Hazardous Waste, Decontamination and Decommissioning, and Clean Up Workers Exposure Assessment Feasibility Study at the Department of Energy Savannah River Site

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DISCLAIMER

Mention of any company or product does not constitute endorsement by the National Institute for Occupational Safety and Health.

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APSF	Actinide Packaging Storage Facility
BNFL	British Nuclear Fuels Limited
BSRI	Bechtel Savannah River, Inc
B&W	Babcock and Wilcox
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIF	Consolidated Incinerator Facility
CW	Clean Up Worker
DCE	Dichloroethylene
D&D	Decontamination and Decommissioning
DeW	Deactivation Worker
DHHS	Department of Health and Human Services
DiW	Dismantlement Worker
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
DWPF	Defense Waste Processing Facility
EM	Environmental Management
EPA	Environmental Protection Agency
ETF	Effluent Treatment Facility
ER	Environmental Restoration
FFA	Federal Facility Agreement
HLW	High Level Waste
HW	Hazardous Waste
HWCTR	Heavy Water Components Test Reactor
HWW	Hazardous Waste Worker

IAEA	International Atomic Energy Agency
ISESM	In Situ Enhanced Soil Mixing
ITP/ESP	In-Tank Precipitation/Extended Sludge Processing
M&O	Management and Operation
MOU	Memorandum of Understanding
MW	Mixed Waste
NASA	National Aeronautics and Space Administration
NEPA	National Energy Policy Act
NIOSH	National Institute for Occupational Safety and Health
NFA	No further action
ORAU	Oak Ridge Associated Universities
PCBs	Polychlorinated Biphenyls
PCE	Perchloroethylene
PSVE	Passive Soil-Vapor Extraction
RBOF	Receiving Basin for Offsite Fuel
RCRA	Resource Conservation and Recovery Act
REMS	Radiation Exposure Monitoring System
RHLWE	Replacement High Level Waste Evaporator
ROD	Record of Decision
RW	Radioactive Waste
SAES	Safety Analysis Engineering Section
SCAPS	Site Characterization and Analysis Penetrometer System
SNF	Spent Nuclear Fuels
S&M	Surveillance and Maintenance
SRO	Savannah River Operations
SRS	Savannah River Site

SVE	Soil Vapor Extraction
TCE	Trichloroethylene
TEDE	Total Effective Dose Equivalent
TSS	Transfer and Storage Service
VOC	Volatile Organic Compounds
WSA	Well Sampling and Analysis
WSRC	Westinghouse Savannah River Company

PREFACE

The Department of Health and Human Services (DHHS), subsequent to the implementation of a Memorandum of Understanding (MOU) between DHHS and the Department of Energy (DOE), conducts a program of independent occupational and environmental research studies with funding from DOE. Research conducted under this MOU focuses on examination of health effects that may result from past, current, or future DOE operations. The National Institute for Occupational Safety and Health (NIOSH) within the Centers for Disease Control and Prevention, one of the centers within DHHS, is charged with the conduct of the occupational health research component of this MOU. This document on the DOE Savannah River Site (SRS) is the background document prepared for the NIOSH project entitled: Exposure Assessment of Hazardous Waste, Decontamination and Decommissioning, and Clean Up Workers.

The purpose of this document is to assemble information relevant to Hazardous Waste Workers (HWW), Decontamination and Decommissioning (D&D) workers, Clean Up Workers (CW) and their activities at the DOE SRS, addressing four primary objectives as listed below:

- Identification of HW, D&D, and CW activities in progress from the recent past or anticipated through the next 10 years
- Demographic definition of the work force performing these activities at the SRS
- Identification of the technologies in use or proposed for future use (including considerations regarding health and safety impact upon the work force)
- Assembly of summary information on potential chemical, mixed, and radiological exposures that may be encountered during these processes

The information is drawn predominantly from existing DOE and contractor documents or reports as well as from open literature or Internet sources. Other source documents may include those assembled for compliance purposes or to define activities dictated by site D&D, restoration, transition, and clean up agreements with local, state, and federal authorities or as mandated by DOE. This assembly of information will support research hypothesis development in the next phase of this project. It will also provide insight and initial data for study feasibility and planning considerations.

The depth and scope of the information assembled provides a midrange presentation of data. Grappling with the needs for substantive information while avoiding premature details and acknowledging changes in data relevance as time elapses influenced both the character and decisions that went into the assembly of this document. The data collection process limited the need for intensive site involvement. This document is descriptive in nature. The resource documents used to assemble the information are referenced. Information that could not be obtained or which did not exist in an accessible form is identified.

The intended application of this document is to provide an overview of HW, D&D, and CW activities at the DOE SRS. Most of the information is presented in two ways:

- A text assembly of information with references
- A tabular presentation

The intent of this approach is to permit disassembly of the document to facilitate combining similar information for different sites, ideally facilitating an assessment of the feasibility of involving multiple sites in a research study.

The limitations of this document should be recognized. The rate of change in organizational structure, work force composition, and site activities at the DOE sites involving HWW, D&D, and CW appears to be increasing in frequency and complexity. This coincides with a compression of the time frame committed to cleaning up sites by DOE, resource reductions, and an increase in the use of autonomous multi-tiered subcontracting. Numerical data are presented as found in the cited references. No verification of summary data provided by the sites or obtained from preexisting documents has been performed. Obstacles that may become substantial regarding exposure characterization of work forces on site include modification of site programs documenting worker exposures; shifts from a stable, long-term work force to temporary or subcontractor workers; and changes in the structure of site management. The information presented may also constitute tangential information related to the objectives specified for this phase of the project.

1.0 Summary

Since the signing of a Memorandum of Understanding between the Department of Energy (DOE) and the Department of Health and Human Services in 1990, the National Institute for Occupational Safety and Health (NIOSH) has had responsibility for management or conduction of analytical health studies of workers at DOE facilities. Unlike most previous DOE-related epidemiologic studies which have focused on past worker exposure from normal facility operations, this report pertains to a feasibility study aimed at identifying and describing records relating to the population of workers at the Savannah River Site (SRS) in Aiken, South Carolina who have been, are currently, or who will be involved with remediation or waste management activities.[1] In many cases, accelerated cleanup schedules are planned for DOE sites across the country with the intention of site remediation within the scope of a ten-year period. There is concern that the workers involved in these cleanup activities, who might encounter hazards to which their predecessors (i.e., production workers) were not exposed, may vanish upon completion of these tasks. It is this concern that initiated and encouraged this study.

The population of interest within the study included workers directly involved in remedial and waste management activities as well as persons providing support, supervision, and monitoring, if these persons are at risk of exposure. For the purpose of the study, NIOSH defined the population of interest to include workers involved in hazardous waste (HW) activities, decontamination and decommissioning (D&D)* activities, and clean up activities. The population of interest included prime contractor workers and subcontract workers holding various job titles. The focus of the study included recent past (1992 to 1996), present, and proposed future (1997 to 2006) remediation activities, current and proposed technologies, and worker group demographics and occupational exposures.

The first phase of the study was to identify, review, and summarize documentation regarding the study population for use as a foundation upon which further studies may be built. Activities involving workers of interest were identified chiefly from information collected from publicly available documents and from interviews with SRS personnel. A limited amount of data was garnered from documents provided by SRS not normally made available to the public. The same set of resources were used to collect other information relevant to the activities identified. Characteristics of the work force(s) involved in these activities and the technologies presently used or proposed for use in these activities were investigated. Information on the types, quantity, availability, and level of radiation exposure data pertaining to the study population, as well as the location and oversight responsibility of the exposure data, were investigated. A large number of personal contacts were made during the course of this project, and a large number of resources were accessed or identified. A detailed listing of these contacts and references is included as part of this formal document and can be found in Sections 10, 11, and 12.

Due to the physical volume of information identified during this study, and due to limitations on retrieval and reproduction costs, only a fraction of the identified documents are included as part of the physical product of the study. The documents and other materials that are included as products of the study were selected on the basis of their value as primary, example, or rare documents or materials. Efforts will be made to provide ample information necessary to physically retrieve any or all of the other identified materials if and when that is deemed useful.

During the course of this study, the partnership agreement between the DOE and the Health and Human Services, as described in the December 24, 1990, Memorandum of Understanding

between these two agencies, helped facilitate the gathering of necessary worker group data for this study.

* The nomenclature relative to D&D workers changed while this report was being prepared. As first used, the term "D&D worker" was usually understood to include not only workers who performed decontamination and decommissioning, but also deactivation and dismantlement workers. In an effort to make the definition more precise and more relevant to most DOE facilities, NIOSH redefined these classifications in June 1997 to more precisely describe the activities performed. The term *deactivation worker* (DeW) was introduced to define workers who performed deactivation or stabilization activities, as well as decontamination and decommissioning. Also redefined was *dismantlement worker* (DiW) as those who dismantle, disassemble, or demolish large scale structures or components and remove the residue from the facility.

2.0 Purpose of Project

As defined in the Work Plan submitted by Oak Ridge Associated Universities (ORAU)[1] in response to the National Institute for Occupational Safety and Health Work Assignment 2695-018, the purpose of this project is to identify, locate, and collect information, subject to availability, on workers involved with waste streams within the DOE SRS facility. The workers of interest include those described as *hazardous waste workers (HWW), decontamination and decommissioning [defined as deactivation workers (DeW) and dismantlement workers (DiW)],* and *clean up workers (CW).* Specifically, the following tasks were identified:

1. Identify and catalog HWW, DeW&DiW, and CW activities in progress or anticipated over the next 5-10 years at the SRS facility.

2. Describe and characterize the HWW, DeW&DiW, and CW populations at SRS.

3. Identify and provide limited descriptions of the major technologies used in the past, in current use, or planned for use in the future in the activities identified in item (1) above.

4. Assemble a catalog of available exposure information, delineated into chemical, mixed, and radiological types, at the SRS for the workers identified in (2) above.

5. Construct a catalog of resources and contacts used to collect information for the project.

The amount of information and data identified, collected, or reviewed for this project was immense and widely scattered. In producing the major reports describing the procedures and results of the project, every attempt was made to use the most credible sources; however, because of limitations of time and personnel prescribed by the NIOSH Statement of Work, it was not possible to validate information or data supplied by the study sites or collected from previously published documents.

3.0 Methods

3.1 General procedures

Methods used to complete this work may be categorized into the following general activities:

- Project management and primary communications
- Field searching
- Data management

The actual pathway to a particular fact of information or to a document may be quite complex and involve a number of different activities.

Following is a brief description of the primary steps taken in performing the work resulting in this document and other associated products of this project.

- All activities of any significance, undertaken in the performance of the project, were recorded in an electronic log to which all research team members had access.
- One team member was designated to periodically reorganize and edit the log to improve its usefulness and remove redundant information.

3.2 Initial project strategy meeting

In January 1997, ORAU investigators and the NIOSH project officer met with representatives of Westinghouse Savannah River Company (WSRC) at the SRS in Aiken, South Carolina to describe the HW, D&D, and CW activities and to outline the types and level of effort anticipated to accomplish the project goals. The meeting was also attended by representatives of Bechtel Savannah River, Inc. (BSRI), and the Department of Energy/Savannah River Operations (DOE/SRO) and lasted approximately three hours. The meeting was extremely well organized and implemented. As the last piece of business accomplished at the meeting, appointments were arranged for visits by the NIOSH and ORAU representatives with a number of the SRS attendees to further discuss project strategies. These appointments were attended as scheduled during the next 2-½ days.

Following is a list of persons attending this initial meeting.

Steven Ahrenholz	NIOSH
Bill Tankersley	ORAU
Nick Ingle	ORAU/Delta 21
John Strickland	WSRC/Medical Division
L. P. Singh	DOE/SRO
Kevin Smith	WSRC/Safety Analysis Engineering Section (SAES)
Saleem Salaymeh	WSRC/SAES
Lisa J. Skinner	WSRC/SAES
Ed Kahal	WSRC/SAES
L. H. (Kay) Strickland	BSRI/Labor Relations
Kenneth W. Crase	WSRC/HP Technician

Bill Austin	WSRC/Facilities Decom
Larry Thebo	BSRI/Envir. Restoration
Gene Bonnettc	BSRI/Transportation
K. L. Metler	BSRI/Transportation
Clayton Lanier	BSRI/Iron Works
Eddy Smith	BSRI/Heavy Equipment
Thomas Jenkins	BSRI/Carpentry
Roger Rollins*	DOE/SRO

*Attended final debriefing meeting only

3.3 Identification, location, and retrieval of pertinent information

At the beginning of the study, the whereabouts or even the existence of data likely to be relevant to the study were unknown. An initial strategy planning meeting of the research team was held to construct a "wish list" of documents that should provide the information needed for the study and make personnel assignments for various tasks within the project. The necessary tasks were generally divided into the following categories:

- Communications with plant and oversight personnel and establishment of major new contacts
- Field activities at local and remote document repositories aimed at locating and retrieval of hard copy documents
- Search for and either retrieval or mapping the location of electronic documents
- Information extracted, summarized, and arranged to address the objectives of the ORAU Work Plan[1]

A list of references and documents may be found in Section 12.

3.4 Review of collected information

Some documents or materials (maps, graphics, listings, etc.) collected were obviously valuable for the study. Examples of this kind of information include the DOE implemented 10-year plan,[2,3] current plant-generated documents listing formally designated waste management or Environmental Restoration (ER) activities, and tables showing distributions of workers by occupational type.

3.5 Assemblage of project materials

As information was gathered through site visits and telephone contacts, it was organized by the team members utilizing a central log and various tables (activities, technologies, contacts). Each team member would record their activities in the central log as the research was done and information products and concepts were gathered. This method of organization proved helpful in eliminating duplication of work among the research team. Hard copy documents were located in a central office area along with notes and bibliographic citations to relevant documents of interest to the project. All team members had access to the organization tools and documents for review during the research process. The report bibliography was compiled from this information collection.

3.6 Worker classification

The worker classification was done as decided upon by DOE and reported in a revision of the Fernald Report.[4] The following were excerpted from that document and edited to fit the SRS situation.

1. Hazardous Waste Worker (HWW)

   That portion of the SRS wage work force involved with the sampling, surveying, containerization, treatment, transportation, storage and disposal, or remediation of hazardous waste (i.e., chemically-contaminated wood, metal, concrete, asphalt, debris, process residues, discarded product, contact waste, etc.). The HWW may also deal with hazardous waste with a radiological component.

