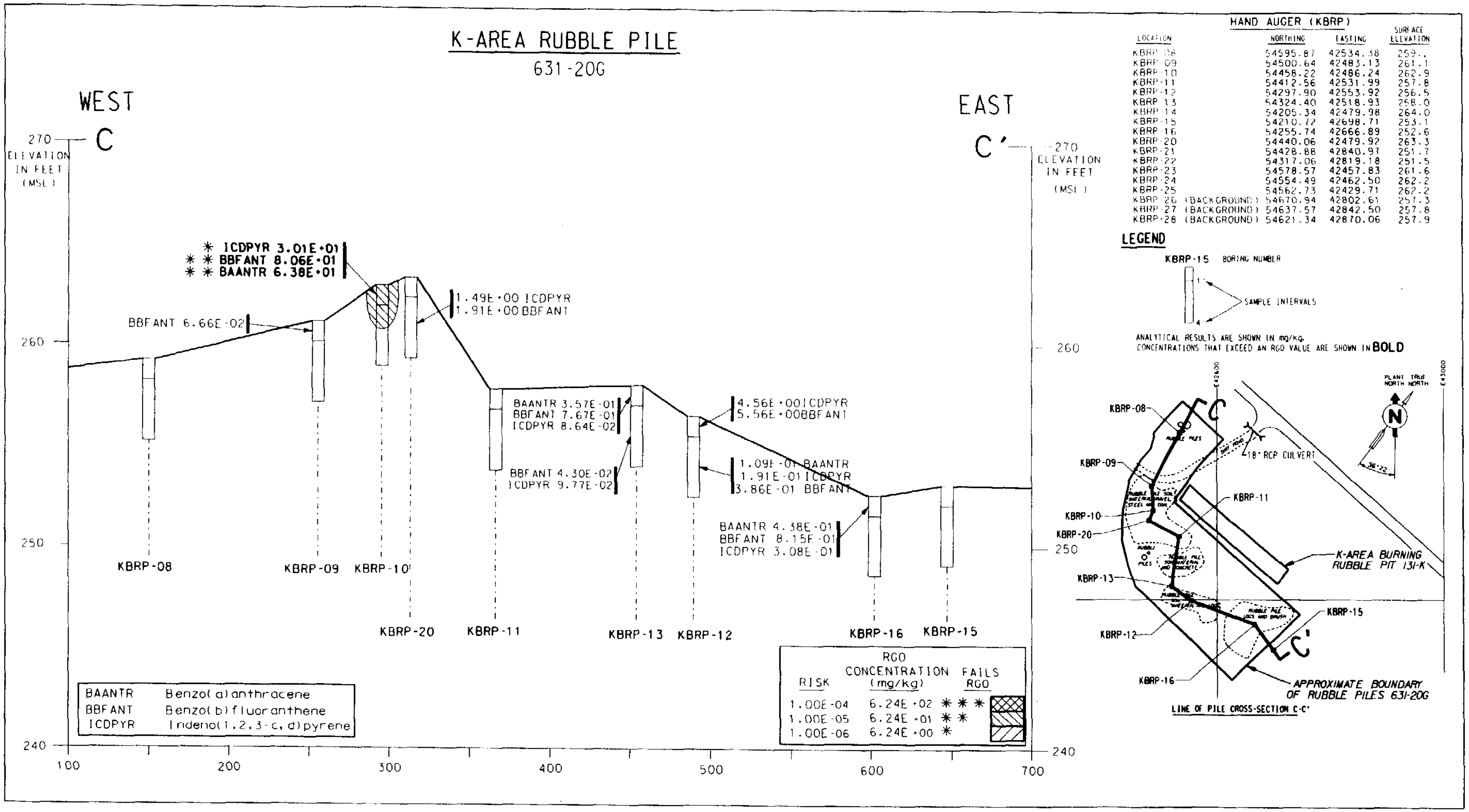

Figure 13. Cross Section of K-Area Rubble Pile Showing Lateral and Vertical Extent of Selected PAHs Exceeding RGOs for Future Industrial Worker

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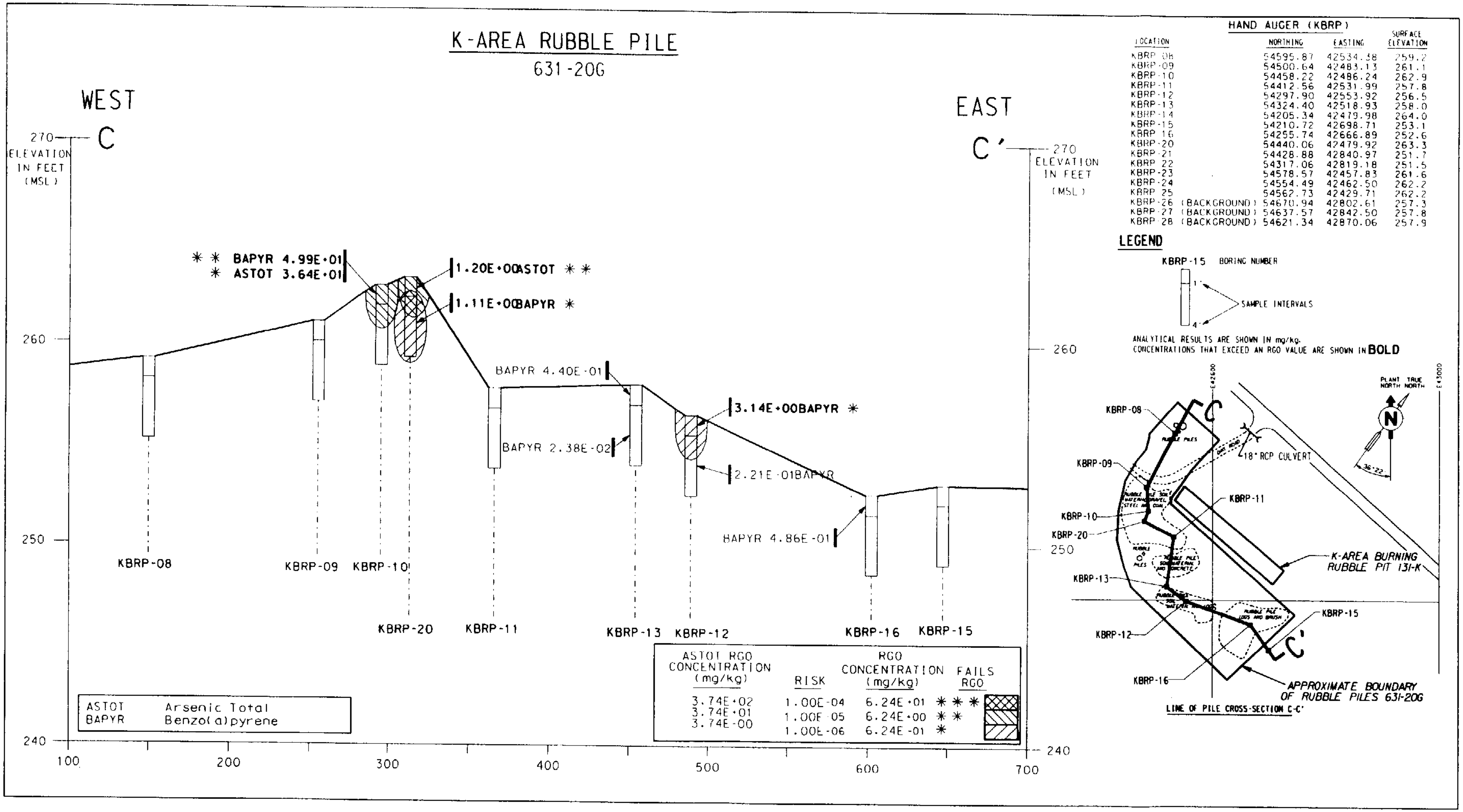

Figure 14. Cross Section of K-Area Rubble Pile Showing Lateral and Vertical Extent of Selected PAHs and Arsenic Exceeding RGOs for Future Industrial Worker

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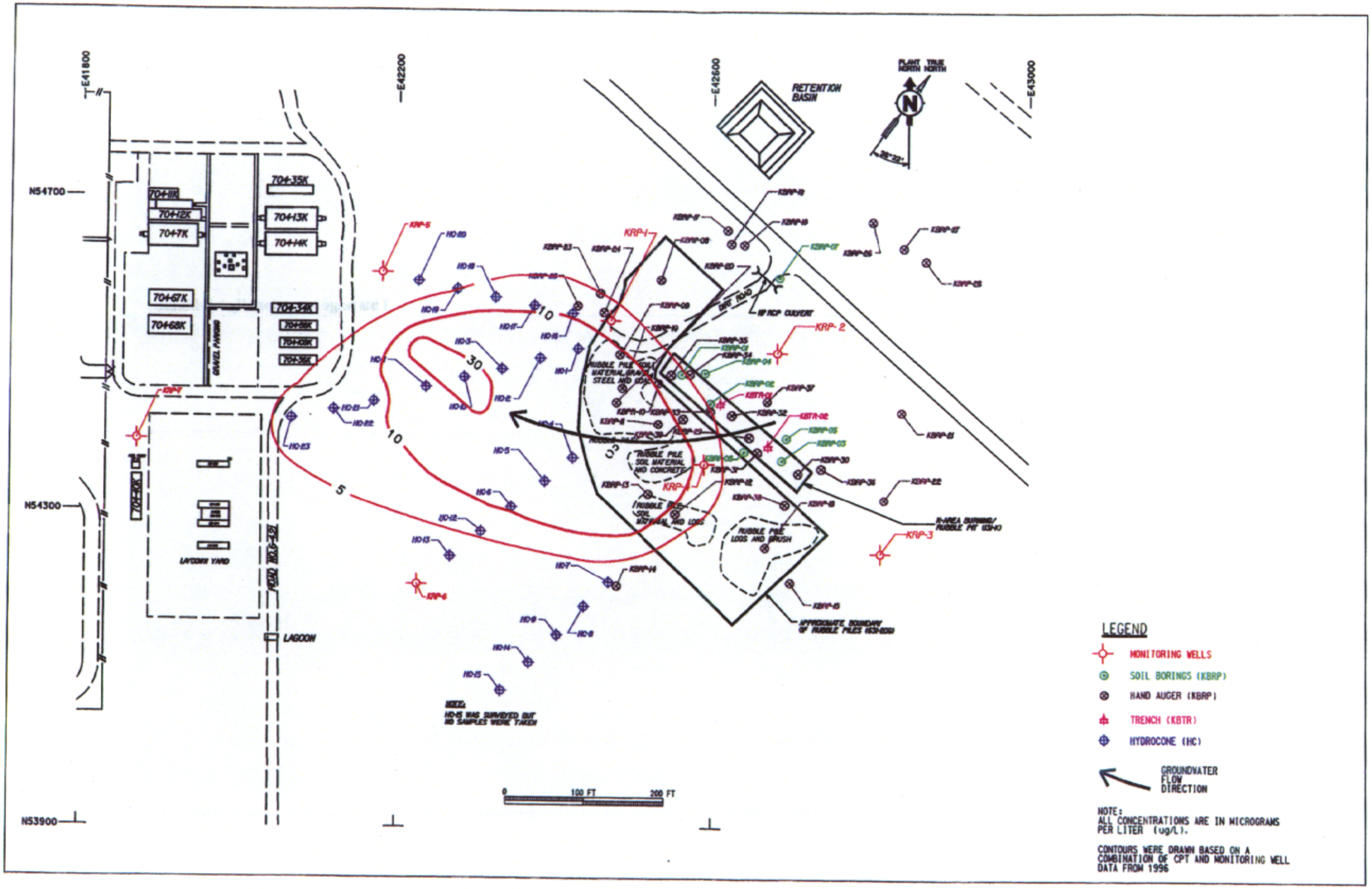

Figure 15. K-Area Burning/Rubble Pit and Rubble Pile PCE Concentration Contour Map

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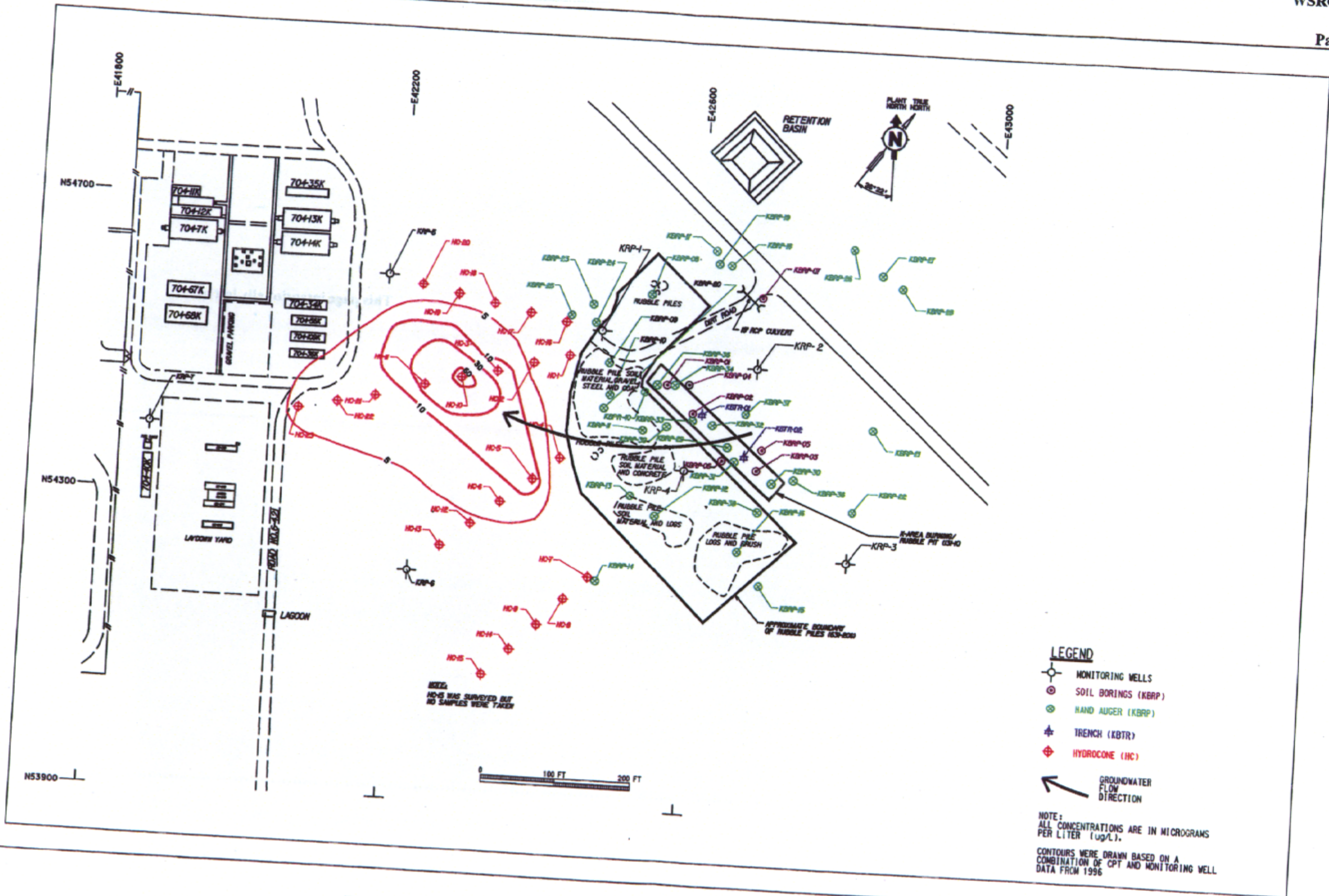

Figure 16. K-Area Burning/Rubble Pit and Rubble Pile TCE Concentration Contour Map

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Alternative BRP-3: Soil Cover over the KBRP with Institutional Controls

Estimated Cost - $256,000
Construction Time to Complete – 6 months

- For this containment alternative, a soil cover is placed over the pit to prevent exposure to human receptors. The actual specifications of the soil cover will be determined during the design phase. The cover design will be consistent with standard engineering practices. All waste (i.e., low-level threat) material and contaminated soil are left in place.