2. Clean Up Worker (CW)

   Those SRS wage workers who are involved with systems operation and maintenance [treatment, transportation, or storage and disposal of all levels of Radioactive Waste (RW) generated during day-to-day activities at the SRS]. The CW identifies, weighs, samples, surveys, containerizes, stores, and prepares RW for shipment or storage. CWs are usually not associated with hazardous or mixed waste; this is the domain of the HWW.

3. Deactivation Worker (DeW)

   Those workers responsible for placing a facility in a safe and stable condition to minimize the long-term cost of a surveillance and maintenance (S&M) program that protects workers, the public, and the environment. Actions include the removal of fuel, draining and/or de-energizing of non-essential systems, removal of stored radioactive, mixed, and hazardous waste materials. Deactivation can also include decontamination activities and small scale dismantlement of process lines, tanks, and equipment. Decommissioning takes place after deactivation and includes S&M. If this S&M result in some exposure potential, those persons performing these activities would be included in the deactivation group.

4. Dismantlement Worker (DiW)

Those workers responsible for the dismantlement, disassembly, or demolition and removal of any large scale structure systems or components and of the residue from the facility.

3.7 Reporting

Reporting of progress for the study is presented in four forms:

- Monthly reports
- Informal reports
- Draft reports
- Final reports

Monthly reports are submitted that include recent progress, problems encountered or changes implemented in the project, and budget information. Informal reports, both written and verbal, are submitted on an irregular but frequent basis to the NIOSH Technical Officer. This provides a mechanism for quickly addressing problems or needs that may arise during the course of the project. Draft reports will be submitted to the NIOSH Technical Officer as draft of the final report. The Technical Officer will make comments on these reports and changes as appropriate will be made in the final report based on these comments. Lastly, as prescribed in the ORAU Work Plan,[1] a final report of methods and findings (this report) will be submitted at the completion of the project.

4.0 Site Overview

SRS is a key federal facility owned by DOE and operated under a Management and Operation (M&O) contract by the WSRC, with BSRI, Babcock and Wilcox (B&W), and British Nuclear Fuels Limited (BNFL) as partners. Currently, SRS is focusing on environmental and waste management activities, national security work, and economic development and technology transfer initiative areas.

The SRS complex, which is spread over 300 square miles, was constructed during the early 1950s to produce tritium and ^{239}plutonium, which are basic materials used in the fabrication of nuclear weapons. Five reactors built on site, produce these nuclear materials by irradiating target materials with neutrons. Also built were support facilities including two chemical separation plants, a heavy water extraction plant, a nuclear fuel and target fabrication facility, and waste management facilities. In the production process, irradiated materials were moved from the reactors to two chemical separation facilities. In these facilities, known as "canyons," the irradiated fuel and target assemblies were chemically processed to separate useful products from waste. After refinement, some nuclear materials were shipped to other DOE sites for final use.

The functions of SRS have been adjusted through the years to meet changing defense requirements. All five of the original SRS production reactors are permanently shut down, a reflection of improved U.S. relations with the former Soviet Union. While production of more tritium will not be necessary for many years, recycling and reloading of tritium to keep the nation's supply of nuclear weapons ready is a continuing site mission. SRS is the nation's only location for recycling tritium from nuclear weapons reservoirs returned from service. All tritium unloading, mixing, and loading are performed in a new facility that went into operation in 1994. This facility replaces a number of SRS facilities that processed the nation's tritium for the last 35 years.

The future of SRS lies in five areas:

- Reducing the nuclear danger
- Environmental and waste management activities
- Transferring applied environmental remediation and management technology to government and non-government entities
- Forming economic and industrial alliances
- Transfer of production technology. To this end, one of the "canyons" is being used to produce ^{239}Pu for deep-space probes.

<u>Historical Overview</u>

1950 E. I. duPont de Nemours and Company was asked by the Atomic Energy Commission to design, construct, and manage the Savannah River Plant.

An area for the site was chosen.

1951 Savannah River Ecology Laboratory begins ecological studies of SRS plants and animals.

Construction began at the site.

1952 Production of heavy water for site reactors begins in Heavy Water Rework Facility.

1953 R-Reactor, the first production reactor, goes critical.

1954 P-Reactor, L-Reactor, K-Reactor go critical.

The first irradiated fuel is discharged.

F-Canyon, a chemical separation facility, begins radioactive operations.

1955 C-Reactor goes critical.

The first plutonium shipment leaves the site.

H-Canyon, a chemical separation facility, begins radioactive operations.

1956 Construction of the basic plant is complete.

1963 Receiving Basin for Off-Site Fuels receives first shipment of off-site spent nuclear fuel.

1964 R-Reactor shuts down.

1968 L-Reactor shuts down for upgrades.

1971 K-Reactor becomes the first production reactor automatically controlled by computers.

1972 The site is designated as the first National Environmental Research Park.

1981 SRS begins environmental clean up program.

M-Area Settling Basin clean up begins under the Resource Conservation and Recovery Act.

1982 Heavy Water Rework Facility closes.

1983 Ground is broken for construction of the Defense Waste Processing Facility.

1985 HB-Line begins producing ^{238}Pu for NASA's deep-space exploration program.

A full-scale ground water remediation system is constructed in M-Area.

1986 Construction of Saltstone begins.

Construction of the Replacement Tritium Facility begins.

1987 duPont notifies DOE that it will not continue to operate and manage the Site.

1988 K-,L-, and P-Reactors are shut down.

Effluent Treatment Facility begins operations to treat low-level radioactive waste water from F- and H- Area separations facilities.

1989 Site officially included on National Priority List and becomes regulated by Environmental Protection Agency (EPA).

WSRC assumes management and operation of site facilities.

1990 Construction of a cooling tower for K-Reactor begins.

Saltstone began operations.

1991 Mixed Waste Management Facility is first SRS facility closed and certified under the provisions of the Resource Conservation and Recovery Act.

L-Reactor shut down.

M-Area Settling Basin closure completed.

Cold War ends, production of nuclear materials for weapons stopped.

1992 K-Reactor operated briefly for last time and connected to cooling water.

Secretary of Energy announces phaseout of all uranium processing.

Non-radioactive operations begins at the Replacement Tritium Facility.

1993 K-Reactor placed in cold-standby condition as Nation's Tritium source.

Non-radioactive test runs of the Defense Waste Processing Facility begin.

Construction begins on Consolidated Incineration Facility.

Tritium introduced into the Replacement Tritium Facility and radioactive operations begins.

Work force Transition and Community Assistance begins at SRS.

1994 SRS Citizens Advisory Board was established.

1996 The Defense Waste Processing Facility introduces radioactive material into the vitrification process.

K-Reactor placed in shutdown condition.

F-Canyon restarts and begins stabilizing nuclear material at SRS.

5.0 Activities

5.1 Overview

At the initial project overview meeting at SRS in January, discussions of activities at SRS relevant to the project were almost entirely directed at ER activities and to a lesser degree toward D&D activities. Since this meeting, however, evaluation of data collected for the project suggested that the scope of activities at the site relevant to the project was broader than the initially identified two facets of the overall environmental effort. It was judged that NIOSH would also be interested in employees who are associated with remediation activities related to stabilization of nuclear material and facilities. Workers involved in these activities at SRS should be of particular interest because this site has transuranics and spent fission products, both of which would present high exposure potential associated with their stabilization. Further, SRS has a number of reactors that may present particularly challenging stabilization problems and; therefore, may require new technological procedures. Finally, the waste management activities at SRS should be of special interest to NIOSH since, according to recently published reports, the site owns approximately 1.265×10^5 cubic meters of high level waste requiring disposal.[5] It is noteworthy that this high level waste accounts for over half the total radiation activity from high level waste at all DOE facilities.[6]

As prescribed in the ORAU Work Plan,[1] the first task within the project was to furnish a catalog and brief description of HWW, D&D, and CW activities (past, present, and 10 years into the future). Providing information on planned or anticipated activities assumed that decisions regarding these activities had been made and documented. However, considerable study of the available information indicated that future activities were difficult to define since the level of funding for subsequent fiscal years is uncertain. Because funding levels for research and development are uncertain, technical information on activities anticipated in the next five to ten years has been very imprecise and variable. In addition, the degree of certainty and priority level of specific activities, already included in established budgets, appear to be continually subject to change such that the situation could be considered fluid.

The prioritization of remediation and clean up activities as described in the Savannah River draft Savannah River Site Risk Ranking and Prioritization[7] depends on such factors as public interest, federal and local health agency concern, and scientific urgency. All of these factors are significantly influenced by federal and local politics, both of which are subsequently influenced by DOE and its contractors as each facility maneuvers for a larger share of remediation and environmental management activity funding. These activities, of course, are greatly influenced in the public arena when national and local politicians become involved. The situation is even further complicated by the recent interest by the new Assistant Secretary of Energy in finishing the bulk of this work within the next ten years under cost and inflation constraints.

Aside from the uncertainty and fluidness that generally characterize the total DOE environmental management and remediation efforts, from the point of view of this NIOSH study, a number of practical problems exist. Assuming it is determined which activities at SRS need to be included in the study, difficulties remain in how to name and list them. Depending on authorship, publication date, and intended audience, DOE and contractor documents naming and describing remediation activities and activities at SRS include considerably different information. In some instances, the differences are interpretable; in other instances, the differences are quite confusing. For example, in the document, "Accelerating Clean up: Focus on 2006, Discussion Draft",[2] written by WSRC for DOE/SRO, 16 key activities are listed under five general areas: (1) Environmental Restoration, (2) High-Level Waste, (3) Nuclear Material Stabilization, (4) Spent Nuclear Fuel, and (5) Solid Waste. In another section of the same report, 70 EM priority activities are listed, with 11 classified as Base Management Activities and 59 classified as Operating Activities.

During the earlier visit at SRS, a list of over 450 ER sites[8] was provided. This list included sites for which ER activities were completed, underway, or proposed. More current information on these activities has subsequently been furnished as electronic spreadsheet data. The U.S. DOE 10-year plan for Savannah River Operations Office,[3] issued in 1996, also referenced this list of ER activities and indicated that action on 111 of the named activities would be completed by 1997, and that approximately 40 percent of the activities would require some clean up activity. The 10-year plan[2] only listed seven ER activities by type of activity: (1) Assessments; (2) Clean up; (3) Operational; (4) Heavy Water Component Test Reactor D&D; (5) M-Area Surveillance; (6) Reactor (P, C, R, K, L); Surveillance and Maintenance; and (7) D-Area Surveillance and Maintenance. These same activities were also grouped by Plant Areas into nine groups in the 1996 Baseline Environmental Management Report[9] and by eight watersheds in an Appendix of the Federal Facility Agreement (FFA) Implementation Plan.

In view of the variously grouped listings of activities, it was decided to use the listing of priority activities identified by SRS in the Accelerating Cleanup: Focus on 2006, Discussion Draft as the basic or core set of remediation activities to address in this report. This was judged to be the most appropriate list of activities for which to provide the details prescribed by NIOSH for the study. Even within this set of activities, it was determined that a number of them were not of the type that provided potential for exposure, and therefore, were excluded. An example of an excluded activity is "SR-IN12 - Operating activities including all site baseline activities necessary to operate the site infrastructure."

5.2 EM activity descriptions (Remediation and waste processing activities)[2,8,10]

The following is a listing of SRS activities judged to be of interest to NIOSH as a part of this research project. These activities are ordered by priority of importance assigned by WSRC and DOE and identified by type of activity or contaminant involved as follows: NM - Nuclear Material, HL - High Level (radioactive waste), SF - Spent (nuclear) Fuel, ER - Environmental Restoration, FA - Facilities Deactivation and Decommissioning, and SW - Solid Waste.

Note that ER activities, ER01-ER07, all have the same description. This is because ER activities are designated by areas within the facilities, associated with its seven flood plains. Each of the major ER activities consists of a large number of subactivities of many types within these flood plain areas. Each major activity is implemented by evaluating each subactivity to determine if, how, and when it is to be remediated. The major activity will be finished when all the subactivities that comprise it are remediated. Consequently, the description of these ER activities include a generic approach for remediation of the inclusive subactivities.

SR-HL04 ITP/ESP Operations

Scope includes:

- 24 hour manning of the ITP Control Room
- Chemical addition and operation of the large, high hazard Microfiltration Facility
- Waste Transfers (between tanks, to/from H-Tank Farm, to DWPF)
- Sludge Washing

Contaminants of concern include ^{90}Sr, ^{137}Cs, ^{238}Pu, ^{239}Pu, and ^{241}Pu.

SR-HL07 Effluent Treatment Facility (ETF) Operations

Scope includes:
- 24-hour surveillance, monitoring, inspecting, and maintenance.
- 24-hour manning of the ETF control room.
- Receipt and processing of routine and peak transfers of waste water to support the safe maintenance of the Separations areas and Tank Farm Evaporator operations.
- Support unloading and treatment of sludge water from Site well sampling.
- Discharge approximately 18 million gallons of treated water to site streams.
- Transfer approximately 150,000-300,000 gallons of concentrated contaminants to Saltstone (Activity SR-HL08) for disposal.
- Critical maintenance activities.

Contaminants of concern include low level radioactive contaminants.

SR-HL05 Vitrification Operations

Scope includes:
- 24-hour operation of the Late Wash and Vitrification Facilities to immobilize high level radioactive waste in glass.
- 24-hour Manning of the DWPF Control Room.
- Receiving Transfers of Sludge Waste and Precipitate Waste from ITP/ESP (SR-HL04).
- Sending Transfers of Recycle Waste to H-Tank Farm (SR-HL01).
- Adjusting and Preparing Feed for the Glass Melter.
- Filling the Canisters with Radioactive Glass.
- Inserting & Welding Canister Plugs.
- Canister Decontamination.
- Transport of Canisters to Glass Waste Storage Building.
- Critical maintenance activities.
- Sample analyses to confirm waste glass quality meets Federal Repository requirements.

Contaminants of concern include ^{90}Sr, ^{137}Cs, ^{238}Pu, ^{239}Pu, and ^{241}Pu.