- The construction process will be accomplished using conventional and commercially available earth-moving equipment. Material used for placement of the soil cover will be obtained from local SRS sources within a short distance of the site. Since there are no RAOs related to contaminant migration at the KBRP, the soil cover does not have to meet a specific performance standard for permeability or leaching, but will be constructed in a manner to promote drainage away from the pit and to reduce the potential for infiltration and leaching.

- Institutional restrictions to maintain cover integrity also are implemented. This alternative, in conjunction with institutional controls, effectively eliminates human-health risk by preventing exposure of receptors. Semiannual monitoring will be performed, as required.

- Alternative BRP-3 effectively eliminates future exposure to human receptors at the KBRP. Exposure to future, human receptors also is mitigated by implementing institutional controls designed to prevent inadvertent disturbance of the site and exposure to subsurface soil.

- Alternative BRP-3 reduces mobility by containment with a soil cover but will not reduce toxicity or volume.

- Portions of the Subtitle D, "Solid Waste Management: Construction, Demolition, and Land-Clearing Debris Landfills" (SC R.61-107.11, Part IV) regulations are relevant and appropriate. This alternative is a permanent solution with long-term effectiveness. Subtitle G regulations for closure of a debris landfill mandate requirements for a two-foot cover, slope to provide appropriate drainage, and a vegetative cover. Engineering and operational controls during construction activities will minimize the potential for erosion and runoff.

- Fugitive dust emissions during soil cover construction activities at the KBRP will be controlled to meet South Carolina regulation SC R.61-62.6, Control of Fugitive Particulate Matter.

- Approximately 1,640 m^3 (2,140 yd^3) of waste material will be left in place. The in-place waste will present a negligible hazard.

- A unit-specific Land-Use Control Implementation Plan (LUCIP) will be developed and submitted with the appropriate OU post-ROD document. Once approved, the LUCIP will be appended to the SRS Land-Use Control Assurance Plan (LUCAP).

- This alternative minimizes costs by meeting RAOs without the need for treatment, removal, or disposal of waste material or contaminated soil. This alternative will take six months to construct and achieve goals. The soil cover construction activities at the KBRP is a task with relatively low capital costs, estimated at $133,000. O&M costs associated with institutional controls, remedy review at five-year intervals, and maintenance/repair of the soil cover for a 30-year period are estimated to be $123,000. The total estimated present worth cost of Alternative BRP-3 is $256,000.

Alternative BRP-4: Removal of the KBRP Wastes and Underlying Contaminated Soil

Estimated Cost - $703,000
Construction Time to Complete – 6 months

- For this removal alternative, the pit contents and underlying contaminated soil, including soil mixed in with waste, are excavated to a depth of 4 m (14 ft) and disposed of at an appropriate off-unit waste management facility. Upon completion of excavation activities, the pit is backfilled with clean soil, and the surface is graded and vegetated for erosion control. Institutional controls are not necessary at the KBRP due to the removal of all waste material and soil exceeding remediation goals.

- Waste characterization for disposal purposes has not been accomplished for material within the rubble pit. However, a review of historical evidence and soil analytical data suggests that it will be classified as nonhazardous. Further sampling and analysis of wastes for their disposition will be performed prior to disposal. For cost purposes, it is assumed that waste material in the rubble pit is nonhazardous and can be disposed of at a solid waste landfill.

- Removing all waste material and underlying contaminated soil at the KBRP to a depth of 4 m (14 ft), and laterally 1.5 m (5 ft) beyond the sides of the pit, effectively eliminates any exposure of future, industrial workers to contaminants. The total volume of waste material (1,640 m^3 [2,140 yd^3]) and underlying contaminated soil 2,330 m^3 [3,050 yd^3]) at the KBRP is approximately 3,970 m^3 (5,190 yd^3). The construction process will be accomplished using conventional and readily available earth-moving equipment. Material used for backfilling the pit will be obtained from local SRS borrow areas within a short distance of the site or equivalent.

- Institutional Controls and five-year remedy reviews are not required since all waste material and KBRP-contaminated soil will be excavated. No long-term monitoring will be required.

- Alternative BRP-4 eliminates human-health risk and contaminant mobility by removing and disposing of pit contents and underlying contaminated soil; however, waste volume and toxicity are not reduced.

- Excavated waste is managed in accordance with RCRA Hazardous Waste Management regulations and SCHWMR.

- Fugitive dust generation is controlled during removal activities to meet South Carolina regulations (SC R.61-62.6), Control of Fugitive Particulate Matter.

- Erosion and sediment controls are implemented to prevent sediment and contaminant runoff to surface water.

- The construction activities for this alternative are straightforward, but classification of waste material and underlying contaminated soil must be determined for disposal options. This alternative will take six months to construct and achieve goals. Assuming that the pit volume and underlying contaminated soil is considered nonhazardous, the total estimated present worth cost of Alternative BRP-4 is $703,000. This amount is the total estimated capital cost. There are no O&M costs associated with this alternative.

Alternative BRP-5a: Treat KBRP Wastes and Underlying Contaminated Soil by Soil Washing

Estimated Cost - $2,766,000
Construction Time to Complete – 12 months

- For this treatment alternative, the contents of the pit and underlying soil to a depth of 4 m (14 ft) are excavated and treated by soil washing. Soil washing is a water-based process for scrubbing soils ex situ to remove contaminants. It requires excavation of material and process steps, including particle-size separation, density separation, flotation, and chemical leaching. This treatment method is effective for PAH-contaminated soil at the KBRP. Treated soil and clean soil, if necessary, are used to backfill the excavation. There also are residual wastes associated with soil washing that require onsite treatment or disposal at an appropriate off-unit waste management facility. Solid waste within the pit is separated from contaminated soil by screening prior to the treatment process.

- Institutional controls and five-year remedy reviews are not required since all waste material and KBRP-contaminated soil is remediated by the soil-washing treatment process. No long-term monitoring will be required.

- Treating all waste material and contaminated soil at the KBRP effectively eliminates any exposure of future, industrial workers to contaminants. The treated soil used to backfill the pit does not have to meet a specific performance standard for permeability, nor are there concerns for infiltration and leaching since all contaminated materials are removed by the treatment process.

- Treatment will reduce volume and eliminate contaminant mobility. Toxicity is not reduced. Contaminants are removed from the soil.

- Excavation and treatment will be managed by Federal regulations and SCHWMR. A National Pollutant Discharge Elimination System (NPDES) permit is required to discharge any wastewater on site from soil washing.

- Fugitive dust generation is controlled during excavation activities to meet South Carolina regulations (SC R.61-62.6).

- Erosion controls are implemented to prevent sediment and contaminant runoff to surface water.

- This treatment alternative involves high costs associated with excavation activities, separating and removing mixed debris from soil to facilitate the treatment process, treating the contaminants by soil washing, disposing of residues left by soil washing, and treating the aqueous stream. This alternative will take 12 months to construct and achieve goals. Considering all these factors, the total estimated present worth cost of Alternative BRP-5a is $2,766,000. This amount is the total estimated capital cost. There are no O&M costs associated with this alternative after the soil washing is complete.

K-Area Rubble Pile

Alternative RP-1: No Action at KRP

Estimated Cost - $52,000
Construction Time to Complete – 0 months

- The No Action alternative for KRP soil makes no remedial efforts to control risk; treat or remove waste; or reduce the toxicity, mobility, or volume of contaminated media. Institutional controls and actions such as land-use restrictions are not incorporated.

- The No Action alternative requires no construction and can be implemented immediately. No ARARs are associated with this alternative.

- There are no capital construction or system O&M costs for the No Action alternative. However, a review of the remedy at five-year intervals, for a period of 30 years, is required by the NCP for remedial actions that result in hazardous substances, pollutants, or contaminants remaining at a waste unit above levels that allow for unlimited use and unrestricted exposure.

Alternative RP-3: Soil Cover over the KRP with Institutional Controls

Estimated Cost - $399,000
Construction Time to Complete – 6 months

- For this containment alternative, a soil cover is placed over the rubble piles to prevent exposure to future, industrial workers. The cover design will be consistent with standard engineering practices. Mixed debris and contaminated soil are left in place. However, in the process of grading the rubble piles in preparation for the soil cover, large pieces of mixed debris (e.g., concrete, wood) are separated and disposed of at a sanitary landfill. Prior to placement of a soil cover over the KRP, numerous trees and brush require clearing, and the mounded rubble piles require grading. After placement of the soil cover over the KRP, the area will be vegetated to control erosion and divert water away from the covered area.

- The construction process will be accomplished using conventional and commercially available earth-moving equipment. Material used for placement of the soil cover will be obtained from local SRS sources within a short distance of the site. Since there are no RAOs related to contaminant migration at the KRP, the soil cover does not have to meet a specific performance standard for permeability or leaching, but will be constructed in a manner to reduce the potential for infiltration and leaching.

- The total volume of mixed piled waste plus one additional foot below the pile at the KRP is approximately 4,050 m^3 (5,300 yd^3). While only a portion of the piled waste (i.e., mixed soil and debris) is contaminated at levels exceeding remedial goals, the alternatives evaluated assume remediation of the complete volume/area of piled waste. This is appropriate since it results in an approach that is effective, more conservative, more easily implemented, and less costly than attempting to better define the distribution of COCs. The in-place waste will present a negligible hazard.

- Institutional restrictions to maintain cover integrity also are implemented. This alternative, in conjunction with institutional controls, effectively eliminates human-health risk by preventing exposure of receptors. Semiannual monitoring will be performed, as required.

- Implementing this alternative effectively eliminates exposure of future, industrial workers at the KRP. Exposure to future, industrial workers also is mitigated by implementing institutional controls designed to prevent inadvertent disturbance of the site by future, industrial activities.

- Alternative RP-3 reduces mobility by containment with a soil cover but will not reduce toxicity or volume.

- Portions of the Subtitle G regulations for closure of a long-term, construction, demolition, and land-clearing debris landfill are relevant and appropriate. These Subtitle G landfill regulations for closure of a debris landfill (SC R.61-107.11, Part IV) mandate requirements for a two-foot cover, a slope to provide appropriate drainage, and a vegetative cover. Engineering and operational controls during construction activities will minimize the potential for erosion and runoff.

- Fugitive dust generation is controlled during soil cover construction activities at the KRP to meet South Carolina regulation SC R.61-62.6, Control of Fugitive Particulate Matter.

- Approximately 2,140 m^3 (2,800 yd^3) of waste material will be left in place. The in-place waste will present a negligible hazard.

- A unit-specific LUCIP will be developed and submitted with the appropriate OU post-ROD document. Once approved, the LUCIP will be appended to the SRS LUCAP.

- This containment alternative minimizes costs by meeting RAOs without the need for treatment, removal, or disposal of contaminated soil. This alternative will take six months to construct and achieve goals. The clearing, grading, and soil cover construction activities at the KRP have relatively low capital costs, estimated at \$277,000. O&M costs associated with institutional controls, remedy review at five-year intervals, and maintenance/repair of the soil cover for a thirty-year period are estimated to be \$122,000. The total estimated present worth cost of Alternative RP-3 is \$399,000.

Alternative RP-4: Remove KRP Wastes for Off-Unit Disposal

Estimated Cost - \$583,000
Construction Time to Complete – 6 months

- For this alternative, the contents of the rubble piles (i.e., soil mixed with debris) and one foot below the piles are removed and disposed of at an appropriate off-unit waste management facility. Once the rubble piles are removed, the soil beneath the piles is sampled to verify that remedial goals are met. Contaminated soil identified beneath the piles during verification sampling is disposed of along with the rubble pile contents. On completion of removal activities, the rubble pile area is backfilled, graded, and vegetated, as necessary. Institutional controls, O&M, and five-year remedy reviews are not necessary at the KRP since all contaminated soil exceeding remediation goals is removed.

- Waste characterization for disposal purposes has not been accomplished for material within the rubble piles. However, a review of historical evidence and analytical soil data suggests that it will be classified as nonhazardous. Further sampling and analysis of wastes for their disposition will be performed prior to disposal. For cost purposes, it is assumed that waste material in the rubble piles is nonhazardous and can be disposed of at a solid waste landfill.

- Removing all wastes and contaminated soil (4,050 m^3 [5,300 yd^3]) at the KRP effectively eliminates any future exposure of industrial workers to contaminants. The construction process will be accomplished using conventional and readily available earth-moving equipment.

- Institutional controls and five-year remedy reviews are not required since all waste material and KRP-contaminated soil will be excavated. No long-term monitoring will be required.

- Alternative RP-4 does not involve any treatment methods to reduce toxicity, mobility, or volume. Mobility is eliminated by removal and disposal of rubble pile contents off-unit. Toxicity and volume are not reduced.

- Excavated waste is managed in accordance with Federal regulations and SCHWMR.

- Fugitive dust generation is controlled during removal activities to meet South Carolina regulations (SC R.61-62.6), Control of Fugitive Particulate Matter.

- Erosion and sediment controls are implemented to prevent sediment and contaminant runoff to surface water.

- The construction activities for this alternative are straightforward, but classification of mixed debris and contaminated soil must be determined for disposal options. This alternative will take six months to construct and achieve goals. It is likely that the mixed debris/soil within and beneath the rubble piles will be considered nonhazardous waste. The total estimated present worth cost of Alternative RP-4 is \$583,000. This amount represents the capital costs associated with this alternative since there will be no O&M costs.

Alternative RP-5a: Treat KRP Wastes by Soil Washing

Estimated Cost - \$3,098,000
Construction Time to Complete – 12 months

- For this treatment alternative, the contents of the rubble piles and one foot below the piles are treated by soil washing. This treatment requires excavation of material and process steps, including particle size separation, density separation, flotation, and chemical leaching. This treatment method is effective for PAH- and arsenic-contaminated soil at the KRP. There are residual wastes associated with soil washing that require onsite treatment or disposal at an appropriate, off-unit solid waste management facility. Solid waste within the rubble piles is separated from contaminated soil by screening prior to the treatment process.

- Institutional controls, O&M, and five-year remedy reviews are not required since the soil washing treatment process effectively remediates all KRP waste material. No long-term monitoring will be required.

- Treating all waste material at the KRP under this alternative effectively eliminates any exposure of future, industrial workers to contaminants. For this alternative, mixed debris, such as coal and asphalt, is separated from contaminated soil prior to treatment. The volume of KRP waste plus one foot below the pile is approximately 4,050 m^3 (5,300 yd^3). The mixed debris, along with residues left over from the soil washing treatment process, are removed and disposed of at an appropriate off-unit waste management facility. Upon completion of treatment activities, the rubble pile area is graded and vegetated for erosional control.

- Treatment will reduce volume and eliminate contaminant mobility. Toxicity is not reduced. Contaminants are removed from the soil.

- Excavation and treatment will be managed by Federal regulations and SCHWMR. An NPDES permit is required to discharge any wastewater onsite from soil washing.

- Fugitive dust generation is controlled during excavation activities to meet South Carolina regulations (SC R.61-62.6).

- Erosion controls are implemented to prevent sediment and contaminant runoff to surface water.

- This treatment alternative involves high costs associated with excavation activities, separating and removing mixed debris from soil to facilitate the treatment process, treating the contaminants by soil washing, disposing of residues left by soil washing, and treating the aqueous stream. This alternative will take 12 months to construct and achieve goals. Considering all these factors, the total estimated present worth cost of Alternative RP-5a is $3,098,000. This amount is the total estimated capital cost. There are no O&M costs associated with this alternative after the soil washing is complete.

Water Table Aquifer

<u>*Alternative GW-1: No Action for Groundwater*</u>

Estimated Cost - $52,000
Construction Time to Complete – 0 months

- The No Action alternative for KBRP and KRP OU groundwater makes no remedial efforts to control risks; treat or remove wastes; or reduce the toxicity, mobility, or volume of contaminated media. In addition, no steps are taken to eliminate human-health risks associated with groundwater contaminants.

- The No Action alternative requires no construction and can be implemented immediately.

- While there is no capital construction or system O&M cost, a review of the remedy at five-year intervals for a period of 30 years is required by the NCP.

Alternative GW-3a: Monitored Natural Attenuation

Estimated Cost - $425,000
Construction Time to Complete – 6 months

- For this alternative, VOC contaminants in groundwater, such as PCE and TCE, will be allowed to degrade naturally at the KBRP/KRP OU. Attenuation employs natural, subsurface treatment processes, such as dispersion, volatilization, potential biodegradation, and adsorption, that will reduce VOC-contaminant concentrations in groundwater to levels below regulatory standards (i.e., MCLs).

- Site modeling demonstrated that natural processes have reduced, and will continue to reduce, VOC concentrations below regulatory standards (WSRC 1998c). According to modeling predictions, VOC concentrations in groundwater will be reduced to below regulatory standards by the year 2004. During the past 10 years of data collected in the study area, groundwater contaminant concentrations have been reduced significantly, and there has been relatively little downgradient movement of the plume.

- Review of historical analytical data from monitoring well KRP-4 shows a well-defined decrease in groundwater contaminant concentrations over time. The current maximum concentrations also are substantially less than peak historical concentrations.

- This alternative is equally effective and less costly than the more aggressive treatment processes.

- Land-use controls (LUCs) prevent future, industrial workers from potential exposure to groundwater at the KBRP/KRP OU.

- The progress of natural attenuation is monitored by continued sampling of existing plume wells and the installation and sampling of new intermediate and compliance wells downgradient of the present contaminant plume. Analytical results of groundwater samples are used to confirm that attenuation processes are proceeding at rates consistent with meeting cleanup objectives. Groundwater contaminants undergo natural attenuation prior to discharge into the nearest surface water body, Indian

Grave Branch. Groundwater is not currently used as a source of water at the KBRP/KRP OU.

- The risk to human health and the environment will decrease as groundwater contaminant concentrations decrease through time by processes of natural attenuation. Compliance monitoring will be used to determine the effectiveness and confirm the degree of attenuation.

- Institutional controls such as land-use restrictions will be implemented to prohibit future groundwater usage at the site until RAOs are achieved. By monitoring the movement, extent, and level of contamination and by providing institutional controls to restrict access to groundwater, the long-term effectiveness provides great confidence.

- The toxicity and volume of contaminants above MCLs are reduced by natural attenuation. The monitoring program provides a means to observe contaminant mobility.

- South Carolina Drinking Water Regulations (MCLs) are applicable (SC R.61.58).

- Erosion controls with a proper drainage system are implemented to prevent sediment runoff.

- Costs associated with Alternative GW-3a include labor and materials to model the groundwater, installation of new compliance monitoring wells, conducting required groundwater sampling on a biannual basis, and maintaining administrative controls. This alternative will take six months to construct and approximately four years to achieve goals (2004). Estimated costs for a four-year O&M period include data evaluation, data reporting, and five-year remedy reviews. The total estimated present worth cost associated with Alternative GW-3a is $425,000.

Alternative GW-3b: Air Sparging with Passive Soil Vapor Extraction (SVE)

Estimated Cost - $644,000
Construction Time to Complete – 12 months

- This in situ treatment alternative involves the injection of air into the contaminated portion of the aquifer. The air moves upward into the vadose zone and, in the process, strips (i.e., sparges) VOCs from the groundwater. Methane can be mixed with air during the sparging process for enhanced biodegradation of groundwater contaminants. A passive SVE system is installed in the vadose zone to enhance the release of organic vapors to the atmosphere. The organic vapors are released during periods of barometric lows.

- The groundwater plume is monitored by sampling existing and new monitoring wells to confirm that this treatment process is reducing contaminant concentrations.

- LUCs prevent future, industrial workers from potential exposure to groundwater at the KBRP/KRP OU.

- The effectiveness of air sparging to remediate groundwater is limited by site-specific conditions such as the low permeability of the formation and low concentrations of VOCs in groundwater. The use of air sparging points generally is most effective when used in small areas with relatively high contaminant concentrations. In this case, numerous air sparging points are required to provide coverage of the groundwater contaminant plume.

- Alternative GW-3b will protect human health and achieve RAOs by removing and possibly biodegrading VOCs.

- The toxicity of the groundwater contaminant plume is reduced with lower contaminant levels and volume of groundwater contaminated levels above MCL's also is reduced. Mobility of VOCs in groundwater is reduced since volatiles are transferred to the vadose zone, then the atmosphere.

- Given an adequate number of sparging points, implementation of this treatment technology meets ARARs and protects human health. Investigation-derived wastes (IDW) produced during sampling of monitoring wells will be managed in accordance with the SRS IDW Waste Management Plan. Erosion controls with a proper drainage system are implemented to prevent sediment runoff. An underground injection control State permit is required and air emissions will comply with South Carolina regulations.

- Capital costs associated with Alternative GW-3b include labor and materials to perform the treatability study and install injection points and air blowers. For this alternative, an estimated 21 injection points are required to adequately cover the extent of the plume. This alternative will take 12 months to construct and approximately two to three years to achieve goals (2002-2003). Also included are O&M costs associated with the air sparging remediation system for an estimated two-year period, which include groundwater and air monitoring, and system maintenance and performance checks. Groundwater, and possibly Underground Injection Control, and air emissions monitoring are required with this remedy. The total estimated present worth cost associated with Alternative GW-3b is $644,000.

Alternative GW-4a: Extraction and Treatment with Liquid-Phase Carbon Adsorption

Estimated Cost - $870,000
Construction Time to Complete – 12 months

- This technology consists of an extraction and treatment system designed to reduce VOCs in a groundwater contaminant plume. This system requires the installation of several extraction wells to adequately cover the extent of the plume. The need for several extraction wells is due to the low permeability of the water table aquifer. The exact number of extraction wells depends on aquifer characteristics, such as specific yield and transmissivity, which determine drawdown and radius of influence. Contaminated water pumped from the extraction wells is passed through canisters containing activated carbon to which VOCs are adsorbed. Effluent water from the carbon-adsorption, treatment system is discharged onsite under an NPDES permit.

- Low, contaminant concentrations allow large volumes of groundwater to be treated per volume of carbon requiring disposal/regeneration. Monitoring of effluent water from the carbon adsorption system is necessary to determine breakthrough.

- Implementation of this treatment technology protects hypothetical, future, industrial workers. Furthermore, LUCs prevent future, industrial workers from potential exposure to groundwater at the KBRP/KRP OU.

- Erosion controls with a proper drainage system are implemented to prevent sediment runoff to surface water. IDW produced during sampling is managed in accordance with the SRS IDW Waste Management Plan. If treated effluent water is discharged on site, an NPDES permit is required.

- This remedial action effectively and permanently addresses the exposure pathways. The toxicity of the groundwater contaminant plume is reduced with lower contaminant levels and volume of groundwater contaminated levels above MCLs is reduced. Mobility of contaminants is reduced by hydraulic controls.

- Groundwater extraction and treatment is readily implemented within a relatively short time period. Construction will involve the use of available materials from commercial vendors and the use of conventional equipment, such as drill rigs. Groundwater sampling will verify that contaminant concentrations are reduced and below MCLs.

- Capital costs associated with Alternative GW-4a include labor and materials for the installation of the extraction and liquid-phase carbon adsorption treatment system. This alternative will take 12 months to construct and two to three years to achieve goals (2002-2003). In addition, the following O&M costs are associated with the system for an estimated period of two years: disposal and replacement of carbon canisters, as needed; groundwater monitoring to verify that groundwater contaminant levels are being reduced; influent and effluent monitoring of the treatment system to observe contaminant levels and recognize breakthrough; measuring drawdown in observation wells to determine radius of influence; and data evaluation/report writing on a regular basis until remediation goals are attained. The total estimated present worth cost associated with Alternative GW-4a is $870,000.

X. COMPARATIVE ANALYSIS OF ALTERNATIVES

Each of the remedial alternatives for soil and groundwater were evaluated using the nine criteria established by the NCP. The criteria were derived from the statutory requirements of CERCLA Section 121. The criteria are as follows:

Threshold Criteria

- Overall protection of human health and the environment

- Compliance with ARARs

Primary 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

In selecting the preferred alternative, the above criteria were used to evaluate the alternatives developed in the focused CMS/FS (WSRC 1999). Seven of the criteria were used to evaluate all the alternatives based on human health and environmental protection, estimated cost, feasibility, and implementability issues. The preferred alternative was evaluated further based on the final two criteria: State acceptance and community acceptance.

The comparative evaluation of remedial alternatives against the first seven NCP criteria for KBRP/KRP OU waste units and groundwater is shown in Tables 4 through 8. Summaries of the comparative analysis are provided below.

K-Area Burning/Rubble Pit

A comparative analysis of the four corrective measure/remedial action alternatives is considered for remediating contaminated KBRP soil. The alternatives are evaluated against the NCP-threshold and primary-balancing criteria in a manner similar to the individual analysis of each alternative. The analysis identifies trade-offs between alternatives. The comparative analysis of alternatives for the KBRP soil is summarized in Table 4.

Table 4. Comparative Analysis of Alternatives for Soil at the K-Area Burning/Rubble Pit

Criterion	Alternative BRP-1 No Action at KBRP	Alternative BRP-3 Soil Cover over the KBRP with Institutional Controls	Alternative BRP-4 Removal of the KBRP Wastes and Underlying Contaminated Soil	Alternative BRP-5a Treat KBRP Wastes and Underlying Contaminated Soil by Soil Washing
Overall Protection of Human Health and the Environment				
Human Health	Not protective	Protective	Protective	Protective
Environment	Not applicable	Not applicable	Not applicable	Not applicable
Control of Source Release	Not applicable	Not applicable	Not applicable	Not applicable
Prevent Exposure of Future Human Receptors to Contaminated Waste/Soil	Not effective	Effective	Effective	Effective
Prevent Exposure of Ecological Receptors to Contaminated Waste/Soil	Not applicable	Not applicable	Not applicable	Not applicable
Effectiveness in Meeting Remediation Goals	Not effective	Effective	Effective	Effective
Compliance with ARARs				
Chemical-Specific	Not applicable	Not applicable	Not applicable	Not applicable
Location-Specific	Not applicable	Must comply with erosion and runoff control requirements (SC R72, SC R61-9.122.26)	Must comply with erosion and runoff control requirements (SC R72, SC R61-9.122.26)	Must comply with erosion and runoff control requirements (SC R72, SC R61-9.122.26)
Action-Specific	Not applicable	Must comply with requirements for fugitive dust emissions (SC R61-62.6) and closure of long-term construction, demolition, and land-clearing debris landfills (40 CFR 261-268, SC R61-107.11)	Must comply with fugitive dust emission requirements (SC R61-62.6), RCRA, and SCHWMR (40 CFR 261-268 and SC R61-107.11)	Must comply with fugitive dust emission requirements (SC R61-62.6), RCRA, SCHWMR, and NPDES requirements (40 CFR 261-268, SC R61-107.11, and 40 CFR 122-125 and SC R61-9.122-125)
Long-Term Effectiveness and Permanence				
Magnitude of Residual Risks	Risk not reduced	Risk is eliminated	Risk is eliminated	Risk is eliminated
Adequacy of Controls	Not adequate	Requires long-term O&M	No controls needed	No controls needed
Permanence	Not permanent	Permanent, assuming long-term controls	Permanent	Permanent
Reduction of Toxicity, Mobility, or Volume				
Treatment Process Used and Materials Treated	None	None	None	Soil washing is employed to remove contaminants from waste and soil

Table 4. Comparative Analysis of Alternatives for Soil at the K-Area Burning/Rubble Pit (continued)

Criterion	Alternative BRP-1 No Action at KBRP	Alternative BRP-3 Soil Cover over the KBRP with Institutional Controls	Alternative BRP-4 Removal of the KBRP Wastes and Underlying Contaminated Soil	Alternative BRP-5a Treat KBRP Wastes and Underlying Contaminated Soil by Soil Washing
Degree of Expected Reduction in Toxicity, Mobility, or Volume	None	Mobility reduced by containment with a soil cover; toxicity and volume not reduced	Mobility reduced with disposal in permitted landfill; toxicity and volume not reduced	Volume and mobility of contaminated material would be reduced by soil washing; toxicity not reduced
Amount of Hazardous Materials Destroyed or Treated	None	None	None	Contaminants not destroyed, but removed from soil
Degree to Which Treatment is Irreversible	No treatment	No treatment	No treatment	Irreversible
Types and Quantities of Residuals Remaining after Treatment	No treatment	No treatment	No treatment	Residuals would include wastewater, oversized waste, and washing fines/sludge
Short-Term Effectiveness				
Risks to Remedial Workers	None	Negligible	Negligible	Negligible
Risks to Community	None	Negligible	Negligible	Negligible
Risks to Environment	None	Negligible	Negligible	Negligible
Time to Achieve Remedial Action Objectives	No time	Circa 2001	Circa 2001	Circa 2001
Implementability				
Availability of Materials, Equipment, Skilled Labor	Not applicable	Readily available	Readily available	Readily available
Ability to Construct and Operate the Technology	Not applicable	Straightforward	Straightforward	Not straightforward
Ability to Obtain Permits/Approvals from Other Agencies	Readily implemented – five-year remedy review	Readily implemented – five-year remedy review	Readily implemented	Not readily implemented
Ability to Monitor Effectiveness of Remedy	Not applicable	Easily monitored	No monitoring required	No monitoring required
Ease of Undertaking Additional Actions (if necessary)	Not incompatible	Not incompatible	Not incompatible	Not incompatible
Time to Implement	No time	Six months to construct after approval of remedial design and work plan	Six months to construct after approval of remedial design and work plan	Six months to construct after approval of remedial design and work plan; six additional months to begin operations
Cost				
Present Worth Capital Cost	None	$133,000	$703,000	$2,766,000
Present Worth O&M Cost	$52,000	$123,000	None	None
Total Present Worth Cost	$52,000	$256,000	$703,000	$2,766,000

Overall Protection of Human Health and the Environment

The No Action alternative (BRP-1) is not protective of future, industrial workers due to potential exposure to PAHs in KBRP surface soil. The action alternatives (i.e., containment, removal, and treatment) are protective of human health. The containment alternative (soil cover), in conjunction with institutional controls, provides protection by eliminating the potential for exposure of hypothetical, future, industrial workers. The removal alternative (BRP-4) eliminates human-health concerns by the excavation and disposal of all waste material and underlying, contaminated soil at the KBRP.

Alternative BRP-4 involves the removal of all soil to a depth of 4.2 m (14 ft); therefore, institutional controls are not required. The ex situ treatment alternative (soil washing) remediates the contents of the pit and the underlying soil to a depth of 4 m (14 ft). This treatment alternative protects human health and does not require institutional controls.

In addition, all alternatives, except the No Action alternative, require land-use controls to ensure short-term protection of human health until the remedy is implemented. The soil cover alternative (BRP-3) requires long-term controls to ensure protection.

There are no ecological COCs and, therefore, there is no risk to the environment from KBRP soil.

Compliance with ARARs

Chemical-Specific ARARs. There are no chemical-specific ARARs for the COCs at the KBRP.

Location-Specific ARARs. There are no location-specific ARARs associated with the No Action alternative. The action alternatives are implemented in a manner that prevents erosion and runoff (SC R72 and SC R61-9.122.26).

Action-Specific ARARs. There are no action-specific ARARs associated with the No Action alternative. South Carolina regulations for fugitive dust emissions apply to the action alternatives (SC R61-62.6). Waste from remedial activities is managed in accordance with RCRA and South Carolina waste management regulations (SC R61-107.11). A NPDES permit is required to discharge wastewater onsite from the soil washing treatment process (40 CFR 122-125 and SC R61-9.122-125).