SR-HL06 Glass Waste Storage

Scope includes:
- 24-hour operation, monitoring, inspection, and maintenance.
- Movement of the canisters produced by DWPF (Activity SR-HL05) to the Glass Waste Storage Building by the Shielded Canister Transporter.
- Operation and maintenance of forced air ventilation systems to remove radioactive decay heat.
- Monitoring and maintenance of radiation monitors and temperature sensors.
- Design and construction of a second glass waste storage building.
- Critical maintenance activities.

Contaminants of concern include ^{90}Sr, ^{137}Cs, ^{238}Pu, ^{239}Pu, and ^{241}Pu.

SR-HL03 Waste Removal

This activity scope includes:

- Outfitting 43 HLW tanks with waste removal equipment (Tank 1-15, 17-39, and 43-47) and 3 tanks with sludge processing equipment (40, 42, and 51). All of this work is to be done on and in the tanks while they contain hundreds of thousands of gallons of highly radioactive and toxic waste. Process piping and valve box installation involves cutting and welding highly radioactive piping by hand which involves working under very stringent quality and occupational health standards.
- Installation of tank washing equipment.
- Tank closure - Each tank will be filled with three different types of grout in distinct layers, all piping and electrical connections will be cut, capped and sealed, all openings will be sealed and each tank will be left in a low maintenance or "cold and dark" mode.
- Closure of other process cells and buildings.

Contaminants of concern include ^{90}Sr, ^{137}Cs, ^{238}Pu, ^{239}Pu, and ^{241}Pu.

SR-ER01 Flood Plain Swamp Activity

Remediation of the Flood Plain Swamp Watershed Activity will consist of the following:

- Preliminary evaluation of known suspect areas to determine if action is necessary.
- Investigation and analysis of the identified waste units and any suspect areas identified through preliminary evaluations to determine further investigation and possible required remediation.
- Implementation of remediation technologies to mitigate the impact of contaminants of concern on human health and the environment.
- Post-action monitoring to ensure that the implemented technology was effective.

Contaminants of concern include hazardous and radioactive wastes.

The Flood Plain Swamp Watershed Activity includes 45 subactivities as listed in the SRS ER Unit List[8] document, dated May 20, 1997. This ER Unit List shows that assessment has been accomplished on 20 activities and that the other 25 activities are scheduled for assessment prior to 2002. Assessment of these and the other ER activities includes determining if, how, and when each subactivity is to be remediated. Of the 20 subactivities that have been assessed, 18 have been remediated, or no remediation was required. Eleven such subactivities have officially been closed, needing "no further action" (NFA). In the seven remaining subactivities, the NFA designation is pending. Of the remaining 27 subactivities, eight have a forecasted completion date on or before 2006. No remediation is presently planned for the remaining 19 subactivities before 2006. However, in some cases, assessment may indicate that little action or NFA is needed, allowing these subactivities to be completed prior to 2006.

SR-ER02 Four Mile Branch Activity

Remediation of the Four Mile Branch Watershed Activity will consist of the following:

- Preliminary evaluation of suspect areas to determine if action is necessary.
- Investigation and analysis of identified waste units and any suspect areas identified through preliminary evaluations to determine further investigation and possible required remediation.
- Implementation of remediation technologies to mitigate the impact of contaminants of concern on human health and the environment.
- Post-action monitoring to ensure that the implemented technology was effective.

Contaminants of concern include hazardous and radioactive wastes.

The status of the 32 Four Mile Branch Watershed subactivities as detailed in the 5/20/97 ER Unit List[8] is shown in the table below.

Table 5-1 Status of 32 Four Mile Branch Watershed Subactivities

	Assessment		Remediation				
	Forecast	Done	Forecast	Done	NFA Decision Completed	NFA Decision Pending	No Present Plans
Number	12	20	13	11	5	6	8*
Latest Date	2003	1997	2004	1997	NA	NA	NA

*Of the eight subactivities for which there are no present plans, some of their assessments may indicate that little or NFA is required and that they can be completed prior to 2006.

SR-ER03 Lower Three Runs Activity

Remediation of the Lower Three Runs Watershed Activity will consist of the following:

- Preliminary evaluation of suspect areas to determine if action is necessary.
- Investigation and analysis of the identified waste units and suspect areas identified through preliminary evaluations to determine further investigation and possible required remediation.
- Implementation of remediation technologies to mitigate the impact of the contaminants of concern on human health and the environment.
- Post-action monitoring to ensure that the implemented technology was effective.

Contaminants of concern include tritium, other radionuclides, chlorinated volatile organics, heavy metals, and sulfates.

This summary of the status of the subactivities contained in the Lower Three Runs Watershed Activity was compiled from information in the 5/20/97 compilation of the ER Unit List.[8] There are 61 subactivities in this watershed and status information on them is tabulated below:

Table 5-2 Status of 61 Lower Three Runs Watershed Subactivities

	Assessment		Remediation				
	Forecast	Done	Forecast	Done	NFA Decision Completed	NFA Decision Pending	No Present Plans
Number	45	16	16	16	9	6	29*
Latest Year	2000	1997	2006	1997	-	NA	NA

*Of the 29 activities for which there are no present plans, some of their assessments may indicate that little or NFA is required and that they can be completed prior to 2006.

SR-ER04 Pen Branch Activity

Remediation of the Pen Branch Watershed Activity will consist of the following:

- Preliminary evaluation of suspect areas to determine if action is necessary.
- Investigation and analysis of the identified waste units and suspect areas identified through preliminary evaluations to determine further investigation and possible required remediation.
- Implementation of remediation technologies to mitigate the impact of the contaminants of concern on human health and the environment.
- Post-action monitoring to ensure that the implemented technology was effective.

Contaminants of concern include low level radioactive materials, nonradioactive organic and inorganic compounds, pesticides, and inert solid wastes.

The Pen Branch Watershed Activity includes 35 subactivities as listed on a 5/20/97 version of the Environment Restoration (ER) Unit List.[8] This unit list shows that assessment has already been accomplished on six of them and the other 29 are scheduled for accomplishment prior to 2004. Of the six subactivities where assessment has been made, all six have been remediated or no remediation was required. Three such subactivities have officially been closed as needing "no further action" (NFA). In the remaining subactivities, the NFA designation is pending. Of the remaining 29 subactivities, 17 have a forecasted completion date on or before 2006. No remediation is presently planned for the remaining 12 subactivities before 2006; however, in some of these cases, assessment may indicate that NFA is needed so that they can also be completed prior to 2006.

SR-ER05 Steel Creek Activity

Remediation of the Steel Creek Watershed Activity will consist of the following:

- Preliminary evaluation of suspect areas to determine if action is necessary.
- Investigation and analysis of the identified waste units and suspect areas identified through preliminary evaluations to determine further investigation and possible required remediation.
- Implementation of remediation technologies to mitigate the impact of the contaminants of concern on human health and the environment.
- Post-action monitoring to ensure that the implemented technology was effective.

Contaminants of concern include tritium, other radionuclides, chlorinated volatile organics, heavy metals, and sulfates.

This summary information on the subactivities contained in the Steel Creek Watershed Activity was compiled from the 5/20/97 ER Unit List.[8] There are 35 subactivities in this watershed, and the status of each subactivity is tabulated below.

Table 5-3 Status of 35 Steel Creek Watershed Subactivities

	Assessment		Remediation				
	Forecast	Done	Forecast	Done	NFA Decision Completed	NFA Decision Pending	No Present Plans
Number	24	11	12	11	6	5	12*
Latest Year	2005	1997	2006	1997	NA	NA	NA

*Of the 12 activities for which there are no present plans, some assessments may indicate that little or NFA is required and that they can be completed prior to 2006.

SR-ER06 Upper Three Runs Activity

Remediation of the Upper Three Runs Watershed Activity will consist of the following:

- Preliminary evaluation of suspect areas to determine if action is necessary.
- Investigation and analysis of the identified waste units and suspect areas identified through preliminary evaluations to determine further investigation and possible required remediation.
- Implementation of remediation technologies to mitigate the impact of the contaminants of concern on human health and the environment.
- Post-action monitoring to ensure that the implemented technology was effective.

Contaminants of concern include volatile organic compounds (VOCs), heavy metals, ^{90}Sr, ^{137}Cs, ^{60}Co, and tritium.

The status of the 229 Upper Three River Watershed subactivities as detailed in the 5/20/97 ER Unit List[8] is shown in the table below.

Table 5-4 Status of 229 Upper Three River Watershed Subactivities

	Assessment		Remediation				
	Forecast	Done	Forecast	Done	NFA Decision Completed	NFA Decision Pending	No Present Plans
Number	155	74	41	64	33	31	124*
Latest Year	2004	1997	2006	1997	NA	NA	NA
*Of the 124 activities for which there are no present plans, some assessments may indicate that little or NFA is required and that they can be completed prior to 2006.							

SR-ER07 Program Management (ER)

This is an administrative activity consisting of Post Closure Management, Waste Certification/Coordination Facility Support Operation, Site Evaluations, Well Sampling and Analysis (WSA), Engineering Technical Initiatives, Technology Demonstration, Watershed Assessment, Development and Implementation of an ER technical support program management plan and other support activities.

SR-SW02 Transuranic Waste Activity (TRU)

TRU Waste Storage Pad Base Operations includes:

- Receipt and storage of newly generated waste.
- Inspection and maintenance of TRU Waste Storage Pads and TRU Waste Containers.
- The removal of earthen cover and retrieval of 8809 55-gallon drums on five TRU Waste Storage Pads.

Contaminants of concern include TRU wastes, including ^{238}Pu.

Contents of the drums are assayed and wastes segregated for packaging and disposition.

SR-SW03 Mixed Low Level Waste Activity (Operations)

The Mixed Waste activity encompasses those activities and resources required for the safe, environmentally sound operations of the Solid Waste Mixed Waste Facilities which have an inventory of approximately 1,440 cubic meters of mixed waste. Three key activities in the management of the various Mixed Waste (MW) streams are storage, treatment (including any characterization activities required prior to treatment), and disposal. Waste treatment activities are conducted to treat the waste prior to disposal to ensure that the requirements of RCRA and the FFC Act of 1992 are met.

Contaminants of concern include mixed wastes including Hg and PCBs.

SR-SW05 Hazardous Waste Activity

The Hazardous Waste Activity includes:

- Receipt from site generators, storage, and ultimate shipment offsite of newly generated hazardous wastes for treatment and disposal.
- Development of sampling and analysis methodologies to adequately characterize waste that has previously been difficult to sample and/or analyze.
- The shipment offsite of legacy hazardous wastes previously considered unshippable for treatment and disposal.

SR-SW04 Low Level Waste Activity (Operations)

The scope of Low Level Waste Activity encompasses those activities and resources required for the safe, environmentally sound operations of the Solid Waste Low level Waste facilities which receive approximately 14,000 cubic meters of low level waste annually. The primary isotopes of concern are tritium, ^{137}Cs, ^{90}Sr, ^{238}Pu and ^{239}Pu. Activities include:

- S&M of legacy waste in storage.
- Receipt of newly generated waste.
- Treatment of the waste as required.
- Verification that the waste meets the facility waste acceptance criteria.
- Placement of the waste in the appropriate disposal repository.
- S&M of the storage and disposal units.

SR-FA20 Reactors Monitoring Activity (Waste Minimization, C Area)

Activities include:

- Waste handling including mixed, radioactive, and hazardous waste types.
- Environmental engineering.
- Operation of the 105-C Waste Minimization Facility.
- Other support activities.

Contaminants of concern include contaminated heavy water, fission by-products, and asbestos.

SR-SW01 Consolidated Incinerator Facility (CIF)

This activity provides for the operation of the CIF. During its designed service life of 30 years, CIF will incinerate approximately one million pounds of solid waste and one million pounds of liquid waste each year. Waste streams processed at CIF will include:

- Low-level solid waste from several on-site sources.
- Low-level radioactive liquid waste (aqueous and organic).
- Liquid Radioactive Organic Waste (ROW) (benzene from the Defense Waste Processing Facility).

Contaminants of concern include low-level radioactive wastes, heavy metals, organics, and mixed wastes.

SR-FA15 M-Area Deactivation Activity

The deactivation of the buildings in the 300-M area will involve:

- Removing and disposing of all process related equipment not needed to support mission requirements.
- Preparation of transition and NEPA documentation.
- Decontamination of facilities where feasible, or dismantlement and removal.
- Asbestos and lead identification.
- Disposition of excess hazardous materials, chemicals, and equipment.
- Environmental and radiological characterization.
- Gross clean out of residual hazardous and radioactive material.

Contaminants of concern include depleted uranium, asbestos, and PCBs.

SR-FA10 R Reactor Deactivation Activity

Deactivation will involve:

- Collection, packaging, and storing of scrap and sludge from the disassembly basin.
- De-ionization and evaporation of water from the disassembly basin.
- De-ionization and evaporation of water from Buildings 106 and 109.
- Filling of Buildings 106 and 109.
- Draining and collection of D_20 and contaminated H_20 from small piping.

Contaminants of concern include fission by-products, asbestos, tritium, Pu, and PCBs.

SR-FA07 Old HB Line Deactivation Activity

This Activity provides for project planning and facility characterization, removal, or fixation of residual radiological and industrial hazards, and the dismantlement and removal of residual equipment as necessary to ensure long term reduction of risks associated with this abandoned facility within H-canyon.

Contaminants of concern include fission by-products, asbestos, tritium, Pu, and PCBs.

SR-FA09 C-Reactor Deactivation Activity

Deactivation will involve:

- Collection, packaging, and storing of scrap and sludge from the disassembly basin.
- De-ionization and evaporation of water from the disassembly basin.
- De-ionization and evaporation of water from Buildings 106 and 109.
- Filling of Buildings 106 and 109.
- Draining and collection of D_20 and contaminated H_20 from small piping.

Contaminants of concern include fission by-products, asbestos, tritium, Pu, and PCBs.

SR-FA11 K-Reactor Deactivation Activity

Deactivation will involve:

- Collection, packaging, and storing of scrap and sludge from the disassembly basin.
- De-ionization and evaporation of water from the disassembly basin.
- De-ionization and evaporation of water from Buildings 106 and 109.
- Filling of Buildings 106 and 109.
- Draining and collection of D_2O and contaminated H_2O from small piping.

Contaminants of concern include fission by-products, asbestos, tritium, Pu, and PCBs.

SR-FA06 235-F Deactivation Activity

The primary objective of the multi-year deactivation program is to reduce the risks associated with these nuclear facilities and lower long term S&M costs. The objective for the surplus facilities is to achieve a passive state of S&M. The maintenance of the building structures and key safety systems (ventilation/monitoring) are expected to be the only routine activities required. It is expected that these conditions will be sustained for up to a 10-year period awaiting final decisions on facility D&D.

Contaminants of concern include Pu.

SR-FA03 FB Line Deactivation Activity

The primary objective of the multi-year deactivation program is to reduce the risks associated with these nuclear facilities and lower long term S&M costs. The objective for the surplus facilities is to achieve a passive state of S&M. The maintenance of the building structures and key safety systems (ventilation/monitoring) are expected to be the only routine activities required. It is expected that these conditions will be sustained for up to a 10-year period awaiting final decisions on facility D&D.

Contaminants of concern include residual radiological and industrial hazards.

SR-ER09 HWCTR Activity (D&D)

This Activity provides for all the aspects of D&D of the Heavy Water Components Test Reactor (HWCTR) from preparation of the Decommissioning Plan to the final release of the HWCTR Site.

Contaminants of concern include chemicals, radiological, and toxic materials.

5.3 EM activity descriptions (Controlled processing operations)[2,8,10]

SR-NM01 F-Area Stabilization Activity (S&M)

F-Area Stabilization Activity supports the safe Surveillance and Maintenance of Nuclear Material Stabilization facilities. This involves maintaining the facilities within their approved safety envelopes. The facilities are the F-Canyon, FB-Line, and 235-F. Inventories within these facilities include different isotopes of plutonium, americium, curium, and uranium. The activities involve operations, maintenance, radiological control, material control and accountability, emergency preparedness, engineering, quality assurance, and training.

SR-NM02 H-Area Stabilization Activity (S&M)

H-Area Stabilization Activity supports the safe Surveillance and Maintenance of Nuclear Material Stabilization facilities. This involves maintaining the facilities within their approved safety envelopes. The facilities are the H-Canyon and HB-Line. Inventories within these facilities include different isotopes of plutonium, uranium, and neptunium. The activities involve operations, maintenance, radiological control, material control and accountability, emergency preparedness, engineering, quality assurance, and training.

SR-HL02 F-Tank Farm (S&M)

Scope includes:

- 24-hour surveillance, monitoring, inspection, sampling and maintenance of 22 underground high level radioactive waste storage tanks (tank volumes range between 750,000 and 1,300,000 gallons each).
- Operation of Evaporator System.
- Waste Transfers (between tanks as well as from F-Canyon and to/from H-Tank Farm).
- Area Radiation and Storm Water Monitoring.
- Critical Maintenance Activities.

Contaminants of concern include liquid high-level radioactive wastes.

SR-HL01 H-Tank Farm (S&M)

Scope includes:

- 24-hour surveillance, monitoring, inspection, sampling, and maintenance of 23 underground high level radioactive waste storage tanks (tank volumes range between 750,000 and 1,300,000 gallons each).
- Operation of 2H evaporator system and Startup and Operation of the Replacement High Level Waste Evaporator (RHLWE).
- Waste Transfers (between tanks as well as from H-Canyon and DWPF, to/from F-Tank Farm, and to ITP/ESP).
- Area Radiation and Storm Water Monitoring.
- Critical Maintenance Activities.

299-H Maintenance Facility Operation (which has shielded maintenance cells for repairs to highly contaminated equipment).

Contaminants of concern include ^{90}Sr, ^{137}Cs, ^{238}Pu, ^{239}Pu, and ^{241}Pu.

SR-HL04 ITP/ESP (S&M)

Scope includes:

- 24-hour surveillance, monitoring, inspection, sampling, and maintenance of six 1.3-million gallon HLW tanks.
- Critical Maintenance Activities.

Contaminants of concern include ^{90}Sr, ^{137}Cs, ^{238}Pu, ^{239}Pu, and ^{241}Pu.

SR-HL09 Tank Farm Safety Activities

- Replace buried service piping with above ground piping.
- Replace deteriorated gang valve systems and enclosures.
- Upgrade cooling systems (pumps, heat exchangers, etc.).
- Electrical upgrades to alleviate overload conditions on electric supply/distribution equipment.
- Replacement of an aging, inadequate storm water system to alleviate existing flooding problems surrounding Tanks 9-12 in H-Area Tank Farm. This activity is required before installing waste removal structures (SR-HL03) on these tanks.

SR-HL08 Saltstone Operations

Scope includes:

- Receive and process approximately 4,000,000 gallons per year salt solution (combined total) from ITP, Late Wash, and ETF.
- Complete disposal vault capping as required.
- Review, revise, and maintain the closure plan.
- Design and construct additional Saltstone Vaults as needed.
- Critical maintenance activities.

Contaminants of concern include Cr, ^{99}Tc, ^{106}Ru, and ^{106}Rh.

SR-SF01 K-Reactor Spent Nuclear Fuel Activity (S&M and Operations)

The scope of this activity includes all programmatic and physical support efforts related to safe storage and handling of Spent Nuclear Fuels (SNF), as well as the stabilization required to maintain K-Reactor in the cold shutdown condition with no capability of restart. Surveillance & Maintenance (S&M) activities are included to ensure the facilities are maintained within their approved safety envelopes.

SR-SF02 L-Reactor Spent Nuclear Fuel Activity (S&M and Operations)

The scope of this activity includes all programmatic and physical support efforts related to safe storage and handling of Spent Nuclear Fuel (SNF), as well as the stabilization required to maintain L-Reactor in the cold shutdown condition with no capability of restart. Surveillance & Maintenance (S&M) activities are included to ensure the facilities are maintained within their approved safety envelopes.

SR-SF05 Heavy Water Operations (K Reactor and D Areas)

The shutdown of the heavy water (moderator) production reactors have resulted in an inventory of heavy water which poses concerns relating to storage and safety. The scope of this activity supports the consolidated storage of heavy water reserves within the K-Reactor facilities. The existing inventory, excluding the water in the reactor storage tanks, will be purified and isotopically upgraded in order to provide the smallest volume for storage, the lowest radiological hazard to workers and the public, and the highest potential for use for resale. In addition, this activity includes S&M of all facilities presently storing heavy water.

SR-FA18 M-Area Monitoring Activity (S&M)

This activity includes all programmatic and physical support efforts associated with maintaining the 300-M Area facilities in a safe and environmentally sound manner until transition to a decontamination and decommissioning (D&D) status is achieved and low cost S&M activities thereafter. The S & M program will be used to maintain facilities and support equipment for fire protection and other requirements.

Contaminants of concern include depleted uranium.

SR-SF02 L-Reactor SNF Activity (Fuel Receipts)

The scope of this activity includes the safe receipt, handling, and waste storage of foreign and domestic research reactor Spent Nuclear Fuels in the L-reactor fuel disassembly basin. These fuels will be transferred to the new Transfer and Storage Service (TSS) facility for interim storage in FY 2002.

SR-SF03 RBOF SNF Activity (Fuel Receipts)

This activity supports all activities that apply to fuel receipt, handling, storage, and shipping to other facilities. The fuel rods have been irradiated and are being stored until a final disposition is approved. Continued on-site shipments from RBOF to L-Basin are needed to conserve RBOF space reserved for those fuels and casks that can only be handled in RBOF. SNF in RBOF will begin to be transferred to the TSS for interim storage in FY-2002.

SR-NM01 F-Area Stabilization (DNFSB Activities)

Nuclear materials determined to be "at risk" in the Interim Management of Nuclear Materials Environmental Impact Statement, the Plutonium Vulnerability and Highly Enriched Uranium Assessments, and the DOE's DNFSB's 94-1 Implementation Plan will be transformed into safe, stable forms suitable for long-term interim storage while awaiting final disposition. This activity covers the stabilization of different isotopes of plutonium, americium, curium, and uranium.

SR-NM02 H-Area Stabilization (DNFSB Activities)

Nuclear materials determined to be "at risk" in the Interim Management of Nuclear Materials Environmental Impact Statement, the Plutonium Vulnerability and Highly Enriched Uranium Assessments, and the DOE's DNFSB's 94-1 Implementation Plan will be transformed into safe, stable forms suitable for long.-term interim storage while awaiting final disposition. This activity covers the stabilization of different isotopes of plutonium, uranium, and neptunium; and the de-inventorying of HB-Line materials for repackaging and/or storage.

SR-SF01 K-Reactor SNF Activity (Fuel Shipping)

The scope of this activity includes the preparation and shipment of DNFSB 94-1 fuels and target elements to the canyons and/or DWPF for stabilization and the safe disposition of these materials.

SR-NM03 Actinide Packaging Storage Facility (APSF) Line Item

This activity covers the design, construction, and startup of the APSF for the interim storage of plutonium metal and oxides. APSF will be located in F-Area. The APSF will consist of a hardened Material Access Area and associated support structures. Process areas and equipment will provide for truck unloading and loading, shipping container unpacking and packing, material confirmation, accountability measurements, International Atomic Energy Agency (IAEA) inspections, plutonium thermal stabilization, material storage, and waste handling.

SR-NM07 Depleted Uranium (DU) Storage

This activity covers the repackaging of all the material into a newly designed container, and construction of a new storage building with material handling cranes for ease of handling and inspection as well as repackaging and decontamination capabilities. The facility will provide safe and environmentally sound interim storage (40 years) while potential final disposition options for the DU are evaluated.

Contaminants of concern include depleted uranium.

SR-SF04 Heavy Water Reprocessing

This activity supports the purification and isotopical upgrade of heavy water inventory in order to provide the smallest volume for storage, the lowest radiological hazard to workers and the public, and the highest potential for use or for resale. Without reprocessing, an additional 1650 drums would be required for long term storage.

SR-SF09 Spent Nuclear Fuel Transfer and Storage

Current plans are to privatize this service through the "Request For Proposal" and competitive bid process. The successful bidder will secure capital funding through private sources, design, permit, build, start-up, and operate the facility. Compensation would be received based on the provision of receipt, characterization, conditioning, packaging, and dry storage services. In addition the initial capital outlay would be amortized and reimbursed over the first several years of facility operation.

The TSS will need to provide remote handling and heavy lifting (cask handling) capability, hot cells, and retrievable dry storage space for the equivalent of approximately 36,000 domestic and foreign research reactor SNF assemblies expected to be received at SRS over the next 40 years. The TSS will prepare the SNF for interim dry storage in a "road ready" package for shipping to a geologic repository or other storage site.

The following table is a listing of SRS activity titles and descriptions tabulated alphabetically by worker category.

Table 5-5 SRS Activity Titles and Descriptions Alphabetically by Worker Category

Contractor Code	Category[a]	Contact(s) or Reference	Activities Title and Brief Description	Exposure Type[b]	Driver[11c]	Time Line[d]	Duration	Workers per Activity
WSRC	CW	2, 8	FA18: M-Area Monitoring Activity includes all programmatic and physical support efforts associated with maintaining the 300 M-Area facilities in a safe and environmentally sound manner.	R	CERCLA RCRA State DOE Orders	1997 -2006	10 years	n/a
WSRC	CW	2, 8	HL01: H-Tank Farm (S&M) includes 24-hour surveillance, monitoring, inspection, sampling, and maintenance of 23 underground high level radioactive waste storage tanks.	R	DNFSB State	1997 -2006	10 years	n/a
WSRC	CW	2, 8	HL02: F-Tank Farm (S&M) includes 24-hour surveillance, monitoring, inspection, sampling and maintenance of 22 underground high level radioactive waste storage tanks.	R	DNFSB State	1997 -2006	10 years	n/a
WSRC	CW	2, 8	HL04: ITP/ESP Operations include the running of the large, high hazard Microfiltration Facility.	R	State	1997-2006	10 years	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
[c]CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; RCRA = Resource Conservation and Recovery Act; FFA = Federal Facility Agreement; DNFSB = Defense Nuclear Federal Safety Board; IAEA = International Atomic Energy Agency
[d] In situations where 1997 is listed as the starting date, these activities where funded in 1997. It is not known if funding began at an earlier date
[e] NF= No funding allocated during 1997 - 2006.
*See Contact list (Section 10) Steve M. King.

Table 5-5 SRS Activity Titles and Descriptions Alphabetically by Worker Category

Contractor Code	Category[a]	Contact(s) or Reference	Activities Title and Brief Description	Exposure Type[b]	Driver[11c]	Time Line[d]	Duration	Workers per Activity
WSRC	CW	2, 8	HL05: Vitrification Operations is the 24-hour operations of the Late Wash and Vitrification Facilities to immobilize high level radioactive waste in glass.	R	State	1995 -2006	12 years	n/a
WSRC	CW	2, 8	HL06: Glass Waste Storage includes: • Monitoring and maintenance of radiation monitors and temperature sensors. • Design and construction of a second glass waste storage building.	R	State	1995 -2006	12 years	n/a
WSRC	CW	2, 8	NM03: Actinide Packaging Line Item covers the design, construction, and startup of the APSF for the interim storage of plutonium metal and oxides.	R	DNFSB DOE Orders	1997 -2002	10 years	n/a
WSRC	CW	2, 8	NM07: Depleted Uranium Storage covers the repackaging of all material into a newly designed container and the construction of a new storage building.	R	DOE Orders	1997 -2006	10 years	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
[c]CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; RCRA = Resource Conservation and Recovery Act; FFA = Federal Facility Agreement; DNFSB = Defense Nuclear Federal Safety Board; IAEA = International Atomic Energy Agency
[d] In situations where 1997 is listed as the starting date, these activities where funded in 1997. It is not known if funding began at an earlier date
[e] NF= No funding allocated during 1997 - 2006.
* See Contact list (Section 10) Steve M. King.