Long-Term Effectiveness and Permanence

The No Action alternative provides no long-term protection of human health. The action alternatives (i.e., containment, removal, and treatment) are permanent solutions with long-term effectiveness. The containment alternative (BRP-3) requires long-term O&M.

Reduction of Toxicity, Mobility, or Volume through Treatment

The No Action alternative does not reduce the toxicity, mobility, or volume of contaminants or contaminated media. The removal alternative (BRP-4) and the containment alternative (BRP-3) involve no treatment methods. Although there are no RAOs related to contaminant migration, mobility is reduced by containment with a soil cover, or by removal. The excavation, removal, and disposal alternative (BRP-4) reduces the potential mobility of contaminants at the site. The treatment alternative (BRP-5a) reduces the mobility and volume of contaminants by soil washing.

Short-Term Effectiveness

The No Action alternative poses no risk to the community or remedial workers. Implementation of the action alternatives (i.e., containment, removal, and treatment) requires proper engineering controls and health/safety procedures to protect remedial workers and the community.

The No Action alternative does not achieve RAOs, while the three action alternatives achieve RAOs within a period of months after implementation.

Implementability

The No Action alternative requires no effort to implement. The containment alternative is relatively easy to implement and monitor. The removal alternative is easy to implement but expensive, primarily due to costs associated with disposal of nonhazardous waste and soil. The most time-consuming, difficult to implement, and costly alternative is treatment by soil washing (BRP-5a), which is a labor-intensive operation. Remedial activities at the KBRP would not disrupt any ongoing activities at the nearby K-Reactor Area.

Cost

The total present worth costs of remedial alternatives addressing soil at the KBRP are as follows:

Alternative BRP-1 (No Action at KBRP)	$52,000
Alternative BRP-3 (Soil Cover over the KBRP with Institutional Controls)	$256,000
Alternative BRP-4 (Removal of KBRP Wastes and Underlying Contaminated Soil)	$703,000
Alternative BRP-5a (Treat KBRP Wastes and Underlying Contaminated Soil by Soil Washing)	$2,766,000

K-Area Rubble Pile

A comparative analysis of the four corrective measure/remedial action alternatives is considered for remediating contaminated soil at the KRP. The alternatives are evaluated against the NCP-threshold and primary-balancing criteria in a manner similar to the individual analysis of each alternative. The analysis identifies trade-offs between alternatives. The comparative analysis of alternatives for KRP soil is summarized in Table 5.

Overall Protection of Human Health and the Environment

The No Action alternative (RP-1) is not protective of future, industrial workers due to potential exposure to PAHs and arsenic in KRP surface soil.

The action alternatives (i.e., containment, removal, and treatment) are protective of human health. The containment alternative (soil cover), in conjunction with institutional controls, provides protection by mitigating risks to the hypothetical, future, industrial worker. The removal alternative (RP-4) eliminates human health concerns by removing all mixed debris and contaminated soil at the KRP. Alternative RP-4 involves the removal of all contaminated media above RGOs and, therefore, institutional controls are not required. The ex situ treatment alternative (soil washing) remediates the contents of the rubble piles.

Table 5. Comparative Analysis of Alternatives for Soil at the K-Area Rubble Pile

Criterion	Alternative RP-1 No Action at KRP	Alternative RP-3 Soil Cover over the KRP with Institutional Controls	Alternative RP-4 Remove KRP Wastes for Off-Unit Disposal	Alternative RP-5a Treat KRP Wastes by Soil Washing
Overall Protection of Human Health and the Environment				
Human Health	Not protective	Protective	Protective	Protective
Environment	Not applicable	Not applicable	Not applicable	Not applicable
Control of Source Release	Not applicable	Not applicable	Not applicable	Not applicable
Prevent Exposure of Future Human Receptors to Mixed Debris/Soil	Not effective	Effective	Effective	Effective
Prevent Exposure of Ecological Receptors to Mixed Debris/Soil	Not applicable	Not applicable	Not applicable	Not applicable
Effectiveness in Meeting Remediation Goals	Not effective	Effective	Effective	Effective
Compliance with ARARs				
Chemical-Specific	Not applicable	Not applicable	Not applicable	Not applicable
Location-Specific	Not applicable	Must comply with erosion and runoff control requirements (SC R72, SC R61-9.122.26)	Must comply with erosion and runoff control requirements (SC R72, SC R61-9.122.26)	Must comply with erosion and runoff control requirements (SC R72, SC R61-9.122.26)
Action-Specific	Not applicable	Must comply with requirements for fugitive dust emissions (SC R61-62.6) and closure of long term construction, demolition, and land-clearing debris landfills (40 CFR 261-268, SC R61-107.11)	Must comply with fugitive dust emission requirements, (SC R61-62.6) RCRA, and SCHWMR (40 CFR 261-268 and SC R61-107.11)	Must comply with fugitive dust emission requirements, (SC R61-62.6) RCRA, SCHWMR, and NPDES requirements (40 CFR 261-268, SC R61-107.11, and 40 CFR 122-125 and SC R61-9.122-125)
Long-Term Effectiveness and Permanence				
Magnitude of Residual Risks	Risk not reduced	Risk is eliminated	Risk is eliminated	Risk is eliminated
Adequacy of Controls	Not adequate	Requires long-term O&M	No controls needed	No controls needed
Permanence	Not permanent	Permanent, assuming long-term controls	Permanent	Permanent
Reduction of Toxicity, Mobility, or Volume				
Treatment Process Used and Materials Treated	None	None	None	Soil washing is employed to remove contaminants from waste and soil
Degree of Expected Reduction in Toxicity, Mobility, or Volume	None	Mobility reduced by containment with native soil cover; toxicity and volume not reduced	Mobility reduced with disposal in permitted landfill; toxicity and volume not reduced	Volume and mobility of contaminated material is reduced by soil washing; toxicity not reduced

Table 5. Comparative Analysis of Alternatives for Soil at the K-Area Rubble Pile (continued)

Criterion	Alternative RP-1 No Action at KRP	Alternative RP-3 Soil Cover over the KRP with Institutional Controls	Alternative RP-4 Remove KRP Wastes for Off-Unit Disposal	Alternative RP-5a Treat KRP Wastes by Soil Washing
Amount of Hazardous Materials Destroyed or Treated	None	None	None	Contaminants not destroyed, but removed from soil
Degree to Which Treatment is Irreversible	No treatment	No treatment	No treatment	Irreversible
Types and Quantities of Residuals Remaining after Treatment	None	No treatment	No treatment	Residuals include wastewater, oversized waste, and washing fines/sludge
Short-Term Effectiveness				
Risks to Remedial Workers	None	Negligible	Negligible	Negligible
Risks to Community	None	Negligible	Negligible	Negligible
Risks to Environment	None	Negligible	Negligible	Negligible
Time to Achieve Remedial Action Objectives	No time	Circa 2001	Circa 2001	Circa 2001
Implementability				
Availability of Materials, Equipment, Skilled Labor	Not applicable	Readily available	Readily available	Readily available
Ability to Construct and Operate the Technology	Not applicable	Straightforward	Straightforward	Not straightforward
Ability to Obtain Permits/Approvals from Other Agencies	Readily implemented – five-year remedy review	Readily implemented – five-year remedy review	Readily implemented	Not readily implemented
Ability to Monitor Effectiveness of Remedy	Not applicable	Easily monitored	No monitoring required	No monitoring required
Ease of Undertaking Additional Actions (if necessary)	Not incompatible	Not incompatible	Not incompatible	Not incompatible
Time to Implement	No time	Six months after approval of remedial design and work plan	Six months after approval of remedial design and work plan	Six months to construct after approval of remedial design and work plan; six additional months to begin operations
Cost				
Present Worth Capital Cost	None	$277,000	$583,000	$3,098,000
Present Worth O&M Cost	$52,000	$122,000	None	None
Total Present Worth Cost	$52,000	$399,000	$583,000	$3,098,000

This treatment alternative protects human health and does not require institutional controls. In addition, all alternatives, except No Action alternatives, require land-use controls to ensure short-term protection of human health until the remedy is implemented. The soil cover alternative (RP-3) requires long-term controls for protection of human health.

There are no ecological COCs and, therefore, there is no risk to the environment from KRP soil.

Compliance with ARARs

Chemical-Specific ARARs. There are no chemical-specific ARARs associated with COCs at the KRP.

Location-Specific ARARs. There are no location-specific ARARs associated with the No Action alternative. The action alternatives are implemented in a manner that prevents erosion and runoff (SC R72 and SC R61-9.122.26).

Action-Specific ARARs. There are no action-specific ARARs associated with the No Action alternative. South Carolina regulations for fugitive dust emissions apply to the action alternatives (SC R61-62.6). Waste from remedial activities are managed in accordance with the RCRA and South Carolina waste management regulations (40 CFR 261-268 and SC R61-107.11).

Long-Term Effectiveness and Permanence

The No Action alternative provides no long-term protection of human health. The action alternatives (i.e., containment, removal, and treatment) are permanent solutions with long-term effectiveness. The containment alternative (RP-3) requires long-term O&M.

Reduction of Toxicity, Mobility, or Volume through Treatment

The No Action alternative does not reduce the toxicity, mobility or volume of contaminants or contaminated media. The removal alternative (RP-4) and the containment alternative (RP-3) involve no treatment methods. Although there are no RAOs related to contaminant migration, mobility is reduced by containment with a soil cover, or by removal. The removal alternative (RP-4) also reduces the mobility of contaminants. The treatment alternative (RP-5a) reduces the mobility and volume of contaminants by soil washing.

Short-Term Effectiveness

The No Action alternative poses no risk to the community or remedial workers. The containment alternative (RP-3) requires grading the rubble piles prior to placement of the soil cover. The removal (RP-4) and treatment (RP-5a) alternatives require handling small to medium volumes of soil contaminated with PAHs and arsenic. Therefore, implementation of the action alternatives (i.e., containment, removal, and treatment) requires proper engineering controls and health/safety procedures to protect remedial workers and the community.

The No Action alternative does not achieve RAOs, while the three action alternatives achieve RAOs within a period of months after implementation.

Implementability

The No Action alternative requires no effort to implement. The placement of a soil cover at the KRP (Alternative RP-3), with institutional controls, is relatively easy to implement and monitor since the soil cover is easily constructed using readily available materials and labor. The removal alternative (RP-4) is easy to implement and the costs are competitive with Alternative RP-3 since excavation of construction/demolition material is easily accomplished using readily available materials and labor. Alternative RP-4 (removal and disposal) assumes the mixed debris/soil can be disposed of as nonhazardous waste. The most time-consuming, difficult to implement, and costly alternative is treatment by soil washing (RP-5a). Soil washing requires excavation of material and numerous, detailed, processing steps including size classification, density classification, flotation, and chemical leaching. Remedial activities at the KRP would not disrupt any ongoing activities at the nearby K-Reactor Area.

Cost

The total present worth costs of remedial alternatives addressing soil at the KRP are as follows:

Alternative RP-1 (No Action at KRP)	$52,000

Alternative RP-3 (Soil Cover over the KRP with Institutional Controls)	\$399,000
Alternative RP-4 (Remove KRP Wastes for Off-Unit Disposal)	\$583,000
Alternative RP-5a (Treat KRP Wastes by Soil Washing)	\$3,098,000

Combined Soil Alternatives at the KBRP and KRP

The KBRP and KRP waste management units, located immediately adjacent to each other, were used to manage similar wastes and have common COCs and RAOs. Remediation of these two waste units is most efficient when approached together with combined implementation of design, mobilization/demobilization, and construction and O&M efforts. KBRP and KRP cost estimates and individual analyses for individual alternatives are presented in Section IX. These individual alternatives are combined as listed below.

The following is a comparative analysis of five, combined, corrective measure/remedial action alternatives being considered for remediation of KBRP and KRP contaminated soil. The five combined alternatives are as follows:

1. Construct Soil Cover over KBRP/KRP and Implement Long-Term Institutional Controls

2. Move KRP Wastes on to KBRP (Consolidate), Restore KRP Area, Construct a Soil Cover over KBRP and KRP Wastes, and Implement Long-Term Institutional Controls

3. Remove KBRP and KRP Wastes for Off-Unit Disposal

4. Excavate KBRP and KRP Wastes, Treat by Soil Washing, and Dispose of Waste Treatment Residuals Off-Unit

5. Remove KRP Wastes for Off-Unit Disposal, Construct Soil Cover over KBRP, and Implement Long-Term Institutional Controls

Combined Alternatives 1, 3, and 4 are the combined implementation of identical actions at the two waste units. Combined Alternative 1 consists of a soil cover (RP-3 and BRP-3), Combined Alternative 3 involves removal with off-unit disposal (RP-4 and BRP-4), and Combined Alternative 4 involves soil washing (RP-5a and BRP-5a). Combined Alternative 2 involves moving the KRP wastes, plus one additional foot, to the KBRP and placing a soil cover over the consolidated wastes. Combined Alternative 5 is removal and off-unit disposal of KRP wastes together with a soil cover over the KBRP (RP-4 and BRP-3).

The combined alternatives are evaluated against the NCP-threshold and primary-balancing criteria. The comparative analysis of these alternatives is summarized in Table 6. A comparative cost summary of individual versus combined implementation of alternatives is presented in Table 7. This table also presents the cost savings due to combined implementation of design, immobilization/demobilization, and construction.

Overall Protection of Human Health and the Environment

All the combined alternatives are protective of human health and the environment. Combined Alternatives 1 and 2 provide protection through the use of a soil barrier and institutional controls that prevent exposure. Combined Alternatives 3 and 4 provide protection by removing or treating contaminated media. Combined Alternative 5 provides protection through both removal and a soil cover with institutional controls.

Compliance with ARARs

Chemical-Specific ARARs. There are no chemical-specific ARARs associated with COCs at the KBRP and KRP.

Location-Specific ARARs. The combined alternatives are implemented in a manner that prevents erosion and runoff (SC R72 and SC R61-9.122.26).

Action-Specific ARARs. South Carolina regulations for fugitive dust emissions apply to all combined alternatives (SC R61-62.6). Waste from remedial activities is managed in accordance with RCRA and South Carolina waste management regulations (40 CFR 261-268 and SC R61-107.11). The soil cover Combined Alternatives 1, 2, and 5 comply with South Carolina regulations for closure of long-term construction, demolition, and land-clearing debris landfills. If wastewater is discharged onsite in Combined Alternative 4, a NPDES permit is required (40 CFR 122-125 and SC R61-9.122-125).

Table 6. Comparative Analysis of Combined Alternatives for Soil at the K-Area Burning/Rubble Pit and K-Area Rubble Pile

Criterion	Alternative 1 Soil Cover over the KBRP and KRP with Institutional Controls	Alternative 2 Move KRP to KBRP, Soil Cover over the KBRP, with Institutional Controls	Alternative 3 Remove KBRP and KRP Wastes for Off-Unit Disposal	Alternative 4 Excavate KBRP and KRP Wastes, Treat by Soil Washing	Alternative 5 Remove KRP Wastes for Off-Unit Disposal, Soil Cover over the KBRP, with Institutional Controls
Overall Protection of Human Health and the Environment					
Human Health	Protective	Protective	Protective	Protective	Protective
Environment	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Control of Source Release	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Prevent Exposure of Future Human Receptors to Contaminated Waste/Soil	Effective	Effective	Effective	Effective	Effective
Prevent Exposure of Ecological Receptors to Contaminated Waste/Soil	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Effectiveness in Meeting Remediation Goals	Effective	Effective	Effective	Effective	Effective
Compliance with ARARs					
Chemical-Specific	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Location-Specific	Must comply with erosion and runoff control requirements (SC R72, SC R61-9.122.26)	Must comply with erosion and runoff control requirements (SC R72, SC R61-9.122.26)	Must comply with erosion and runoff control requirements (SC R72, SC R61-9.122.26)	Must comply with erosion and runoff control requirements (SC R72, SC R61-9.122.26)	Must comply with erosion and runoff control requirements (SC R72, SC R61-9.122.26)
Action-Specific	Must comply with requirements for fugitive dust emissions (SC R61-62.6) and closure of long-term construction, demolition, and land-clearing debris landfills (40 CFR 261-268, SC R61-107.11)	Must comply with requirements for fugitive dust emissions (SC R61-62.6) and closure of long-term construction, demolition, and land-clearing debris landfills (40 CFR 261-268, SC R61-107.11)	Must comply with fugitive dust emission requirements, (SC R61-62.6) RCRA, and SCHWMR (40 CFR 261-268 and SC R61-107.11)	Must comply with fugitive dust emission requirements, (SC R61-62.6) RCRA, SCHWMR, and NPDES requirements (40 CFR 261-268, SC R61-107.11, and 40 CFR 122-125 and SC R61-9.122-125)	Must comply with fugitive dust emission requirements, (SC R61-62.6) RCRA, SCHWMR, and closure of long-term construction, demolition, and land-clearing debris landfills (40 CFR 261-268 and SC R61-107.11)
Long-Term Effectiveness and Permanence					
Magnitude of Residual Risks	Risk is eliminated	Risk is eliminated	Risk is eliminated	Risk is eliminated	Risk is eliminated
Adequacy of Controls	Requires long-term O&M	Requires long-term O&M	No controls needed	No controls needed	Requires long-term O&M
Permanence	Permanent, assuming long-term controls	Permanent, assuming long-term controls	Permanent	Permanent	Permanent, assuming long-term controls
Reduction of Toxicity, Mobility, or Volume					
Treatment Process Used and Materials Treated	None	None	None	Soil washing removes contaminants from waste and soil	None

Table 6. Comparative Analysis of Combined Alternatives for Soil at the K-Area Burning/Rubble Pit and K-Area Rubble Pile (continued)

Criterion	Alternative 1 Soil Cover over the KBRP and KRP with Institutional Controls	Alternative 2 Move KRP to KBRP, Soil Cover over the KBRP, with Institutional Controls	Alternative 3 Remove KBRP and KRP Wastes for Off-Unit Disposal	Alternative 4 Excavate KBRP and KRP Wastes, Treat by Soil Washing	Alternative 5 Remove KRP Wastes for Off-Unit Disposal, Soil Cover over the KBRP, with Institutional Controls
Degree of Expected Reduction in Toxicity, Mobility, or Volume	Mobility reduced by containment with a soil cover; toxicity and volume not reduced	Mobility reduced by containment with a soil cover; toxicity and volume not reduced	Mobility reduced with disposal in permitted landfill; toxicity and volume not reduced	Volume and mobility of contaminated material would be reduced by soil washing; toxicity not reduced	Mobility reduced by either containment with soil cover or disposal in permitted landfill; toxicity and volume not reduced
Amount of Hazardous Materials Destroyed or Treated	None	None	None	Contaminants not destroyed, but removed from soil	None
Degree to Which Treatment is Irreversible	No treatment	No treatment	No treatment	Irreversible	No treatment
Types and Quantities of Residuals Remaining after Treatment	No treatment	No treatment	No treatment	Residuals would include wastewater, oversized waste, and washing fines/sludge	No treatment
Short-Term Effectiveness					
Risks to Remedial Workers	Negligible	Negligible	Negligible	Negligible	Negligible
Risks to Community	Negligible	Negligible	Negligible	Negligible	Negligible
Risks to Environment	Negligible	Negligible	Negligible	Negligible	Negligible
Time to Achieve Remedial Action Objectives	Circa 2001	Circa 2001	Circa 2001	Circa 2001	Circa 2001
Implementability					
Availability of Materials, Equipment, Skilled Labor	Readily available	Readily available	Readily available	Readily available	Readily available
Ability to Construct and Operate the Technology	Straightforward	Straightforward	Straightforward	Not straightforward	Straightforward
Ability to Obtain Permits/Approvals from Other Agencies	Readily implemented – five-year remedy review	Readily implemented – five-year remedy review	Readily Implemented	Not readily implemented	Readily implemented – five-year remedy review
Ability to Monitor Effectiveness of Remedy	Easily monitored	Easily monitored	No monitoring required	No monitoring required	Easily monitored
Ease of Undertaking Additional Actions (if necessary)	Not incompatible	Not incompatible	Not incompatible	Not incompatible	Not incompatible
Time to Implement	Six months to construct after approval of remedial design and work plan	Six months to construct after approval of remedial design and work plan	Six months to construct after approval of remedial design and work plan	Six months to construct after approval of remedial design and work plan; six additional months to begin operations	Six months to construct after approval of remedial design and work plan
Cost					
Present Worth Capital Cost	$318,000	$389,000	$1,219,000	$5,401,000	$656,000
Present Worth O&M Cost	$122,000	$122,000	None	None	$122,000
Total Present Worth Cost	$440,000	$512,000	$1,219,000	$5,401,000	$778,000

Table 7. Comparative Cost Analysis of Individual versus Combined Alternative Implementation

	Soil Cover	Consolidate KRP to KBRP with Soil Cover	Removal & Disposal	Soil Washing	Remove KRP; Soil Cover at KBRP
KBRP	$256,000	---	$703,000	$2,766,000	$256,000
KRP	$399,000	---	$583,000	$3,098,000	$583,000
Individual Implementation	**$655,000**	---	**$1,286,000**	**$5,864,000**	**$839,000**
Combined Implementation	**$440,000**	**$512,000**	**$1,219,000**	**$5,401,000**	**$778,000**
	Combined Alternative 1	Combined Alternative 2	Combined Alternative 3	Combined Alternative 4	Combined Alternative 5
	BRP-3 + RP-3	---	BRP-4 + RP-4	BRP-5a+ RP-5a	BRP-3 + RP-4
Cost Savings	**$215,000**	---	**$67,000**	**463,000**	**$61,000**

Note: Cost savings are due to combined implementation of design, mobilization/demobilization, and construction of remedies.

Long-Term Effectiveness and Permanence

All the combined alternatives are permanent solutions with long-term effectiveness. Since Combined Alternatives 1, 2, and 5 involve leaving wastes and contaminated media at the site, long-term maintenance and institutional controls are required to maintain effectiveness in protecting human health and the environment.

Reduction of Toxicity, Mobility, or Volume through Treatment

Combined Alternatives 1, 2, 3, and 5 involve no treatment methods. Although there are no RAOs related to contaminant migration, mobility is reduced by containment with a soil cover, or by removal. Excavation, removal, and disposal Combined Alternatives 3 and 5 reduce the potential mobility of contaminants through disposal in a permitted, waste management facility. Treatment Combined Alternative 4 reduces the potential mobility and volume of contaminants by soil washing.

Short-Term Effectiveness

Containment Combined Alternatives 1, 2, and 5 require grading the rubble piles prior to placement of the soil cover. Removal Combined Alternatives 3 and 5, and treatment Combined Alternative 4 require handling small to medium volumes of soil contaminated with PAHs and arsenic. Therefore, implementation of these combined alternatives requires proper engineering controls and health/safety procedures to protect remedial workers, the community, and the environment. All combined alternatives require land-use controls to ensure short-term protection of human health until the remedy is implemented.

The five combined alternatives achieve RAOs within a period of months after implementation.

Implementability

Soil cover Combined Alternatives 1, 2, and 5, with institutional controls, are relatively easy to implement and monitor. Removal and cover Combined Alternative 5 is easy to implement and the costs are somewhat competitive (i.e., 80% higher) with Combined Alternative 1, placing a soil cover over the KBRP and KRP. Removal Combined Alternative 3 is easy to implement and does not require institutional controls upon completion. Treatment by soil washing, Combined Alternative 4, is the most time consuming, difficult, and costly combined alternative to implement. Remedial activities at the KBRP and KRP would not disrupt ongoing activities at the nearby K-Reactor Area.

Cost

The total present worth costs of combined remedial alternatives addressing soil at the KBRP and KRP are as follows:

Alternative 1 (Soil Cover over the KBRP and KRP with Institutional Controls)	\$440,000
Alternative 2 (Move KRP to KBRP Soil Cover over the KBRP with Institutional Controls)	\$512,000
Alternative 3 (Remove KBRP and KRP Wastes for Off-Unit Disposal)	\$1,219,000
Alternative 4 (Excavate KBRP and KRP Wastes, Treat by Soil Washing)	\$5,401,000
Alternative 5 (Remove KRP Wastes for Off-Unit Disposal, Soil Cover over the KBRP with Institutional Controls)	\$778,000

Groundwater at the K-Area Burning/Rubble Pit and Rubble Pile

A comparative analysis of the four corrective measure/remedial action alternatives being considered for remediating contaminated groundwater at the KBRP/KRP OU is presented in Table 8. The alternatives are evaluated against the NCP-threshold and primary-balancing criteria, similar to the individual analysis of each alternative. The analysis identifies trade-offs between alternatives.

Overall Protection of Human Health and the Environment

The No Action alternative is not protective of human health. The action alternatives (i.e., monitored natural attenuation, in situ treatment, and ex situ treatment) are protective of human health and achieve RAOs.

The monitored natural attenuation alternative (GW-3a) provides protection of human health and the environment by reducing contaminant levels in groundwater through natural treatment processes such as dispersion and potential biodegradation.

Table 8. Comparative Analysis of Alternatives for Groundwater at the K-Area Burning/Rubble Pit and Rubble Pile

Criterion	Alternative GW-1 No Action for Groundwater	Alternative GW-3a Monitored Natural Attenuation	Alternative GW-3b Air Sparging with Passive Soil Vapor Extraction (SVE)	Alternative GW-4a Extraction and Treatment with Liquid-Phase Carbon Adsorption
Overall Protection of Human Health and the Environment				
Human Health	Not protective	Protective	Protective	Protective
Environment	Not applicable	Not applicable	Not applicable	Not applicable
Control of Source Release	Not applicable	Unnecessary (no CMCOCs)	Unnecessary (no CMCOCs)	Unnecessary (no CMCOCs)
Prevent Exposure of Future Human Receptors to Contaminated Groundwater	Not effective	Effective	Effective	Effective
Effectiveness in Meeting Remediation Goals	Not effective	Effective	Effective	Effective
Compliance with ARARs				
Chemical-Specific	Would not meet ARARs (MCLs) (40 CFR 141 and SC R61-58, 68)	Would meet ARARs (MCLs) (40 CFR 141 and SC R61-58, 68)	Would meet ARARs (MCLs) (40 CFR 141 and SC R61-58, 68)	Would meet ARARs (MCLs) (40 CFR 141 and SC R61-58, 68)
Location-Specific	Not applicable	Must comply with erosion and runoff control requirements (SC R72 and SC R61-9.122.26)	Must comply with erosion and runoff control requirements (SC R72 and SC R61-9.122.26)	Must comply with erosion and runoff control requirements (SC R72 and SC R61-9.122.26)
Action-Specific	Not applicable	None	UIC and air emissions requirements (40 CFR 144-147, SC R61-62.5, SC R61-62.6)	NPDES requirements and air emissions (40 CFR 122-125 and SC R61-9.122-125)
Long-Term Effectiveness and Permanence				
Magnitude of Residual Risks	While risks could be reduced, monitoring and controls are not in place to assess risk and prevent exposure	Risk is eliminated	Risk is eliminated	Risk is eliminated
Adequacy of Controls	Not adequate	Adequate	Adequate	Adequate
Permanence	Not permanent	Permanent	Permanent	Permanent
Reduction of Toxicity, Mobility, or Volume				
Treatment Process Used and Materials Treated	None	Natural, intrinsic treatment processes reduce contaminant levels in groundwater, and reduce risk	In situ air sparging with passive SVE, removes chlorinated VOCs from aquifer; the application of methane can be tested for enhanced biodegradation	Ex situ carbon adsorption removes VOCs (i.e., PCE and TCE) from groundwater

Table 8. Comparative Analysis of Alternatives for Groundwater at the K-Area Burning/Rubble Pit and Rubble Pile (continued)

Criterion	Alternative GW-1 No Action for Groundwater	Alternative GW-3a Monitored Natural Attenuation	Alternative GW-3b Air Sparging with Passive Soil Vapor Extraction (SVE)	Alternative GW-4a Extraction and Treatment with Liquid-Phase Carbon Adsorption
Degree of Expected Reduction in Toxicity, Mobility, or Volume	Reduction of toxicity and volume are not assessed without monitoring	The toxicity is reduced, with lower contaminant levels; volume of groundwater contaminated at levels above MCLs is reduced	Toxicity is reduced, with lower contaminant levels; volume of groundwater contaminated at levels above MCLs is reduced	Toxicity is reduced, with lower contaminant levels; volume of groundwater contaminated at levels above MCLs is reduced; mobility of contaminants is reduced by hydraulic control
Amount of Hazardous Materials Destroyed or Treated	None	Remediates approximately 0.9 kg of contaminant in 4.2 million gallons of groundwater	Remediates approximately 0.9 kg of contaminant in 4.2 million gallons of groundwater	Remediates approximately 0.9 kg of contaminant
Degree to Which Treatment is Irreversible	No treatment	Irreversible	Irreversible	Irreversible
Types and Quantities of Residuals Remaining after Treatment	None	None	None	Carbon canisters
Short-Term Effectiveness				
Risks to Remedial Workers	None	Negligible	Negligible	Negligible
Risks to Community	None	Negligible	Negligible	Negligible
Risks to Environment	None	Negligible	Negligible	Negligible
Estimated Time to Achieve Remedial Action Objectives	Does not achieve RAOs	Circa year 2004	Circa 2002/2003	Circa 2002/2003
Implementability				
Availability of Materials, Equipment, Skilled Labor	Not applicable	Readily available	Readily available	Readily available
Ability to Construct and Operate the Technology	Not applicable	Not applicable	Straightforward	Straightforward
Ability to Obtain Permits/Approvals from Other Agencies	Readily implemented – five-year remedy review	Readily implemented – Mixing Zone permit and five-year remedy review	Readily implemented – UIC and air emissions permit	Readily implemented – NPDES discharge permit.
Ability to Monitor Effectiveness of Remedy	Not applicable	Easily monitored	Easily monitored	Easily monitored
Ease of Undertaking Additional Actions (if necessary)	Not incompatible	Not incompatible	Not incompatible	Not incompatible
Time to Implement	No time	Six months after approval of remedial design and work plan	Six months to construct after approval of remedial design and work plan; six additional months to startup	Six months to construct after approval of remedial design and work plan; six additional months to startup
Cost				
Present Worth Capital Cost	None	$202,000	$394,000	$599,000
Present Worth O&M Cost	$52,000	$223,000	$250,000	$271,000
Total Present Worth Cost	$52,000	$425,000	$644,000	$870,000

Contaminant levels are reduced to below regulatory standards (i.e., MCLs) under Alternative GW-3a. Air sparging, with passive SVE (Alternative GW-3b), and extraction, with liquid-phase carbon adsorption (GW-4a), are in situ and ex situ forms of treatment designed to reduce contaminants in groundwater to below MCLs. These treatment forms are protective of human health and the environment. Existing institutional and administrative controls remain in effect to restrict groundwater usage. There are no RAOs associated with contaminant mobility at the site; therefore, control of source material is not a factor when considering preferred groundwater remedial alternatives. In addition, all alternatives, except No Action, require land-use controls to ensure short-term protection of human health until RAOs are achieved.

There are no ecological COCs and, therefore, there is no risk to the environment from groundwater at the KBRP and KRP OU.

Compliance with ARARs

Chemical-Specific ARARs. The No Action alternative takes no steps to treat contaminated groundwater or monitor the progress of ongoing, natural remediation processes. All action alternatives effectively remediate contaminated groundwater and meet the requirements of ARARs (i.e., MCLs; 40 CFR 141 and SC R61-58, 68).