Table 5-5 SRS Activity Titles and Descriptions Alphabetically by Worker Category

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WSRC	CW	2, 8	SF01: K-Reactor SNF Activity (Fuel Shipping) includes the preparation and shipment of DNFSB 94-1 fuels and target elements to the canyons.	R	DNFSB State DOE Orders	1997 -2006	10 years	n/a
WSRC	CW	2, 8	SF01: K-Reactor SNF Activity includes all programmatic and physical support efforts related to safe storage and handling of SNF, as well as the stabilization required to maintain K-Reactor in the cold shutdown condition.	R	DNFSB State DOE Orders	1997 -2006	10 years	n/a
WSRC	CW	2, 8	SF02: L-Reactor SNF Activity (Fuel Receipts) includes the safe receipt, handling, and waste storage of foreign and domestic research reactor SNF in the L-Reactor fuel disassembly basin.	R	DNFSB State DOE Orders	1997 -2006	10 years	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
[c]CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; RCRA = Resource Conservation and Recovery Act; FFA = Federal Facility Agreement; DNFSB = Defense Nuclear Federal Safety Board; IAEA = International Atomic Energy Agency
[d] In situations where 1997 is listed as the starting date, these activities where funded in 1997. It is not known if funding began at an earlier date
[e] NF= No funding allocated during 1997 - 2006.
[*]See Contact list (Section 10) Steve M. King.

Table 5-5 SRS Activity Titles and Descriptions Alphabetically by Worker Category

Contractor Code	Category[a]	Contact(s) or Reference	Activities Title and Brief Description	Exposure Type[b]	Driver[11c]	Time Line[d]	Duration	Workers per Activity
WSRC	CW	2, 8	SF02: L-Reactor SNF Activity includes all programmatic and physical support efforts related to safe storage and handling of SNF, as well as the stabilization required to maintain L-Reactor in the cold shutdown condition.	R	DNFSB State DOE Orders	1997 -2006	10 years	n/a
WSRC	CW	2, 8	SF03: RBOF SNF Activity (Fuel Receipts) supports all activities that apply to fuel receipt, handling, storage, and shipping to other facilities.	R	DNFSB DOE Orders	1997 -2006	10 years	n/a
WSRC	CW	2, 8	SF04: Heavy Water Processing supports the purification and isotopical upgrade of heavy water inventory.	R	RCRA DOE Orders	1997 -2006	10 years	n/a
WSRC	CW	2, 8	SF05: Heavy Water Operations (K Reactor and D Areas) supports the consolidated storage of heavy water reserves within the K-Reactor facilities. In addition, this activity includes S&M of all facilities presently storing heavy water.	R	CERCLA	1997 -2006	10 years	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
[c]CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; RCRA = Resource Conservation and Recovery Act; FFA = Federal Facility Agreement; DNFSB = Defense Nuclear Federal Safety Board; IAEA = International Atomic Energy Agency
[d] In situations where 1997 is listed as the starting date, these activities where funded in 1997. It is not known if funding began at an earlier date
[e]NF= No funding allocated during 1997 - 2006.
*See Contact list (Section 10) Steve M. King.

Table 5-5 SRS Activity Titles and Descriptions Alphabetically by Worker Category

Contractor Code	Category[a]	Contact(s) or Reference	Activities Title and Brief Description	Exposure Type[b]	Driver[11c]	Time Line[d]	Duration	Workers per Activity
WSRC	CW	2, 8	SF09: SNF Transfer and Storage provides remote handling and heavy lifting (cask handling) capability, hot cells, and retrievable dry storage space for the equivalent of approximately 36,000 domestic and foreign research reactor.	R	DOE Orders	1997 -2006	10 years	n/a
WSRC	CW	2, 8	SW02: Transuranic (TRU) Waste Activity is the removal of earthen cover and retrieval of 8,809 55-gallon drums on five TRU waste storage pads.	R	RCRA State	1997 -2006	10 years	n/a
WSRC	CW	2, 8	SW04: Low Level Waste Activity encompasses those activities and resources required for the safe, environmentally sound operations of the Solid Waste Low Level Waste facilities.	R	DNFSB DOE Orders IAEA	1997 -2006	10 years	n/a
B&W	DeW/ DiW	2, 8	ER09: HWCTR Activity provides for all the aspects of D&D of the HWCTR.	C,R	CERCLA	1994 -2006	13 years	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
[c]CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; RCRA = Resource Conservation and Recovery Act; FFA = Federal Facility Agreement; DNFSB = Defense Nuclear Federal Safety Board; IAEA = International Atomic Energy Agency
[d] In situations where 1997 is listed as the starting date, these activities where funded in 1997. It is not known if funding began at an earlier date
[e] NF= No funding allocated during 1997 - 2006.
[1] See Contact list (Section 10) Steve M. King.

Table 5-5 SRS Activity Titles and Descriptions Alphabetically by Worker Category

Contractor Code	Category[a]	Contact(s) or Reference	Activities Title and Brief Description	Exposure Type[b]	Driver[11c]	Time Line[d]	Duration	Workers per Activity
B&W	DeW	2, 8	FA03: FB Line Deactivation Activity reduce the risks associated with these nuclear facilities and lower long term S&M costs.	C,R	CERCLA RCRA DNFSB State DOE Orders	NF[e]	n/a	n/a
B&W	DeW	2, 8	FA06: 235-F Deactivation Activity will reduce the risks associated with these nuclear facilities and lower long term S&M costs.	C,R	CERCLA RCRA DNFSB State DOE Orders	NF[e]	n/a	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
[c]CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; RCRA = Resource Conservation and Recovery Act; FFA = Federal Facility Agreement; DNFSB = Defense Nuclear Federal Safety Board; IAEA = International Atomic Energy Agency
[d] In situations where 1997 is listed as the starting date, these activities where funded in 1997. It is not known if funding began at an earlier date
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B&W	DeW	2, 8	FA07: Old HB Line Deactivation Activity involves planning and facility characterization, removal, or fixation of residual radiological and industrial hazards.	C,R	CERCLA RCRA DNFSB State DOE Orders	NF[e]	n/a	n/a
B&W	DeW	2, 8	FA09: C-Reactor Deactivation Activity will involve collection, packaging, and storing of scrap and sludge, de-ionization and evaporation of water, draining and collection of D_20 and contaminated H_20 from small piping.	C,R	State DOE Orders	NF[e]	n/a	n/a
B&W	DeW	2, 8	FA10: R-Reactor Deactivation Activity will involve the collection, de-ionization and evaporation of water, and draining and collection of D_20 and contaminated H_20 from small piping.	C,R	State DOE Orders	NF[e]	n/a	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
[c]CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; RCRA = Resource Conservation and Recovery Act; FFA = Federal Facility Agreement; DNFSB = Defense Nuclear Federal Safety Board; IAEA = International Atomic Energy Agency
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Contractor Code	Category[a]	Contact(s) or Reference	Activities Title and Brief Description	Exposure Type[b]	Driver[11c]	Time Line[d]	Duration	Workers per Activity
B&W	DeW	2, 8	FA11: K-Reactor Deactivation Activity will involve collection, packaging, and storing of scrap and sludge from the disassembly basin, draining and collection of D_20 and contaminated H_20.	C,R	State DOE Orders	NF[e]	n/a	n/a
B&W	DeW	2, 8	FA15: M-Area Deactivation Activity involves the deactivation of the buildings in the 300-M area will involve: • Removing and disposing of all process related equipment. • Decontamination of facilities where feasible. • Clean out of residual hazardous and radioactive material.	C,R	CERCLA RCRA State DOE Orders	NF[e]	n/a	n/a
WSRC	DeW	2, 8	HL04: ITP/ESP (S&M) includes 24-hour surveillance, monitoring, inspection, sampling, and maintenance of six 1.3-million gallon HLW tanks.	C,R	State	1997 -2006	10 years	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
[c]CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; RCRA = Resource Conservation and Recovery Act; FFA = Federal Facility Agreement; DNFSB = Defense Nuclear Federal Safety Board; IAEA = International Atomic Energy Agency
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Contractor Code	Category[a]	Contact(s) or Reference	Activities Title and Brief Description	Exposure Type[b]	Driver[11c]	Time Line[d]	Duration	Workers per Activity
WSRC	DeW	2, 8	NM01: F-Area Stabilization (DNFSB Activities). Nuclear materials determined to be "at risk" will be transformed into safe, stable forms suitable for long-term interim storage.	C,R	DNFSB DOE Orders	1997 -2006	10 years	n/a
WSRC	DeW	2, 8	NM01: F-Area Stabilization Activity supports the safe S&M of nuclear material stabilization facilities F-Canyon, FB-Line, and 235-F.	C,R	DNFSB DOE Orders	1997 -2006	10 years	n/a
WSRC	DeW	2, 8	NM02: H-Area Stabilization (DNFSB Activities). Nuclear materials determined to be "at risk" will be transformed into safe, stable forms suitable for long.-term interim storage.	C,R	DNFSB DOE Orders	1997 -2006	10 years	n/a
WSRC	DeW	2, 8	NM02: H-Area Stabilization Activity supports the safe S&M of nuclear material stabilization facilities H-Canyon and HB-Line.	C,R	DNFSB DOE Orders	1997 -2006	10 years	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
[c]CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; RCRA = Resource Conservation and Recovery Act; FFA = Federal Facility Agreement; DNFSB = Defense Nuclear Federal Safety Board; IAEA = International Atomic Energy Agency
[d] In situations where 1997 is listed as the starting date, these activities where funded in 1997. It is not known if funding began at an earlier date
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Table 5-5 SRS Activity Titles and Descriptions Alphabetically by Worker Category

Contractor Code	Category[a]	Contact(s) or Reference	Activities Title and Brief Description	Exposure Type[b]	Driver[11c]	Time Line[d]	Duration	Workers per Activity
BSRI	HWW/ CW	2, 8, SMK*	ER01: Flood Plain Swamp Activity consists of preliminary evaluation, investigation, and implementation of remediation technologies to mitigate the impact of contaminants of concern. Includes 45 subactivities.	C,M,R	CERCLA RCRA FFA State DOE Orders	1993 -2006	14 years	n/a
BSRI	HWW/ CW	2, 8, SMK*	ER02: Four Mile Branch Activity consists of the preliminary evaluation, investigation, and implementation of remediation technologies to mitigate the impact of contaminants of concern. Includes 32 subactivities.	C,M,R	CERCLA RCRA FFA State DOE Orders	1993 -2006	14 years	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
[c]CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; RCRA = Resource Conservation and Recovery Act; FFA = Federal Facility Agreement; DNFSB = Defense Nuclear Federal Safety Board; IAEA = International Atomic Energy Agency
[d] In situations where 1997 is listed as the starting date, these activities where funded in 1997. It is not known if funding began at an earlier date
[e]NF= No funding allocated during 1997 - 2006.
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Table 5-5 SRS Activity Titles and Descriptions Alphabetically by Worker Category

Contractor Code	Category[a]	Contact(s) or Reference	Activities Title and Brief Description	Exposure Type[b]	Driver[11c]	Time Line[d]	Duration	Workers per Activity
BSRI	HWW/ CW	2, 8, SMK*	ER03: Lower Three Runs Activity consists of the preliminary evaluation, investigation, and implementation of remediation technologies to mitigate the impact of contaminants of concern. Includes 61 subactivities.	C,M,R	CERCLA RCRA FFA State DOE Orders	1993 -2006	14 years	n/a
BSRI	HWW/ CW	2, 8, SMK*	ER04: Pen Branch Activity consists of the preliminary evaluation, investigation, and implementation of remediation technologies to mitigate the impact of contaminants of concern. Includes 35 subactivities.	C,M,R	CERCLA RCRA FFA State DOE Orders	1991 -2006	16 years	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
[c]CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; RCRA = Resource Conservation and Recovery Act; FFA = Federal Facility Agreement; DNFSB = Defense Nuclear Federal Safety Board; IAEA = International Atomic Energy Agency
[d] In situations where 1997 is listed as the starting date, these activities where funded in 1997. It is not known if funding began at an earlier date
[e] NF= No funding allocated during 1997 - 2006.
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Contractor Code	Category[a]	Contact(s) or Reference	Activities Title and Brief Description	Exposure Type[b]	Driver[11c]	Time Line[d]	Duration	Workers per Activity
BSRI	HWW/ CW	2, 8, SMK*	ER05: Steel Creek Activity consists of the preliminary evaluation, investigation, and implementation of remediation technologies to mitigate the impact of contaminants of concern. Includes 35 subactivities.	C,M,R	CERCLA RCRA FFA State DOE Orders	1994 -2006	13 years	n/a
BSRI	HWW/ CW	2, 8, SMK*	ER06: Upper Three Runs Activity consists of the preliminary evaluation, investigation, and implementation of remediation technologies to mitigate the impact of contaminants of concern Includes 229 .	C,M.R	CERCLA RCRA FFA State DOE Orders	1990 -2006	17 years	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
[c]CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; RCRA = Resource Conservation and Recovery Act; FFA = Federal Facility Agreement; DNFSB = Defense Nuclear Federal Safety Board; IAEA = International Atomic Energy Agency
[d] In situations where 1997 is listed as the starting date, these activities where funded in 1997. It is not known if funding began at an earlier date
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Table 5-5 SRS Activity Titles and Descriptions Alphabetically by Worker Category

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BSRI	HWW/ CW	2, 8, SMK*	ER07: Program Management consists of post closure management, and facility support operation.	C,M,R	CERCLA RCRA State DOE Orders	1990 -2006	17 years	n/a
WSRC	HWW/ CW	2, 8	FA20: Reactors Monitoring Activity includes operation of the 105-C Waste Minimization Facility.	C, M, R	CERCLA RCRA State DOE Orders	1997 - 2006	10 years	n/a
WSRC	HWW/ CW	2, 8	HL03: Waste Removal includes outfitting 43 HLW tanks with waste removal equipment and three tanks with sludge processing equipment. Each tank will be filled with three different types of grout after waste is removed.	C,R	State	1997 - 2006	10 years	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
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Contractor Code	Category[a]	Contact(s) or Reference	Activities Title and Brief Description	Exposure Type[b]	Driver[11c]	Time Line[d]	Duration	Workers per Activity
WSRC	HWW/ CW	2, 8	HL07: Effluent Treatment Facility operations include receipt and processing of routine and peak transfers of waste water to support the safe maintenance of the Separations areas and Tank Farm Evaporator operations.	C,M,R	DNFSB State	1981-2006	26 years	n/a
WSRC	HWW/ CW	2, 8	HL08: Saltstone Operations includes receiving and processing approximately 4 million gallons per year of salt solutions.	C,R	State	1997 -2006	10 years	n/a
WSRC	HWW/ CW	2, 8	HL09: Tank Farm Safety Activities • Replace buried service piping and deteriorated gang valve systems. • Upgrade cooling systems.	C,R	DNFSB State	1997 -2002	6 years	n/a
BNFL	HWW/ CW	2, 8	SW01: Consolidated Incinerator Facility (CIF) provides for the operation of the CIF.	C,M,R	RCRA State DOE Orders	2000 -2006	7 years	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
[c]CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; RCRA = Resource Conservation and Recovery Act; FFA = Federal Facility Agreement; DNFSB = Defense Nuclear Federal Safety Board; IAEA = International Atomic Energy Agency
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WSRC	HWW/ CW	2, 8	SW03: Mixed Low Level Waste Activity encompasses those activities and resources required for the safe, environmentally sound operations of the Solid Waste Mixed Waste Facilities	C,M,R	RCRA State DOE Orders	1997-2006	10 years	n/a
WSRC	HWW/ CW	2, 8	SW05: Hazardous Waste Activity includes the receipt of waste from site generators, storage, and ultimate shipment offsite of newly generated hazardous wastes for treatment and disposal.	C,M,R	RCRA State DOE Orders	1997 -2006	10 years	n/a