Location-Specific ARARs. Location-specific ARARs are not applicable to the No Action alternative. The action alternatives are implemented in a manner that prevents erosion and runoff (SC R72 and SC R61-9.122.26).

Action-Specific ARARs. There are no action-specific ARARs associated with the No Action and monitored natural attenuation alternatives. Action-specific ARARs applicable to other alternatives include RCRA waste management requirements (40 CFR 261-268), NPDES discharge requirements (40 CFR 122-125 and SC R61-9.122-125), and South Carolina Underground Injection Control and air emissions regulations (40 CFR 144-147, SC R61-62.5, and SC R61-62.6). The monitored natural attenuation alternative generates no waste.

Long-Term Effectiveness and Permanence

The No Action alternative provides no long-term protection of human health. The action alternatives are permanent remedies that provide long-term effectiveness.

Reduction of Toxicity, Mobility, or Volume through Treatment

The No Action alternative does not reduce the toxicity, mobility, or volume of contaminants or contaminated media. The toxicity and volume of contaminants above MCLs are reduced by the other groundwater treatment alternatives. Alternative GW-4a reduces the mobility of groundwater by imparting some hydraulic control. Toxicity also is reduced with lower contaminant concentrations.

Short-Term Effectiveness

The No Action alternative poses no short-term risk to the community, remedial workers, or the environment. Implementing the action alternatives involves no substantial short-term risks to the remedial worker and the environment.

The No Action alternative does not achieve RAOs, while the action alternatives achieve RAOs within a period of years after implementation.

Implementability

The No Action alternative requires no effort to implement. Of the three action alternatives, monitored natural attenuation (GW-3a) is the easiest to implement and least costly, but takes the longest time, about six years, to achieve RAOs. The other two treatment alternatives require more effort to implement, are more costly, and RAOs are achieved only one or two years earlier than with monitored natural attenuation. All alternatives are easy to implement and are ready to operate within a period of months after final approval. For the monitored natural attenuation alternative, the natural, intrinsic, remedial processes proceed, even before compliance monitoring is fully implemented. Remedial equipment required for the treatment alternatives is readily available through local or regional vendors. Remedial activities at the KBRP/KRP OU would not disrupt ongoing activities in the vicinity of the K-Reactor Area.

Cost

The total present worth costs of remedial alternatives addressing groundwater at the KBRP/KRP OU are as follows:

Alternative GW-1: (No Action for Groundwater)	$52,000

Alternative GW-3a:	(Monitored Natural Attenuation)	$425,000
Alternative GW-3b:	(Air Sparging with Passive Soil-Vapor Extraction)	$644,000
Alternative GW-4a:	(Extraction and Treatment with Liquid-Phase Carbon Adsorption)	$870,000

The costs for the groundwater remedial alternatives range from a low of $52,000 for No Action to $870,000. Monitored natural attenuation is the most cost-effective, action alternative with a cost of $425,000. The other two action alternatives have costs of $644,000 and $870,000, respectively. Although other action alternatives have shorter remedial periods, O&M costs are higher than monitored natural attenuation and capital costs are substantial, leading to a much higher overall remedial cost.

The estimated, remedial effectiveness of the monitored natural attenuation alternative is derived from the groundwater model. It is predicted that remediation would be completed in the year 2004. If a more aggressive remedial approach were selected, implementation would occur during the year 2001, assuming a ROD approval in the year 1999. RAOs likely are achieved within a two-year period, but less than two years earlier than with monitored natural attenuation alone.

State and Community Acceptance

The State and community is requested to comment on the RFI/RI Report, the BRA, the CMS/FS, and the SB/PP. The concurrence or opposition to the preferred alternative is considered. This criterion will be achieved through approval of this ROD. The Responsiveness Summary is discussed in Section XIV.

After the ROD is approved, a Corrective Measures Implementation/Remedial Action Implementation Plan is prepared, reviewed by regulators, and approved. This process will take approximately nine months, beginning on or before October 2000 and ending on or before August 2001. Once approved, remedial construction activities will begin and proceed for approximately seven months, until March 2002. A Post Construction Report/Final Remediation Plan will be developed, with final regulator approval scheduled for October 2002.

XI. THE SELECTED REMEDIES

Based on the risks identified in Section VII, the KBRP/KRP OU poses risks to human health. Based on risk evaluations, remedial actions are appropriate for these waste units and impacted media that are associated with this OU.

An evaluation of potential alternatives was performed in accordance with the NCP as summarized in Section X. Based on this evaluation, the selected alternatives for remediating the various waste units and media are as follows:

K-Area Burning/Rubble Pit and K-Area Rubble Pile	Soil Cover over the KBRP and KRP with Institutional Controls
K-Area Water Table Aquifer	Monitored Natural Attenuation

The decision factors that led to the soil and groundwater remedy selections follow. The selected remedies are protective of both human health and the environment, are effective in meeting RAOs, and are permanent solutions. The selected remedies will comply with ARARs and will not pose short-term risks to remedial workers, the community, or the environment. The selected remedies are easily implemented with relatively low cost. In addition, the remedies meet State and Federal regulatory and community acceptance.

The selected remedies were chosen over other alternatives since they represent the solutions that best satisfy the nine criteria specified by US EPA to be considered in remedy selection. A conceptual sketch of the selected remedies is shown in Figure 17. Remedies can change as a result of the remedial design or construction processes. Changes will be documented in the Administrative Record File utilizing a memo, an explanation of significant difference or in a ROD amendment.

KBRP/KRP Soil

The KBRP and KRP are waste management units located immediately adjacent to each other. The units were used to manage similar wastes and have common COCs and RAOs. Remediation of these two subunits is most efficient when they are approached together with combined design, construction and O&M efforts. Therefore, this site will approach cleanup of the KBRP and KRP using a combined design and construction strategy. The life-cycle cost for a soil cover remedy is a combination of both capital and

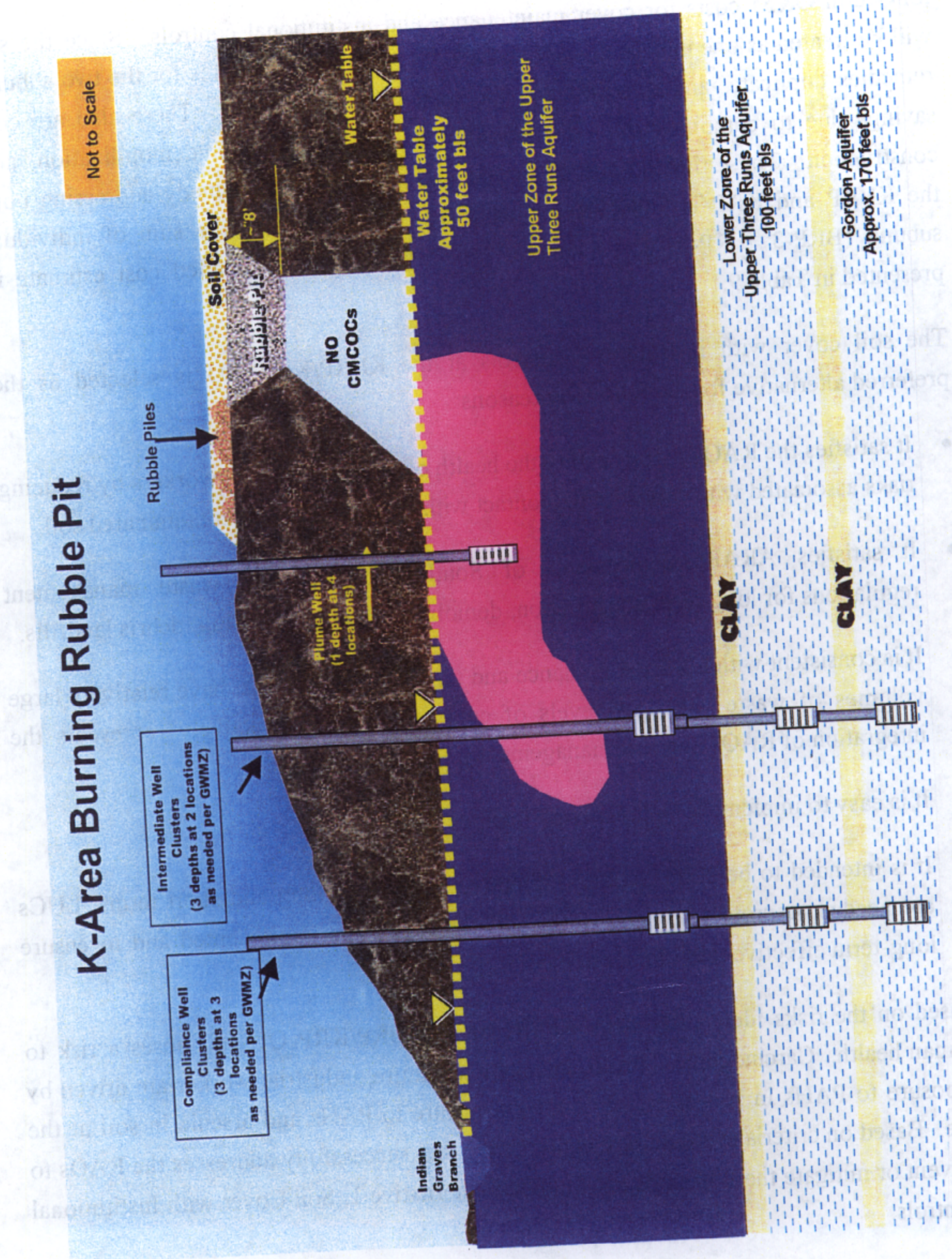

Figure 17. Conceptual Sketch of the Soil and Groundwater Selected Remedies

long-term O&M costs for cover maintenance and institutional controls. Since the site will be treated as one unit for long-term care, separate cost estimates for the two subunit remedies duplicate, and overestimate, the total OU O&M costs. There also are cost savings due to combined implementation of design, mobilization/demobilization, and construction. The estimated cost of implementing a soil cover remedy addressing both the KBRP and KRP is $440,000. This is $215,000 less than the sum of individual subunit (BRP-3 + RP-3) cost estimates (see Section X). A detailed cost estimate is presented in Table 9.

The soil cover with institutional controls at the KBRP/KRP OU is selected as the preferred alternative for the following reasons:

- It satisfies the RAOs by protecting the health of future, industrial workers by reducing risks associated with exposure to, contact with, and ingestion of contaminated soil.

- It satisfies ARAR requirements of South Carolina solid waste management regulations for long-term construction, demolition and land-clearing, debris landfills.

- It is consistent with US EPA guidance and the NCP for sites that have relatively large volumes of waste with low levels of contamination; it effectively represents the integration of RAOs and risk management principles.

- It is easy to implement and relatively inexpensive.

- It is intended to be permanent and effective in both the long and short terms; LUCs are needed to protect human health until the remedy is implemented and to ensure long-term effectiveness of the remedy.

Based on the risks identified in the RFI/RI/BRA, KBRP/KRP OU soil poses a risk to human health. Carcinogenic risks to the potential, future, industrial worker are driven by exposure to PAHs in soil at the pit and by exposure to PAHs and arsenic in soil at the pile. Based on criteria evaluation, the alternative that successfully addresses the RAOs to prevent or mitigate these hazards is Combined Alternative 1, Soil Cover with Institutional Controls.

Table 9. Cost of Combined Alternative 1: Soil Cover over the KBRP and KRP with Institutional Controls

Item	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
Construction of Soil Cover				
Soil Erosion & Sediment Control Plan	1	ea	$15,000	$15,000
Clearing of Brush & Small Trees (Pit & Pile)	2.2	acre	$2,300	$5,076
Site Grading	2.2	acre	$600	$1,324
Soil Cover, Pit & Pile (Min 1-ft Thickness, Vegetated)	1.8	acre	$67,291	$123,745
Institutional Controls				
Deed Restrictions	1	ea	$5,000	$5,000
Access Controls (Signs)	6	ea	$48	$289
Subtotal - Direct Capital Cost				$150,433 *
Mobilization/Demobilization	2% of subtotal direct capital			$3,009 *
Site Preparation	2% of subtotal direct capital			$3,009 *
Total Direct Capital Cost	(sum of * items)			$156,451
Indirect Capital Costs				
Engineering & Design	25% of direct capital			$39,113
Project/Construction Management	25% of direct capital			$39,113
Health & Safety	8% of direct capital			$12,516
Overhead & Profit	30% of direct capital			$46,935
Contingency	15% of direct capital			$23,468
Total Indirect Capital Cost				$161,144
Total Estimated Capital Cost				$317,595
Direct O&M Costs				
Annual Costs	30 year O&M period			
Access Controls	1	ea	$500	$500
Cover Repair	1	ea	$2,400	$2,400
Subtotal - Annual Costs				$2,900
ªPresent Worth Annual Costs				$44,580
Five Year Costs				
Remedy Review	1	ea	$13,312	$13,312
Subtotal - Five Year O&M Costs				$13,312
ªPresent Worth Five Year Costs				$37,034
Total Present Worth Direct O&M Cost				$81,614
Indirect O&M Costs				
Project/Admin Management	10% of direct O&M			$8,161
Health & Safety	10% of direct O&M			$8,161
Overhead & Profit	30% of direct O&M			$24,484
Total Present Worth Indirect O&M Cost				$40,807
Total Estimated Present Worth O&M Cost				$122,422
TOTAL ESTIMATED PRESENT WORTH COST				$440,016

ª 5% discount rate

Prior to placement of a soil cover over the KBRP/KRP OU, trees and brush will be cleared and graded where needed. Engineered efforts will be utilized to minimize the footprint (total acreage) of the soil cover. Isolated rubble piles, where sampling and analysis indicated no contamination above remedial goals, will be used as fill material. The resultant surface area will be verified as clean by confirmatory sampling, graded, and vegetated. Engineered controls, procedures, and verification sampling will be employed to ensure protection of workers, prevent erosion, limit sediment runoff, and control fugitive dust generation. Once the soil cover is in place, the area will be vegetated and erosion control measures installed to divert water. The institutional control boundary will be defined based on the final soil cover configuration. Details will be provided in the post-ROD documentation.

The KBRP is located in an area recommended for industrial use by the SRS CAB. The *Savannah River Site Future Use Report Stakeholder Recommendations for SRS Land and Facilities* (US DOE 1996) includes the recommendation that "residential uses of SRS land should be prohibited", and the *Federal Facility Agreement Implementation Plan* (WSRC 1996) designated the KBRP as an industrial zone. The planned, future use of the KBRP and KRP by US DOE is continued industrial usage. In addition, existing SRS institutional controls prevent exposure to the future, industrial worker by limiting activities in the vicinity of the KBRP. In the event the property ever were transferred to nonfederal ownership, land-use restrictions and deed notifications will be filed.

KBRP/KRP OU Groundwater

Monitored natural attenuation is selected as the preferred alternative for the following reasons:

- It satisfies the RAOs since the health of future, industrial workers is protected by reducing risks associated with exposure to, contact with, and ingestion of contaminated groundwater.
- It satisfies the RAOs by preventing further degradation of groundwater and meets ARARs (i.e., MCLs) to allow beneficial uses of groundwater.
- It reduces the toxicity of groundwater with lower contaminant levels, and the volume of groundwater exceeding MCLs is reduced.

- It is easy to implement and relatively inexpensive, with comparable results.

- It is a permanent and effective remedy.

Monitored natural attenuation is implemented by establishing a groundwater "mixing zone" in accordance with South Carolina guidance (SCDHEC 1997). The KBRP/KRP OU groundwater plume meets all guidance criteria. The use of monitored natural attenuation as a remedy at the KBRP/KRP OU is consistent with US EPA policy in all respects, including the following:

- The efficacy of monitored natural attenuation is demonstrated by a groundwater flow and contaminant transport model that indicates a clear trend of decreasing VOC concentrations within the groundwater plume (Geotrans 1998).