[a]CW = Clean up Worker; DeW = Deactivation Worker; DiW = Dismantlement Worker; HWW = Hazardous Waste Worker
[b]C = Chemical; M = Mixed; R = Radiological
[c]CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; RCRA = Resource Conservation and Recovery Act; FFA = Federal Facility Agreement; DNFSB = Defense Nuclear Federal Safety Board; IAEA = International Atomic Energy Agency
[d] In situations where 1997 is listed as the starting date, these activities where funded in 1997. It is not known if funding began at an earlier date
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6.0 Work Force Demographics

6.1 General

A number of factors make the description and inventory of workers at SRS quite difficult. Currently, there are 12,000-13,000 workers at SRS who are employed by the four management partners: WSRC, BSRI, BNFL, and B&W. Not surprisingly, this number is changing significantly and frequently due to changes in skills requirements resulting from the dramatic changes in the activities prescribed for SRS by DOE. From the activities associated with nuclear materials production for which SRS was designed and in which the facility engaged for more than thirty years, the majority of current activities at SRS are directed toward stabilization and storage of nuclear processing materials, deactivation of nuclear processing equipment, and remediation of environmental contamination. According to all resources used in this study, the change in activities at SRS, from nuclear materials production to nuclear materials and equipment management and ER, will continue for many years. As a result of this ongoing change, the number of workers and the types of workers required to perform designated activities at SRS are also in a state of continual change. The term designated by DOE for this change in character and size of the work force is "restructuring."

A characterization of the population of workers involved in remediation activities at SRS is further complicated by the fact that much of the work on many of the activities is performed by subcontracted workers, the number of which is scheduled to be increased in coming years. One of the goals prescribed by NIOSH for the present study was to identify workers at SRS by job title or other industry designation and determine the number of such workers by remediation activity. To date, requests made to several SRS human resources contacts for the number and types of workers associated with specific activities have not been met. Considerable information has been gathered in efforts to understand the quite complex business relationships that exist among the four SRS management partners and the many subcontractors who perform much of the work at SRS. A thorough comprehension of these business relationships will be necessary to identify appropriate populations for meaningful health studies and to locate and retrieve relevant data on such populations.

There are several major factors that underlie the problems encountered when attempting to collect demographic information on SRS subcontractor populations. Most of these troublesome factors are related to the concepts and provisions incorporated in specifications included in each subcontract. These major factors are listed below, then discussed in detail following the listing.

1. Many subcontract fees are based on completion of task rather than worker-hour units.

2. When contracts do specify worker-hours unit, the number and identity of workers contributing invoiced worker-hours is usually not required.

3. Generation and maintenance of records may be specifically delegated to the subcontractor, while requiring only limited and summary records to be provided to the prime contractor.

4. In some cases, requirements for records generation and maintenance by "sub-subcontractors" may not be explicitly described in contract specifications.

5. All difficulties regarding contractual obligations relating to generation and maintenance of records by subcontractors are generally magnified when tertiary or even more distant subcontractors are employed.

Lengthy and detailed discussions about demographics of subcontractor populations were conducted with senior management, line management, human resources, and labor relations personnel at SRS. An overall consistent impression was given that subcontractor personnel record-keeping was considered a responsibility of the subcontractor rather than SRS. During these discussions, repeated queries were made about the procedures for establishment of contractual specifications, especially those relating to (1) characteristics of the contracted work force and (2) generation and maintenance of health and safety records. The responses to these queries were remarkably consistent.

In general, contracts are written to specify the:

- Tasks to be performed
- Time frame in which the tasks will be completed
- Regulatory requirements to be met
- Fees to be paid

Noticeably absent are specifications pertaining to the subcontractor work force per se. It seems apparent, and is confirmed by personal communications, that the number of workers and characteristics of those workers in the contractors' work forces are left to the discretion of the contractors. Payment of fees may be based on units of worker-hours, but the distribution of worker-hours among a contractor's work force is not specified within the contract. This means that 96 worker-hours may be contributed by one worker over 12 days or 4 workers over three days. For the purpose of the current study, while the number of worker-hours may be of some use, such records are not useful for identifying the workers actually involved in the activities of interest.

As expected, one of the prime specifications included in each contract let by SRS, is the meeting of all regulatory requirements for health and safety compliance, including personnel training, use of mandated methodologies and equipment, and generation and maintenance of required records. Again, during the many communications with SRS personnel on the subject of records and records maintenance, all of the SRS personnel described a consistent position taken by the site. As a plant policy, specifications for all required documentation of subcontractors' health and safety activities and management of the resulting records are supposed to be included in the original contract. There is some indication that subcontractors may be required to supply summary records at the time of contract closure. However, this policy appears to be implemented inconsistently.

In some cases, requirements for records generation and maintenance by subcontractors may not be explicitly described in contract specifications. According to SRS sources, the inclusion of such contractual requirements is the responsibility of the Facility Subcontract Representative who may or may not include them. Perhaps most significant, all difficulties regarding contractual obligations relating to generation and maintenance of records by subcontractors are generally magnified when tertiary or even more distant subcontractors are employed. At this time, the level of contractual control intended or actually maintained by SRS over tertiary subcontractors is uncertain.

In spite of the difficulties discovered in collecting demographic information on subcontractor populations, efforts are still underway to determine other sources of these data. Formal requests for basic demographics have been submitted to designated contacts in the Labor Relations and Human Resources (HR) Departments at SRS. The HR Department has provided a detailed analysis of the current SRS work force (not including subcontractors) categorized by employee type. According to the Labor Relations contact, the requested information pertaining specifically to construction crafts is available and will be delivered.

6.2 Current status of M&O work force

The remarkable changes in operations at SRS over the last 10-15 years have resulted in equally remarkable changes in the associated work force. Within the last four years, SRS has seen a reduction in force of more than 10,000 employees.[2] Further reductions in force are anticipated between 1997 and 2006, but at a much lower rate. Considerable effort is being expended in strategic planning for maintaining an appropriately skilled work force for planned activities while minimizing the impact of these significant changes on the working community as a whole.

The following sections were excerpted from the *SRS Accelerating Cleanup: Focus on 2006 Discussion Draft.*[2] The narrative and tables present a concise summary of the current status and immediate plans pertaining to plant demographics including worker age, length of service, and skill mix.

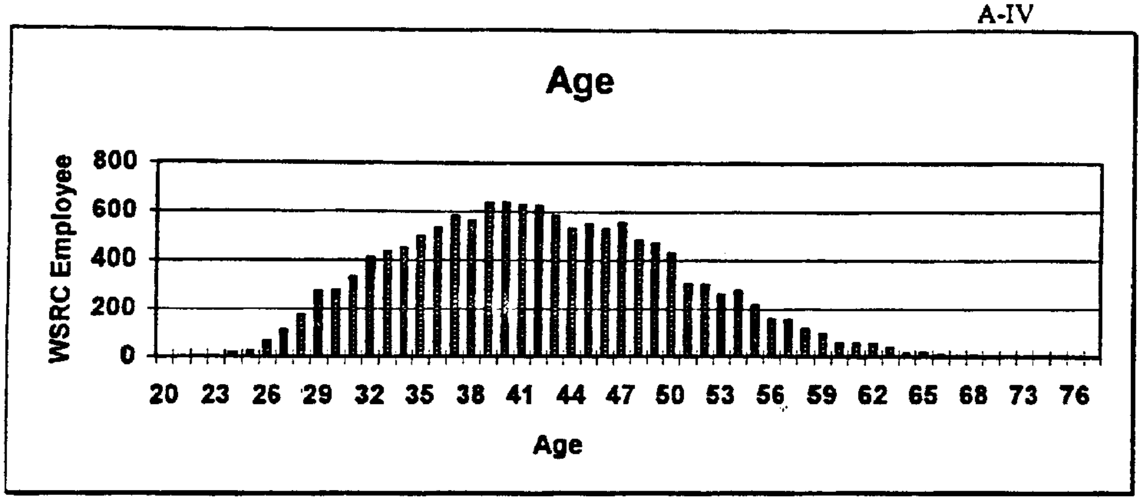
Demographic & Skill Mix

The average age and years of service for WSRC employees (including BSRI, BNFL, and B&W) is 47 and 22.5 years respectively. See graphs A-IV and B-IV for distribution and C-IV for skill mix.

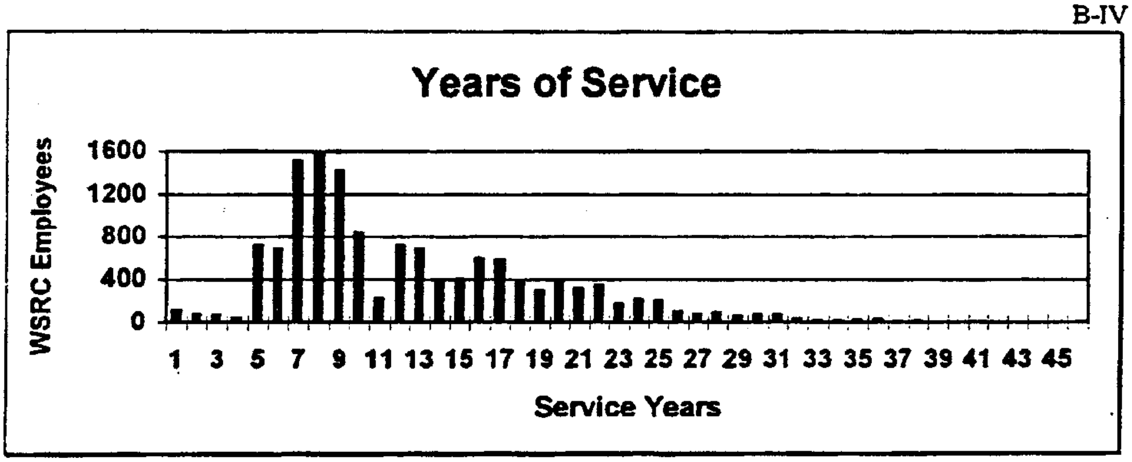
Attention is called to Tables 8-1 through 8-5 in Section 8: Exposures. These tables show the skill mix of the employees, which were designed by WSRC, for employees at the SRS which were classified as working in a "Waste Processing/Management" type facility.

Note: It is obvious to the writers that data in these graphs are incorrect or do not support statements made about these data on the previous pages.

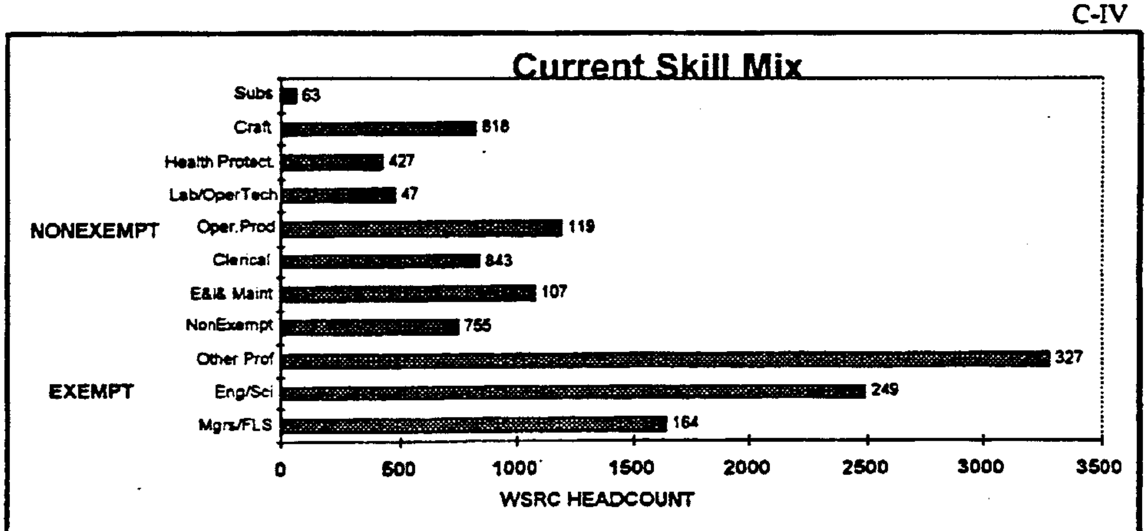
A-IV



B-IV



C-IV



Approximately 22% of the site's work force will be eligible for retirement by 2006, leaving 78% of the current relatively stable work force available through 2006.

Graph C-IV on the previous page lists the current SRS skill mix. Of the skills listed, the following are considered most likely to be of interest to NIOSH regarding this activity: Subs, Craft, E&I& Maintenance, and Nonexempt. The bulk of the workers in these job titles would be considered Hazardous Waste Workers; however, these people may also be considered Clean Up Workers, Deactivation Workers, and Dismantlement Workers for some activities.

Table 6-1 below was extracted from the information in Table 8-5 in Section 8.2.