- The former source of VOC release to groundwater (KBRP) is depleted. This conclusion is supported by groundwater monitoring and sampling within the KBRP. In recent years, the groundwater concentrations at the source have fallen to MCL levels. Contaminant fate and transport modeling, with data from sampling of source materials, identified no CMCOCs.

- The KBRP/KRP OU groundwater plume is an old plume that likely has existed for more than 40 years and is shrinking in size. The rate of groundwater movement is slow, approximately 1.2×10^{-6} m per second (123 ft per year). This low-flow velocity, together with natural attenuation processes, results in a plume that is essentially stationary, with no substantial movement in a downgradient direction.

- Natural attenuation processes will result in reduced VOC concentrations to levels less than MCLs within a reasonable time, estimated to be year 2004. This remedial period compares very favorably with more aggressive remedial approaches. An aggressive remedial system, such as air sparging/ nutrient injection with passive SVE, could not be implemented prior to August 2001, assuming a ROD approval in the year 1999. Air Sparging with passive SVE would achieve RAOs only one to two years earlier than monitored natural attenuation.

- The natural attenuation processes are not creating degradation products more toxic than PCE or TCE at levels that exceed MCLs.

- The groundwater modeling indicates that there is downward movement of groundwater, but MCLs will not be exceeded in deeper groundwater. Sampling and analysis data showing no contamination of deeper groundwater units confirms this modeling prediction.

- The shallow contaminated groundwater unit currently is not used. Because of land usage and low yield, it has little or no potential of being an underground source of drinking water. There is no current or projected demand for usage of the shallow groundwater. There is no planned change in nearby groundwater usage that would accelerate lateral or vertical movement of groundwater and contaminants.

- The KBRP/KRP OU groundwater plume is located a substantial distance from points of discharge to surface water (i.e., Indian Grave Branch). There is no possibility of VOC discharge to surface water. There also is no possibility of significant VOC release to air or manmade structures.

Monitored natural attenuation is implemented by establishing a groundwater "mixing zone", in accordance with South Carolina guidance (SCDHEC 1997). The South Carolina criteria for establishing a mixing zone are as follows:

1. Reasonable measures have been taken and/or binding commitments are made to minimize the addition of contaminants to groundwater and/or control groundwater contaminant migration.

2. The groundwater in question is confined to a shallow, geologic unit with little or no potential of being an Underground Source of Drinking Water (It discharges or will discharge to surface waters without contravening the surface water standards set forth in SC R.61-68).

3. The contaminant(s) in question occurs on the property of the applicant, and there is minimum possibility for groundwater withdrawals, present or future, to create drawdown such that contaminants would flow offsite.

4. The contaminants or combination of contaminants in question are not dangerously toxic, mobile, or persistent.

Monitored natural attenuation is most applicable to those situations where the source no longer is present, the groundwater plume is shrinking in size, and concentrations are relatively low. These situations are typical of either old plumes or plumes where more aggressive remediation (i.e., pump and treat) has reduced contaminant levels in groundwater to low levels. In these situations, aggressive remediation often is not efficient, with continued contaminant reduction sometimes due as much to natural intrinsic processes as to the remedial actions. The KBRP/KRP OU groundwater plume is of this nature, having no active source, being old in age, low in concentration, and shrinking in size with very little downgradient movement.

Monitored natural attenuation also is appropriate since the lateral migration of the plume at the KBRP appears to be hindered by a facies change (clayey strata) that occurs downgradient. Due to these types of characteristics, aggressive remedial approaches offer little advantage in accelerating the remediation. The earliest an aggressive alternative can be implemented is within two years of ROD approval, including post-ROD document approval and construction. Groundwater modeling predicts that PCE and TCE concentrations will be less than 10 μg/L, and near the MCLs (5 μg/L) by the time an aggressive remedial alternative can be implemented. Aggressive remediation will speed achievement of RAOs by approximately one to two years. The additional cost for aggressive remediation and resulting acceleration of RAO achievement is $219,000 or more.

One of the most difficult factors to estimate precisely in groundwater remediation is the time necessary to achieve RAOs. Since annual O&M costs of more aggressive groundwater remediation projects are substantial, an error of even one or two years in the estimated remedial time significantly influences total remedial cost. The sensitivity of total remedial cost to the length of the remediation time period was evaluated for each alternative by estimating the incremental cost associated with one additional year of operation. This analysis shows that monitored natural attenuation is the alternative that is least sensitive to an increase in the remedial time, with an added present value cost of only $41,000/year, a 10% increase. An increase of one year in operation of the other alternative remedial systems increases total remedial costs to $212,000, a 33% increase; and to $232,000, a 27% increase, respectively. Therefore, the monitored natural attenuation alternative has much less cost risk than the more aggressive remedial alternatives.

The benefit derived from KBRP/KRP OU groundwater remediation is returning groundwater, within a reasonable time, to a quality sufficient for beneficial use. All of the remedial alternatives are equally effective in providing this benefit. The monitored natural attenuation alternative achieves RAOs by 2004; while the more aggressive alternatives require approximately four years, two years to implement and two years of active remediation. All of these remedial periods are reasonable.

Monitored natural attenuation is the most cost-effective groundwater remedial alternative, with a cost of $425,000. The estimated volumes for the monitored natural attenuation alternative are derived from the groundwater model, and it is predicted that remediation will be complete in the year 2004. By this time, RAOs will be achieved by returning groundwater to below MCLs to allow beneficial uses. Groundwater contaminant levels will be reduced to below MCLs prior to discharge into any surface water bodies in the study area.

The KBRP/KRP OU is located within a federally owned facility with no current plans to transfer property ownership. The water table aquifer at the KBRP/KRP OU is not used. Costs associated with monitored natural attenuation include labor and materials to model the groundwater, installation of new compliance monitoring wells, conducting required groundwater sampling (quarterly for the first year then semiannually), and maintaining administrative controls. Costs are estimated for a four-year O&M period and include data evaluation and reporting, and five-year remedy reviews. Total estimated present worth cost of monitored natural attenuation is $425,000 (capital cost: $202,000; O&M cost: $223,000). See detailed cost estimate in Table 10.

If the attenuation does not progress as expected, an active contingency measure has been considered by US DOE and regulatory authorities. Evidence of unsatisfactory attenuation progress will include longer than expected or unreasonable remedial times, exceeded intermediate concentration levels, or exceeded MCLs at compliance points. Presently, Alternative GW-3b, Air Sparging with Passive SVE, is approved for employment as the contingency measure if natural attenuation does not progress as modeled. However, in the future, the contingency alternative can change. A plan for corrective action will be completed within 90 days after a trigger level has been confirmed.

Table 10. Cost of Alternative GW-3a: Monitored Natural Attenuation

Item	Quantity	Units	Unit Cost	Total Cost	
Direct Capital Costs					
Construct Mixing Zone Monitoring System					
Install Monitoring Wells	11	ea	$9,818	$108,000	
Subtotal - Direct Capital Cost				$108,000	*
Mobilization/Demobilization	2% of subtotal direct capital			$2,160	*
Site Preparation	5% of subtotal direct capital			$5,400	*
Total Direct Capital Cost	(sum of * items)			**$115,560**	
Indirect Capital Costs					
Engineering & Design	0% of direct capital			$0	
Project/Construction Management	25% of direct capital			$28,890	
Health & Safety	5% of direct capital			$5,778	
Overhead & Profit	30% of direct capital			$34,668	
Contingency	15% of direct capital			$17,334	
Total Indirect Capital Cost				**$86,670**	
Total Estimated Capital Cost				**$202,230**	
Direct O&M Costs					
Annual Costs	4 year O&M period				
Access Controls	1	ea	$500	$500	
Monitoring System Maintenance	18	well	$800	$14,400	
*Groundwater Monitoring (quarterly; 1st year)	1	ea	$33,800	$33,800	
*Groundwater Monitoring (semiannual; 2nd yr & there	1	ea	$16,900	$16,900	
Mixing Zone Performance Analysis Report	1	ea	$5,000	$5,000	
Subtotal - Annual Costs (1st year)				$53,701	
Subtotal - Annual Costs (2nd year and thereafter)				$36,801	
[a]Present Worth Annual Costs				$146,590	
Five Year Costs					
Remedy Review	1	ea	$13,312	$13,312	
Subtotal - Five Year O&M Costs				$13,312	
[a]Present Worth Five Year Costs				$10,430	
Total Present Worth Direct O&M Cost				**$157,020**	
Indirect O&M Costs					
Project/Admin Management	10% of direct O&M			$15,702	
Health & Safety	2% of direct O&M			$3,140	
Overhead & Profit	30% of direct O&M			$47,106	
Total Present Worth Indirect O&M Cost				**$65,948**	
Total Estimated Present Worth O&M Cost				**$222,968**	
TOTAL ESTIMATED PRESENT WORTH COST				**$425,198**	

*Note: The groundwater monitoring will consist of sampling of up to nine compliance point wells (three wells in each of three clusters), plus two intermediate clusters of three wells (maximum), plus four existing plume monitoring wells. The sampling and analysis will be quarterly the first year and semiannual thereafter, with analysis for the modified TCL VOCs found in the mixing zone application.
This alternative would generate no waste.

[a] 5% discount rate

Any changes to the approved remedy (other than Alternative GW-3b) will be documented in the Administrative Record File by utilizing a memo, an explanation of significant difference, or ROD amendment, depending upon the magnitude of the change. Details of the contingency plan are provided as an attachment to the Groundwater Mixing Zone Application for the K-Area Burning/Rubble Pit and Rubble Pile (WSRC 1998a).

Performance monitoring is a fundamental component of natural attenuation. The purpose of the monitoring program is to show that natural attenuation continues at historical rates and in accordance with the groundwater model. According to modeling, the plume continues to shrink with little downgradient movement and no impact to downgradient receptors. Modeling validation and compliance will be demonstrated by sampling and analyzing groundwater from the compliance, intermediate, and plume monitoring wells shown in Figure 18. For this alternative, groundwater monitoring locations and parameters, such as compounds and sampling frequency, are established in the groundwater mixing zone (GWMZ).

The GWMZ established a long-term groundwater monitoring program to ensure maximum Mixing Zone Concentration Limits (MZCL) are not exceeded. The GWMZ predicts that any exceedance of these maximum MZCLs will lead to an exceedance in MCLs at the compliance boundary. The screened zone, purpose, sampling analyte list, frequency, and predicted compliance level (i.e., MZCL) for each GWMZ monitoring well are listed in Tables 11 and 12.

The placement of the proposed compliance well clusters was chosen at the terminus of the projected maximum extent of the groundwater contaminant plume, as determined by the groundwater model. The proposed compliance wells are located at the plume's projected downgradient boundary. Soil cutting, decontamination fluids, development water, and purge water will be managed and dispositioned in accordance with the approved Investigation-Derived Waste Management Plan (WSRC 1994). Any decontamination fluids or purge water found to exceed these values will be sent to either the M-1 Air Stripper, the Effluent Treatment Facility, or the TNX Facility at the SRS, depending on the constituents found in the fluids. Both the Effluent Treatment Facility and the M-1 Air Stripper facilities are CERCLA Offsite Rule approved. The TNX Facility will be an alternate pending CERCLA Offsite Rule approval.

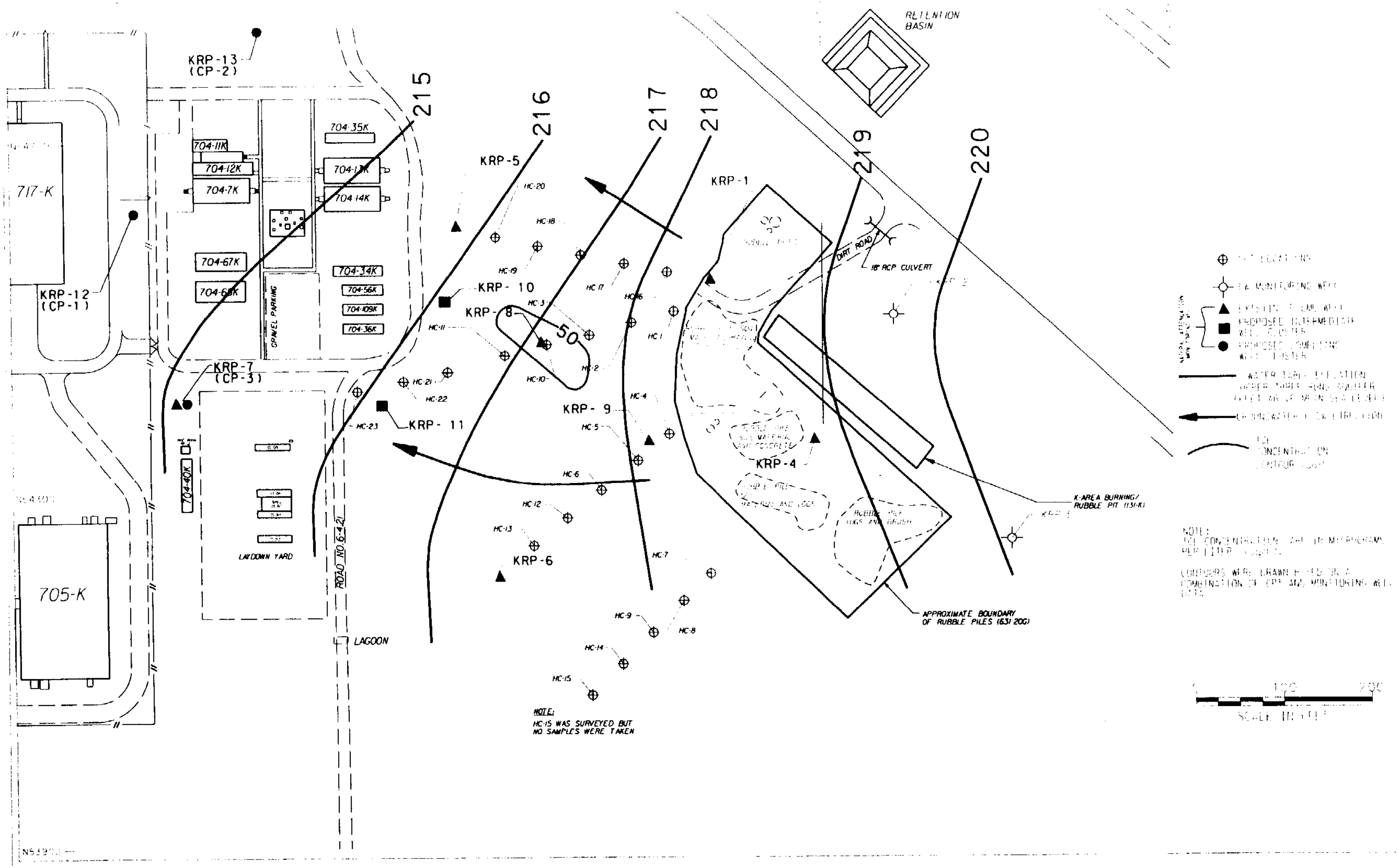

Figure 18. Compliance, Intermediate and Plume Well Cluster Location Map

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Table 11. Sampling Schedule and Compliance Criteria Levels

Well Identification (screen zone)[2]	Site Well Identification	Constituents to be Analyzed[1]	Compliance Trigger Levels	Sampling Frequency	Reporting Frequency
Plume Wells KRP-4, -5, -6, & -8. (Existing water table wells)	KRP-4, -5, -6, & -8,	TCL VOCs	MZCL (43-μg/L for PCE and 61-μg/L for TCE)	Quarterly (first year) then Semiannually	Annually
Intermediate Wells KRP-10 & -11	KRP-10 & -11	TCL VOCs	MZCL (43 -μg/L for PCE and 61 μg/L for TCE)	Quarterly (first year) then Semiannually	Annually
Intermediate Well-10 & -11 (Lower zone of Upper Three Runs Aquifer)	KRP-10B & -11B	TCL VOCs	MZCL [Note 1] (5.0 -μg/L for PCE and 5.0 -μg/L for TCE)	Quarterly (first year) then Semiannually	Annually
Intermediate Well –10 & -11 (Gordon Aquifer)	KRP-10A & -11A	TCL VOCs	MZCL (5.0 μg/L for PCE and 5.0 -μg/L for TCE)	Quarterly (first year) then Semiannually	Annually
Compliance Well Clusters CP3, CP1, & CP2 (Water table, Lower zone of Upper Three Runs Aquifer, and Gordon Aquifer)	KRP-7, -12, -13 KRP-7B, -12B, & -13B KRP-7A, -12A & -13A	TCL VOCs	MCL (5-μg/L for PCE and TCE)	Annually	Annually

Notes: 1. See Table 12 for details.
2. Well screens are 10 ft

Table 12. Sample Analyses/Target Compound List of Volatile Organic Compounds

TARGET COMPOUND LIST: VOLATILES (Modified)	
	Method
Acetone	8260
Benzene	8260
Bromodichloromethane	8260
Bromoform	8260
Bromomethane (Methyl bromide)	8260
2-Butanone (MEK)	8260
Carbon disulfide	8260
Carbon tetrachloride	8260
Chlorobenzene	8260
Chlorodibromomethane	8260
Chloroethane	8260
Chloroform	8260
Chloromethane (Methyl chloride)	8260
1,1-Dichloroethane	8260
1,2-Dichloroethane	8260
1,1-Dichloroethene	8260
1,2-Dichloroethene (total)	8260
*cis- 1,2-Dichloromethane	8260
*trans-1,2-Dichloromethane	8260
1,2-Dichloropropane	8260
cis-1,3-Dichloropropene	8260
trans-1,3-Dichloropropene	8260
*1,4-Dioxane	8260
Ethyl benzene	8260
2-Hexanone	8260
4-Methyl-2-pentanone	8260
Stryene	8260
1,1,2,2-Tetrachloroethane	8260
Tetrachloroethene (PCE)	8260
Toluene	8260
1,1,1-Trichloroethane	8260
*1,1,2-Trichloro-1,2,2 trifluoroethane (Freon 113)	8260
1,1,2-Trichloroethane	8260
Trichloroethene (TCE)	8260
*1,2,3-Trimethylbenzene	8260
*1,2,4-Trimethylbenzene	8260
*1,3,5-Trimethylbenzene	8260
Vinyl acetate	8260
Vinyl chloride	8260
Xylenes (total)	8260

* These compounds have been added to the standard TCL VOC list.

Estimated Outcomes of Selected Remedies

The selected soil remedy will leave the waste in place with negligible hazards. The KBRP/KRP OU is anticipated to be industrial land use for the future land-use scenario, as recommended by the SRS CAB and US DOE (US DOE 1996). Although the remediation decisions for this unit were based on the industrial-use scenario, the groundwater remedy will achieve the more protective, residential-use scenario. Based on the selected remedy, LUCs will be required. Groundwater remediation will be complete in 2004. By this time, RAOs will be achieved by returning groundwater to below MCLs to allow beneficial uses. The LUCIP will detail how SRS will implement, maintain, and monitor the LUC elements of the KBRP/KRP OU selected remedies to ensure that the remedies remain protective of human health and the environment. In the long term, if the property ever is transferred to nonfederal ownership, the U.S. Government will take those actions necessary pursuant to Section 120(h) of CERCLA (i.e., deed notification disclosing former waste management, disposal activities).

XII. STATUTORY DETERMINATIONS

Based on the KBRP/KRP RFI/RI/BRA (WSRC 1998b), the KBRP/KRP OU does pose risk to human health. Therefore, for industrial land use, a determination has been made that a soil cover over the KBRP and KRP and monitored natural attenuation within the water table aquifer protect human health for the KBRP/KRP OU waste units and associated environmental media.

The selected soil remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. Even though the soil remedy does not satisfy the statutory preference for treatment, it is the only practicable remedy because there is no discernible contaminant source, there is no principal threat source material, and the waste represents only a low level threat.

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

Because these remedies will result in hazardous substances remaining onsite above levels that allow for unlimited use and unrestricted exposure, a review will be conducted within five years after initiation of remedial actions to ensure that the remedies continue to provide adequate protection of human health and the environment.

Institutional controls will be an integral part of the selected remedies mentioned above. Institutional controls implemented at the site will consist of future land-use restrictions and access controls such as signs. Per the US EPA-Region IV LUC Policy, a LUCAP for SRS has been developed and submitted to the regulators for their approval. In addition, a LUCIP for the KBRP/KRP OU will be developed and submitted to the regulators for their approval with the post-ROD documentation. The LUCIP will detail how SRS will implement, maintain, and monitor the LUC elements of the KBRP/KRP OU preferred alternative to ensure that the remedies remain protective of human health and the environment.

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 deed notification shall, in perpetuity, notify any potential purchaser that the property has been used for the management and disposal of waste. These requirements also are 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 and groundwater use of the property. However, the need for these deed restrictions may be re-evaluated 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 re-evaluation of the need for deed restrictions will be done through an amended ROD with US EPA and SCDHEC review and approval.

In addition, if the site is ever transferred to nonfederal ownership, a survey plat of the area will be prepared, certified by a professional land surveyor, and recorded with the appropriate county recording agency. If the KBRP/KRP is transferred to nonfederal ownership prior to remediation of the groundwater to the MCLs and the reduction of soil risks to acceptable levels for the COCs, reevaluation of the need for deed restrictions will be performed through an amended ROD, with US EPA and SCDHEC approval. The survey plat will be reviewed and updated, as necessary, at the time the site is transferred, and will be recorded with the appropriate county recording agency.

XIII. EXPLANATION OF SIGNIFICANT CHANGES

The SB/PP and the draft RCRA permit modification provide for involvement with the community through a document review process and a public comment period. Comments received during the 45-day public comment period (i.e., February 18, 2000, through April 2, 2000) are addressed in Appendix A of this ROD, and are available with the final RCRA permit.

XIV. RESPONSIVENESS SUMMARY

No comments were received during the public comment period. The Proposed Plan also was presented in an open public meeting to the SRS CAB Environmental Remediation Committee on March 7, 2000. The Responsiveness Summary is provided as Appendix A of this document.

XV. POST-ROD DOCUMENTS SCHEDULE AND DESCRIPTION

The post-ROD document and implementation schedule is summarized below and illustrated in Figure 19.

The Corrective Measures Implementation/Remedial Action Implementation Plan Work Plan for the KBRP/KRP OU will be submitted to the regulators for review and approval. This document includes the following:

- general description of unit;
- remedial action schedule;
- discussion of design activities, design criteria, and permitting requirements;
- design drawings and a discussion of the permit and construction specifications;

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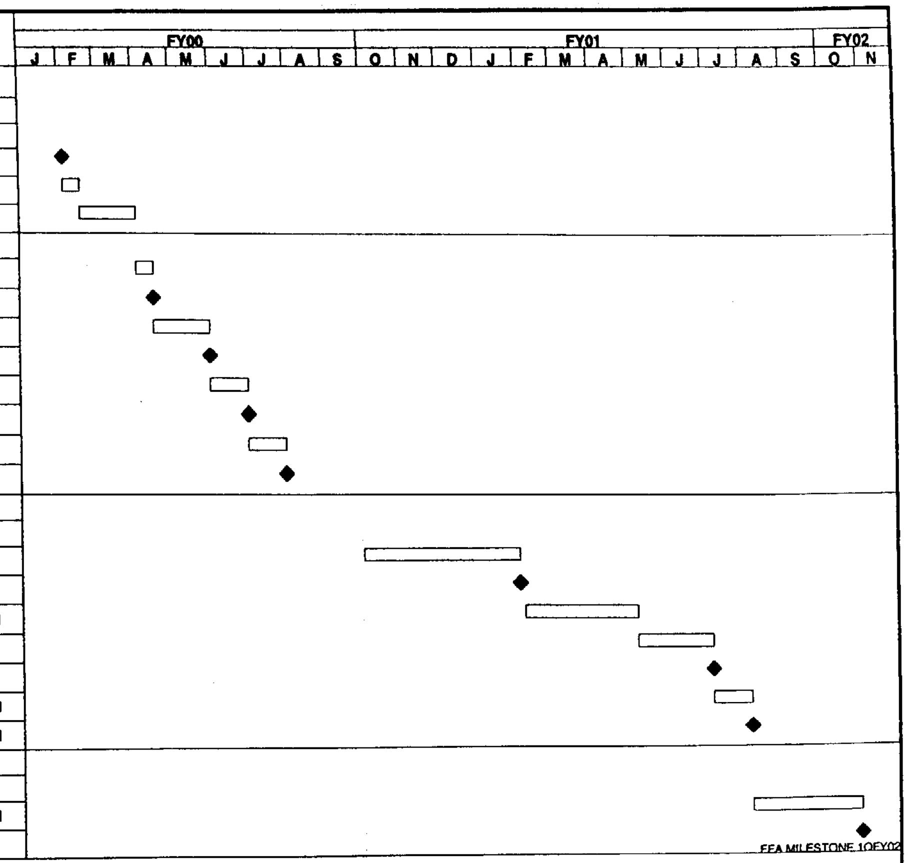
Activity Description	Orig Dur	Early Start	Early Finish
CA 1219 K-AREA B/R/P (131-K)			
LCS 14 - STATEMENT OF BASIS/PROPOSED PLAN & ROD			
RECEIPT OF EPA/SCDHEC APPROVAL REV. 1.2 SB/PP	0		04FEB00
NOTIFICATION OF PUBLIC COMMENT PERIOD	14	05FEB00	18FEB00
PUBLIC COMMENT PERIOD	45	19FEB00	03APR00
RESPONSIVENESS SUMMARY & APPROVAL	14	04APR00	17APR00
Submit Rev. 0 ROD	0		17APR00
EPA/SCDHEC REVIEW REV. 0 ROD	45	18APR00	01JUN00
EPA/SCDHEC RETURNS COMMENTS ROD	0		01JUN00
INCORPORATE COMMENTS FROM REV 1 ROD	30	02JUN00	01JUL00
SRS SUBMITTAL OF REV. 1 ROD	0		01JUL00
EPA/SCDHEC FINAL REVIEW & APPROVAL REV. 1 ROD	30	02JUL00	31JUL00
SUBMIT FINAL SIGNED ROD	0		31JUL00
LCS 15 - DETAILED ENG & PRECONST ACTIVITIES			
DEVELOP CMI/RAIP WORKPLAN	85	02OCT00	02FEB01
SRS SUBMITTAL OF REV.0 CMI/RAIP WORKPLAN	0		02FEB01
EPA/SCDHEC REVIEW REV.0 CMI/RAIP	90	06FEB01	06MAY01
SRS INCORPORATE EPA/SCDHEC COMMENTS REV1	60	07MAY01	05JUL01
SRS SUBMITTAL OF REV. 1 CMI/RAIP WORKPLAN	0		05JUL01
EPA/SCHDEC FINAL REVIEW & APP REV1 CMI/RAIP	30	06JUL01	04AUG01
EPA/SCHDEC FINAL APPROVAL	0		04AUG01
LCS 16 - CONSTRUCTION			
MOBILIZATION	61	06AUG01	30OCT01
REMEDIAL ACTION (RA) START DATE	0	31OCT01	



Early Bar
Progress Bar
Critical Activity

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Sheet 1 of 1

Environmental Restoration
CA 1219 K-AREA BURNING/RUBBLE PIT
POST-ROD IMPLEMENTATION SCHEDULE

Date	Revision	Checked	Approved
	REV. 0		

Figure 19. Post-ROD Document and Implementation Schedule

- remedial design change control and US EPA/SCDHEC review of remedial design changes;
- waste management;
- a discussion of Quality Assurance, the Health and Safety Plan, and Emergency Plan Implementation Strategy;
- requirements for project closeout; and a
- LUCIP.

After the ROD is approved a Corrective Measures Implementation/Remedial Action Implementation Plan is prepared, reviewed by regulators, and approved. This process will take approximately nine months, beginning on or before October 2000 and ending on or before August 2001. Once approved, remedial construction activities will begin and proceed for approximately seven months, until March 2002. A Post Construction Report/Final Remediation Plan will be developed, with final regulator approval scheduled for October 2002.

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XVI. REFERENCES

GeoTrans, HSI 1998. *Groundwater Flow and Solute Transport Modeling Report for the K-area Burning/Rubble Pit and Rubble Pile*, HSI GeoTrans, Inc., Sterling, VA

Hamm et al, 1997. Hamm, L.L., S.E. Aleman, W.F. Jones, G.P. Flach, J.S. Haselow, P.S. Huyakorn, S. Panday, and T. Birdie, 1997. FACT: *Subsurface Flow and Contaminant Transport Documentation and User's Guide,* Version 1.0, WSRCTR-95-223

SCDHEC, 1997. *Groundwater Mixing Zone Application Guidance*, Department of Health and Environmental Control, Columbia, South Carolina, May 1997

US DOE, 1994. Public Involvement, A Plan for Savannah River Site, Savannah River Operations Office, Aiken, SC.

US DOE, 1996. *Savannah River Site Future Use Project Report, Stakeholder Recommendations for SRS Land and Facilities (U).* Savannah River Operations Office, Aiken, South Carolina, January

US EPA, 1991. *A Guide to Principal Threat and Low Level Threat Wastes.* Superfund Publication 9380.3-06FS. Office of Solid Waste and Emergency Response, United States Environmental Protection Agency, November

US EPA, 1995. Region IV Supplemental Guidance to RAGS: Region 4 Bulletins, Human Health and Ecological Risk Assessment, November

WSRC, 1993. *Federal Facility Agreement for the Savannah River Site.* Docket No. 89-05-FF, WSRC-RP-94-42. Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1994. *Investigation-Derived Waste Management Plan.* WSRC-RP-94-1227, Rev. 2. Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1996a. *Savannah River Site Federal Facility Agreement Implementation Plan.* WSRC-RP-94-1200, Rev. 0. Westinghouse Savannah River Company, Savannah River Site, Aiken, SC. August

WSRC, 1996b. *Phase II RCRA Facility Investigation/Remedial Investigation Work Plan for the K-Area Burning/Rubble Pit and Rubble Pile (U).* WSRC-RP-95-1548. Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1998a. Groundwater Mixing Zone Application for the K-Area Burning/Rubble Pit and Rubble Pile. WSRC-RP-98-4084. Westinghouse Savannah River Company, Savannah Rive Site, Aiken, SC

WSRC, 1998b. *RCRA Facility Investigation/Remedial Investigation Report with the Baseline Risk Assessment for the K-Area Burning/Rubble Pit (131-K) and Rubble Pile (631-20G) Operable Unit (U).* WSRC-RP-97-442, Rev. 1.2. Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1998c. *Groundwater Flow and Solute Transport Modeling Report for the K-Area Burning/Rubble Pit and Rubble Pile.* WSRC-RP-98-5052. Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1999. *Corrective Measures Study/Feasibility Study for the KBRP and KRP Operable Unit (U).* WSRC-RP-97-860. Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2000. *Statement of Basis/Proposed Plan for the K-Area Burning/Rubble Pit (131-K) and Rubble Pile (631-20G) Operable Unit (U).* WSRC-RP-97-861. Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

APPENDIX A

RESPONSIVENESS SUMMARY

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Responsiveness Summary

The 45-day public comment period for the Statement of Basis/Proposed Plan for the K-Area Burning/Rubble Pit (131-K) and Rubble Pile (631-20G) Operable Unit (U) began on February 18, 2000, and ended on April 2, 2000. There were no comments received from the public for the KBRP/KRP OU. The Environmental Remediation Committee of the SRS CAB was given a briefing on the preferred alternative on March 7, 2000. There were no comments.

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