Table 6-1 Demographic Description of SRS Workers

Category	Contractor	No. Workers	Industry Profile	Top 5 Job Titles	No. Workers	Primary Activity Titles
HWW [a]	Bechtel Construction	570 [b]	Solid, Hazardous, and Mixed Waste Remediation	1. Electrician 2. Pipe Fitter 3. Laborers 4. Misc Repair 5. Carpenters	1. 100 2. 84 3. 80 4. 57 5. 34	Waste Remediation
HWW [a]	Westinghouse Savannah River Site Subcontractors	218	Solid, Hazardous, and Mixed Waste Remediation and D&D of contaminated sites	1. Misc[d] 2. Misc Repair & Construction	1. 212 2. 6	Waste Remediation and D&D
HWW [a]	Westinghouse Savannah River Company	3,093 [c]	Solid, Hazardous, and Mixed Waste Treatment, Storage, and Disposal Workers,	1. Misc 2. Operators 3. Mechanics 4. Rad Techs 5. Other Techs	1. 419 2. 361 3. 360 4. 114 5. 58	Solid, Hazardous, and Mixed Waste Treatment, Storage, Disposal, Transportation, and Systems Maintenance

[a] Bulk of the activities involves HWWs; however, on some activities, these people may also be considered CW, DeW, and DiW.
[b] This information includes 151 administrative, technical, and clerical support personnel and is based on the 1996 REMS data available on the Internet at site http://REMS.EH.DOE.GOV
[c] This information includes 1,449 administrative, technical, and clerical support personnel and is based on the 1996 REMS data available on the Internet at site http://REMS.EH.DOE.GOV
[d] The REMS database only contains job classifications. The jobs of all persons reported to that system have their jobs fit into those classifications.

Attrition, Critical Skills & Subcontractors[2]

Historically, attrition has been running approximately 2.8% to 3.0% over a period of five years (without considering work force restructuring). SRS M&O contractors have maintained critical skills via selective hiring, reduction of force, and a blend of privatization outsourcing and fixed price subcontracting. (See Graph C-IV for current entire WSRC work force skill mix.) SRS plans to maximize subcontracts for short-term critical skills and maintain its critical core competency skills to support longer term mission and mission viability. Construction craft skills will continue to follow the normal ebb and flow of construction activity for all SRS activities.

Community Impact[2]

After the 10,000 reduction in force of the last four years and the current planned FY97 reduction (to accommodate FY98 funding and scope decrease), the major community impacts have already occurred, and continue to be felt, e.g., soft real estate market. The Discussion Draft[2] activities a gradual decrease in WSRC staffing from 12,200 (at the end of calendar year 1997) to about 10,000 at the end of the planning period. The flat funding profile along with normal staffing attrition and critical skill hiring will hopefully minimize any further negative community impact due to previous major staffing reductions. Flat funding planning (without the previous major voluntary and involuntary work force reduction) significantly improves the ability to plan and mange work force population and skills.

Challenges[2]

In order to accomplish other Discussion Draft objectives such as reducing support costs, (costs for support activities include fire protection, human resource support, etc.), a significant challenge exists to achieve a proper balance of work force skills without unnecessary reductions in force. Support-type employees may be retrained so that they could work in a direct mission area. If the retraining is not completely successful, there may be reductions in force in support areas, with offsetting new hires for specific mission activities. It is not possible at this time to predict the precise fiscal years, if any, in which such restructuring actions would be necessary. These actions would also be highly dependent upon the degree of success in achieving the efficiency challenges. To the extent that savings achievements permit SRS to undertake work not currently included in the Discussion Draft work scope, the required skill mix could change radically. Since the work to be added would depend on the work accomplished and the priorities at that point, the required skills cannot be accurately defined in advance but could well require significant restructuring of the work force.

The following table shows the distribution of employees at SRS (February 1997) categorized by type of worker and immediately planned changes in this distribution resulting from necessary work force restructuring.

Table 6-2 WSRC/BSRI Work Force Analysis (February 1997)[2]

	WSRC	BSRI	LSE	Sub	Total
Managers and First Line Supervisors (FLS)					
Managers	1,026	112		1	1,139
FLS	495	1			496
Managers & FLS	1,521	113		1	1,635
Professionals (Administrative)					
Administrative Advisor	28	2			30
Administrative Assistant	73	7			80
Meeting Planner	3				3
Contracts Administrator	6	29			35
Education Outreach	5				5
Ethics	2				2
Field Procurement Engineering	36	11			47
Financial	163	2			165
Human Resources	42	8			50
Intellectual Property	2				2
Labor Relations		2			2
Legal	6	1			7
Material Engineering	11	0			11
Paralegal	3				3
Procurement	116	11			127
Subcontract Technical	8	3		69	80
Training	100	11		6	117
Library	2				2
Media Services	8				8
Procedure Systems	5				5
Records/Information	19	1			20
Technical Editing	7				7
	4				4
Video Systems	1				1
Audit	11				11

Table 6-2 WSRC/BSRI Work Force Analysis (February 1997)[2]

	WSRC	BSRI	LSE	Sub	Total
Investigations					
Administration Lead	133	23			156
Public Relations	24				24
Project Administration	8	2			10
Asset Management	10	1			11
Facility Management	22				22
Material Management	22	1			23
Property Management	6	2			8
Administrative	892	117		75	1,084
Operations					
Cost Controls	12	29			41
Estimating	9	9			18
Planning/Scheduling	38	32			70
Program Planning	55	3			58
Project Controls	44	66			110
Construction Management		21			21
Emergency Preparedness	32				32
Emergency Response	4				4
Fire Protection	10				10
Safety	30	9			39
Security	24				24
Operations Lead	203	37			240
Maintenance Support	85	1			86
Operations Support	183	10			193
Procedures	100	5		2	107
Technical Support	137	33			170
OPS/Technical Training	150	2		68	220
Non/Technical Training	16				16
Work Control	157	11			168
Construction Coordination	4	87			91
Construction Engineering		150			150
Designer	1	57			58
Project Engineer	2	22			24

Table 6-2 WSRC/BSRI Work Force Analysis (February 1997)[2]

	WSRC	BSRI	LSE	Sub	Total
Project Management	59	10			69
Startup/Test Engineering	3	9			12
Quality Assurance	124	20			144
Quality Control Engineering	25	18			43
Hazardous Materials	11				11
Household Services					
Traffic Services					
Vehicle Services					
Operations	1,518	641		70	2,229
Technical					
Engineer	241	19		12	272
A-Criticality Engineer	31				31
A-Design Engineer	107	207		10	324
A-Process/Chem Engineer	254	14			268
A-Project Control Engineer	1				1
A-R&D Engineer	196	7			203
A-Regulatory Engineer	14	1			15
A-Safety Compliance Engineer	92				92
A-Sys/Con Engineer	299	49			348
A-Telecommunication Engineer					
A-Computer Engineer	12				12
A-Configuration Engineer					
A-Waste Certifiers Engineer					
Scientist	171	1			172
A-Chemist	65				65
A-Geoscience Professional	16	5			21
Technical Advisor	86	15			101
Classification Security	5				5
Environmental	114	10			124
Facility Evaluation Board	10				10
Laboratory Support	8	1			9
Non-Destructive Examination	17	3			20
Nuclear Accountability	8				8

Table 6-2 WSRC/BSRI Work Force Analysis (February 1997)[2]

	WSRC	BSRI	LSE	Sub	Total
Nuclear Material	8				8
Waste Certification	30	2			32
Health Physics	22				22
Industrial Hygiene	10				10
Computer Security	7	0			7
Computer Support	248	14		10	272
Process Computing	50				50
Technical Lead	106	5			111
Medical Doctor	8				8
Nursing	17				17
Optometry	1				1
Psychology	1				1
Program Management	44	1			45
Technical	2,299	354		32	2,685
Professional	4,709	1,112		177	5,998
NonExempt (WSRC)					
Operator - Separations	444				444
Operator - Tritium	101				101
Operator - DWPF	158				158
Operator - Reactor	103				103
Operator - Reactor Materials	74				74
Operator - Waste Management	291				291
Operator - Power	74				74
Mechanic - Equipment Repair	39				39
Mechanic - E&I	633				633
Mechanic - Maintenance	439	2			441
Quality Inspector	87				87
Medical	11				11
Rad Control & Health Protection	427			6	433
Laboratory	398			3	401
Industrial Hygiene	16				16
Mobile Equipment	92				92

Table 6-2 WSRC/BSRI Work Force Analysis (February 1997)[2]

	WSRC	BSRI	LSE	Sub	Total
Operations Technician	74				74
Railroad	10				10
Material Processor	88		7		95
Clerical	850	8		1	859
Computer Systems	23	1			24
Drafter	18				18
General Service Operator	18		2		20
Illustrator	9				9
Photography	6				6
Reproduction	27				27
Rigger	67				67
Glassblower	2				2
Locksmith	4				4
Emergency Response Serv - Other	18				18
Emergency Response Serv - Sr.	40				40
Emergency Operating Center	10				10
WSRC NonExempt	4,651	11	9	10	4,681
BSRI/Construction Craft					
Non Manual BSRI - Office & Clerical		75			75
Non Manual BSRI - Technicians		16			16
Construction Craft - Craft Workers		822			822
Construction Craft - Operatives					
BSRI/Construction Craft		913			913
NonExempt	4,651	924	9	10	5,594
Exempt and NonExempt Total	10,881	2,149	9	188	13,227

6.3 Locating subcontract workers for epidemiologic study

During the conduct of this study, WSRC contacts repeatedly confirmed that a large portion of remediation activities have been, and will be, performed by subcontract workers. The preferred procedure calls for virtually all aspects of a subcontracted project to be within the responsibility of the primary subcontractor. In addition to performing the physical activities prescribed within the subcontract, these aspects include, but are not limited to, hiring of workers, assuring that workers meet required certifications, performing required monitoring of workers, management of required monitoring records, and submission of required occupational reports to appropriate agencies. An exception to this protocol involves the monitoring of subcontract workers for exposure to radiation. Currently, WSRC continues to designate the type of monitoring devices to be used, provides (possibly for a fee) the monitoring devices, and maintains records of data generated from the monitoring devices. Monitoring records for subcontract workers can be identified within the total monitored population at WSRC, however, the subcontract workers are not identified by subcontractor, nor by subcontract. Considering these facts, the pathway necessarily followed to identify subcontract workers would be the following:

1. Identify remediation activity of interest. Information about completed, ongoing, and planned remediation activities can be collected from public documents, Internet sites, or this report.

2. Identify contract number of the activity of interest from WSRC, BSRI, B&W, or BNFL managers in ER, D&D, and Waste departments. If possible, at this time also identify the activity Subcontractor Technical Representative (STR). The STR for each activity should be familiar with, and has oversight for, almost all aspects of the activity including approval of completed work.

3. Identify the primary subcontractor(s) for the activity of interest from WSRC Procurement Department. All contracts are issued through the Procurement Department, and this is the location of records containing contract titles, numbers, and dates; and contractor names.

4. Contact primary subcontractor(s) to identify employees performing work specified in activity of interest. At this time the primary subcontractor(s) should also be asked to identify any other subcontractors that participated in the activity of interest.

5. If additional subcontractors are identified by the primary subcontractor, steps (4) and (5) should be iterated until all subcontract workers have been identified.

7.0 Technologies

7.1 Descriptions of major technologies

A number of technologies are used at the SRS to remediate hazardous or radioactive waste sites. The major technologies used are briefly described below.

Air Sparging[12,13,14]

Air sparging, soil venting, in situ air stripping, or in situ volatilization are the various names used for this soil treatment technology for removing VOCs from the saturated zone. Air is injected into contaminated ground water and displaces the water in the soil pore spaces and causes the soil contaminants to desorb, volatilize, and enter the saturated zone vapor phase. Dissolved ground water contaminants also volatilize into the saturated zone vapor phase and migrate up through the aquifer to the unsaturated zone. The soil vacuum extraction system then removes the contaminants as described below.

An advantage is that in addition to the mass-transfer mechanism of air sparging, it also increases biodegradation by increasing the oxygen content of the groundwater. Other advantages are that it is an in situ source control process which eliminates the need for discharge of treated water as in conventional pump and treat processes; it takes advantage of more than one treatment mechanism (i.e. aerobic biodegradation, volatilization from non aqueous phase liquids, and stripping from water); and air sparging is associated with soil vapor extraction which is recognized as a cost effective source control remedy.

Disadvantages are the fact that there is little fundamental knowledge as a result of insufficient scientific research on air sparging, and carefully controlled soil vapor extraction techniques must be employed to compensate for the net positive pressure created in air sparging to prevent contaminant migration to previously uncontaminated areas.

Air Stripping[13]

Air stripping is a full-scale technology in which VOCs are separated from groundwater by greatly increasing the surface area of the contaminated water exposed to air. This process is generally conducted in a packed tower or an aeration tank. Packed tower air strippers include a spray nozzle at the top of the tower to distribute contaminated water over the packing in the column, a fan to force air countercurrent to the water flow, and a sump at the bottom of the tower to collect decontaminated water. Aeration tanks involve the injection of air creating an air lift pumping system due to the density gradient. This causes the ground water with entrained air bubbles to rise and separate volatile contaminants from dissolved to vapor phase. Ground water is recirculated through the stripping well until remediation goals are met.

Air stripping is used to separate VOCs from water. It is ineffective for inorganic contaminants. Henry's law constant is used to determine whether air stripping will be effective. (Generally, organic compounds with constants greater than 0.01 atmospheres - m^3/mol are considered amenable to stripping). Some compounds that have been successfully separated from water using air stripping include chloroethane, trichloroethylene (TCE), dichloroethylene (DCE), and perchloroethylene (PCE).

Barometric Pumping (Baroball)[13]

Barometric pumping, also know as Passive Soil-Vapor Extraction (PSVE), takes advantage of natural pressure gradients to cause the flow of contaminant-laden subsurface air from the vadose zone to the surface. These gradients are caused by changes in atmospheric pressure which fluctuate diurnally and with the movement of large air masses. When atmospheric pressure increases, permeation into the soil occurs, opposed by the viscosity of air as it passes through small openings to pressurize soil pores. Then, after surface pressure drops, the pressurized pores act as a reservoir of compressed air that tries to flow to the surface.

The baroball increases the effectiveness of barometric pumping by using a simple valve to prevent the inflow of air into a venting well from the atmosphere but allow gas to flow from the well to the atmosphere. Air flowing into a well can reduce contaminant removal by diluting and disbursing the pollutant.

Application of passive soil-vapor extraction systems involves the creation and utilization of pathways to produce a directed air flow in response to natural pressure changes. Because the driving force for flow is free, the technology is inherently inexpensive.

A major advantage of barometric pumping and the baroball are that they can remove residual contamination effectively and efficiently without the need for main-powered vacuum pumps and blowers. As a result, it offers large cost savings in capital investment, maintenance, and cost of operations compared to the conventional active VOC extraction methods. It also will work for any contamination vapor in the vadose zone (i.e., above the water table).

Bioremediation[13,15,16,17,18,19,20]

Bioremediation, or bioreclamation, uses microorganisms such as bacteria, fungi and yeast, or their extracts, to dissolve and/or degrade organic contaminants such as oil, gasoline, detergents, polychlorinated hydrocarbons, pesticides, and gases or inorganic contaminants in soil and water, and render them harmless. Bioremediation is most efficient as a polishing step used in conjunction with some other type of treatment that results in trace amounts of toxic pollutants in large volumes of soils or industrial effluents. To optimize the bioremediation process, variables such as temperature, pH, dissolved oxygen concentration, nutrient concentration, redox potential, and rate of mixing are controlled.

A major advantage of bioremediation is that the cost is roughly one-third to one-half of conventional chemical and physical remediation technologies, and it is faster than many other methods. In addition, because treatment is in situ, the risk of worker exposure is reduced significantly. However, microbial activity can be inhibited by factors such as high concentrations of heavy metals, the presence of toxic organic substances such as chlorine and inorganic salts, and the formation of toxic byproducts.

Bioventing[13,21]

Bioventing is an adaptation of soil vapor extraction to treat relatively non-volatile materials, such as diesel fuel oil in soil. In addition it is useful for reducing the cost of air pollution abatement for in situ treatment of biodegradable volatile materials, such as gasoline and non-halogenated solvents. Bioventing is the process of providing a flow of oxygen through the contaminated soil and allowing a slight negative pressure due to low gas flow rates. This combined with adequate soil moisture, controlled through humidification of the injected air, maximizes biodegradation and reduces the amount of mechanical stripping necessary through soil vapor extraction. The advantages are that the equipment is simple, the process takes advantage of natural processes, and the recirculation of extracted soil gas to injection wells can greatly reduce air pollution abatement costs. The disadvantages are there is a slightly increased risk of spreading volatiles through the soil gas to previously uncontaminated areas, and this method only works for cleaning up hazardous material that is readily biodegradable.

Capping (Low permeability cover, Kaolin, and Geosynthetic)[22,23,24]

Cap Closure technology utilizes a variety of material from low permeability soil to geosynthetic covers all designed to stabilize the waste and stop infiltration of rainwater. Once the waste has been stabilized, if it still contains hazardous material, the area (usually a basin or ditch) will be topped with a cap.

Depending on the amounts of hazardous waste left, caps may just be nothing more than a backfilling of earth, a low permeability cover, or some highly impervious material in order that no ground water will be moving through the hazardous substances. Two types of capping widely used at Savannah River are the Kaolin clay cover and the Geosynthetic cap. The traditional Kaolin clay cover layers a foundation layer of 2 feet of native soil, two 1 foot rock areas which serves as a gas vent and drainage layer and sandwiches a 2 foot Kaolin clay barrier that protects the waste from surface water. These layers are covered with soil and grass or with other materials depending on the planned usage. The use of the Geosynthetic cap reduces the thickness of a like cap by about 4 feet since it is 1 inch thick and takes the place of the two rock layers and the Kaolin clay.

Catalytic Oxidation[13]

Oxidation equipment is used for destroying contaminants in the exhaust gas from air strippers and Soil Vapor Extraction (SVE) systems. Catalytic oxidation is a relatively recently applied alternative for the treatment of VOCs in air streams resulting from remedial operations. The addition of a catalyst accelerates the rate of oxidation by adsorbing the oxygen and the contaminant on the catalyst surface where they react to form carbon dioxide, water, and hydrochloric gas. The catalyst enables the oxidation reaction to occur at much lower temperatures than required by a conventional thermal oxidation.

Catalyst systems used to oxidize VOCs typically use metal oxides such as nickel oxide, copper oxide, manganese dioxide, or chromium oxide. Noble metals such as and platinum and palladium may also be used.

More than 20 firms manufacture catalytic oxidation systems specifically for remedial activities. These firms will generally supply the equipment to remedial action contractors for integration with specific remedial technologies, such as in situ vapor extraction of organics from soil or air stripping of organics from groundwater.

Despite its relatively newer application in remedial activities, catalytic oxidation is a mature technology, and its status as an implementable technology is well established. Nevertheless, the technology continues to evolve with respect to heat recovery techniques, catalysts to increase destruction efficiency and/or to extend the operating life of the catalyst bed, and performance data on a wider range of VOCs.

Cone Penetrometer Gamma Probe

Cone penetrometers are used for in situ characterization of VOCs within the soil profile, in the vadose zone, or an aquifer headspace. The apparatus consists of a penetrometer for penetrating the soil and a gas chromatograph instrument for detecting the VOCs present in the subsurface or gamma detectors for detecting gamma emitters in this subsurface.

Cone penetrometers bring the interrogative method to the sample in its native environment, providing faster, safer, and more cost-effective characterizations. The DOE has recently purchased a mobile Site Characterization and Analysis Penetrometer System (SCAPS) to transport around the country for taking samples. Cone penetrometers not only provide valuable information about the hazardous components of the subsurface, it also provides physical, geochemical, and geophysical information about the subsurface. At SRS, they are using it with gamma detectors on the probe. Because it is less invasive and no waste cuttings are brought to the surface as with traditional drilling methods, the potential for exposure of site exploration personnel is minimized. This is a relatively new technology and the disadvantages have not yet been discovered.

Decontamination[25]

Decontamination involves a large number of technologies ranging from very simple procedures to highly technical processes. Examples include brushing, washing, steaming, grinding, blasting, dissolving, extraction, and electrical migration. Many of these technologies are common industrial procedures requiring little special training or equipment. Additional controls may be required to protect decontamination workers from spray or dust generated. Often, decontamination of facilities, equipment, or materials may be more costly than disposal.

Demolition (Conventional)[26]

Conventional demolition involves destruction of concrete and other structural materials using wrecking balls and hydraulic or pneumatic hammers. This is an accepted, mature technology requiring commonly available equipment and requiring little specialized training. During demolition, a large amount of dust is often generated and it is usually impractical to contain. Also, any reinforcing steel encountered has to be cut by other means.

Dismantlement[26]

Dismantlement includes a variety of disassembly activities for the purpose of removing contaminated structures, parts, or materials, in some cases separating these from uncontaminated structures, parts, or materials. Salvage of uncontaminated structures, parts, or materials may be possible. Dismantlement activities may present high potential for exposures to contaminants as well as potential for physical injury. Dismantlement may result in reclamation of valuable equipment or materials, but also may be more costly than total disposal.

Equipment Removal (Conventional Disassembly)[26]

Conventional disassembly includes sawing with toothed or abrasive blades or severing with edged tools (chisels) and dismantling by removing fasteners. Cutting can be done in air or under a liquid, using power or hand tools. This is a common and accepted technology requiring inexpensive equipment and little specialized training, and there is little danger of equipment contamination. Adaption of the technology for use by remote manipulation will be required for certain equipment and facilities.

Incineration[26]

Incinerators operating at temperatures of 870°C to 1200°C are used to volatilize and combust with oxygen, halogenated and other refractory organics in hazardous waste. These incinerators can be used to meet the 99.9999% efficiency requirements for polychlorinated biphenyls (PCBs) and dioxins.

Incinerator off-gas requires treatment by an air pollution control system to remove particulates and neutralize and remove acid gases.

Incineration is used to remediate soils contaminated with hazardous waste. It's advantage is that it can dispose of waste contaminated with dioxins and PCBs which are extremely difficult if not impossible to dispose of in other ways. Some of its disadvantages are: (1) there is a limited number of incinerators licensed to burn dioxins and PCBs, (2) there are feed and material handling required that impact applicability and cost, (3) some contaminants cause operational problems, (4) volatile heavy metals (cadmium, lead, mercury, and arsenic) leave the combustion unit with the flue gases and require gas cleaning systems for removal.

Institutional Controls

If contamination cannot be stabilized or remediated satisfactorily, the area may be fenced off or entry otherwise controlled or other administrative actions taken that will minimize the possibility that damage will be done to people or the environment by this contamination.

Jet Grouting[24]

Jet grouting involves the injection of various grouting agents into soil/waste matrices that result in forming a soil/waste/grout monolith that has a natural analog of a long-lived material. The grouting material cements the waste in place, thus encapsulating the waste in a block that is impervious to water migration. The technique can also be used as an intermediate stage to solidify waste to prevent future aerosolization of contaminants, should retrieval be necessary. This technology has the potential to significantly reduce worker exposure.

Jet grouting technology that is capable of isolating waste material from the natural environment has several advantages. The technology can stabilize a variety of DOE sites; is compatible with complex mixtures of various contaminants; isolates and encapsulates buried materials containing radioactive and other hazardous waste; is applicable to various waste forms and surrounding materials, and isolation of buried structures such as waste storage tanks; and has a natural analog, both in formation and longevity.

Pump and Treat and (Reinject)[27,28,29,30]

Pump and treat, also called extraction and treatment, is the most common process for remediating contaminated ground water. Over 35% of remediation activities include pump and treat methods. It is useful for aqueous phase contamination removal as well as hydraulic containment of plumes. In a pump and treat system, the extraction well field is configured to contain and remove a contaminant plume from an aquifer. Once contaminated water is extracted, a treatment system is implemented to remove the hazardous components to a degree that meets effluent standards for reinjection or surface water discharge. If it meets reinjection standards, it is usually reinjected.

The advantages of pump and treat are clearly the removal of the contamination and restoration of the water to a useable condition. This method of remediation has been practiced for a relatively long time and there is considerable evidence of its successfulness. However, it is costly and there are some limitations to using pump and treat methods. After an initial period of pumping, the percentage of contaminant being extracted per unit volume of water decreases dramatically and it literally takes years and years to effectively remove the trace levels of contaminant required to achieve a level of purity that meets today's drinking water standards. It is often recommended that other remediation strategies such as bioremediation be used in conjunction with pump and treat.

Real Time Analysis

Real time analysis is any analyses for which the results are available simultaneously with the measurement. We have not had the opportunity to determine what analyses is involved or whether they all are a single technique such as a recording pH or gamma detector. A look at the subactivities' real time analysis show that most are associated with basins, pits, piles, or outfalls. These appear to be situations where it might be hazardous or difficult to sample for laboratory analysis and that samplings are done with a real time instrument which can be read remotely.

Recirculation Wells[31,24]

Recirculation wells are used to treat contaminated ground water by pumping the water into the bottom of the well, aerating the water within the well to volatilize the VOCs, extracting the gases for above ground treatment, and releasing the clean water from the top of the well without bringing it to the surface. The reintroduction of the clean water above the water table creates a circulation cell which moves contaminated water into the well for treatment.

With recirculation wells, remediation is achieved faster, more efficiently, and less expensively than with traditional pump and treat methods or air stripping. Many of the pump and treat wells in place today can be adapted for this use. This type of "in-well stripping" is applicable to any strippable contaminant including chlorinated solvents and hydrocarbons such as the aromatic components in petroleum fuels. However, many aquifers are too deep for full penetration by a well to be practical. In addition, full penetration wells have a tendency to mix a contaminant throughout the aquifer depth, making it more difficult to remove. Therefore, partially penetrating recirculating wells (i.e. wells that extend only partially through the aquifer) are more commonly used at this time.

Remove and Backfill or (Capping)[24]

Contamination can be just removed and relocated. In some cases when this removal leaves a depression or a ditch, it will be backfilled with available uncontaminated soil. In other situations, if removal did not bring the level of hazardous waste to the desired point, it could be necessary to cap the remaining waste. There is a separate listing for capping in this section.

Soil Mixing[32]

Soil Mixing, auger mixing, etc. also known as In Situ Enhanced Soil Mixing (ISESM), has been used for a number of years in the construction industry. It is a treatment technology that has been demonstrated and deployed to remediate soils contaminated with VOCs. Soils are mixed with a single-blade auger or with a combination of augers ranging in diameter from 3 to 12 feet. Cement grout is typically mixed with soil to create a foundation system or barrier wall. Mixing is likely to be effectively applied to depths of 40 feet, although commercial venders have worked at depths as great as 100 feet with the smaller diameter augers. Worker safety risks for all the processes include those associated with standard drilling operations and potential exposure to VOCs and particulates in off-gas.

The major advantages of ISESM is that it encompasses a number of in situ technologies that can treat contaminated soils, especially those of a fine-grained nature, which are difficult to treat with other remediation technologies. Contaminants are either removed from the soils or stabilized in place. The mixing process allows good access for reagent delivery to all soil particles. ISESM is also attractive for contaminated sites that contain low permeability soils that cannot be remediated using other technologies. It is particularly suited to shallow applications, above the water table, but can be used at greater depths.

Soil Washing[13]

Soil washing is a water-based process for scrubbing soils ex situ to remove contaminants. The process removes contaminants from soils in one of two ways: (1) by dissolving or suspending them in the wash solution (which is later treated by conventional wastewater treatment methods) or (2) by concentrating them into a smaller volume of soil through particle size separation, gravity separation, and scrubbing.

Soil washing systems incorporating the most removal techniques offer the greatest promise for application to soils contaminated with a wide variety of heavy metals, radionuclides, and organic contaminants. Washing processes that separate the fine clay and silt particles from the coarser sand and gravel soil particles effectively separate and concentrate the contaminants into a smaller volume of soil that can be further treated or disposed of . Gravity separation is effective for removing high or low specific gravity particles such as heavy metal-containing compounds.

At the present time, soil washing is used extensively in Europe but has had limited use in the United States. It is most commonly used in combination with the following technologies: bioremediation, incineration, and solidification/stabilization. Depending on the process used, the washing agent and soil fines are residuals that require further treatment.

The target contaminant groups for soil washing are semi-VOCs, fuels, and inorganics. The technology can be used on selected VOCs and pesticides. The technology offers the potential for recovery of metals and can clean a wide range of organic and inorganic contaminants from coarse-grained soils.

Thermal Desorption[13,24,33]

Thermal desorption is a separation technology used to eliminate organic wastes from soils, sludges, and other solid matrices. Separation occurs by heating the mixed waste to low level temperatures of 100°C to 287°C. There are various types of dryers and apparatus for carrying out the desorption process but they all work on the same basic principle. The contaminated material is heated, usually in phases, and the volatiles and water vapor are collected and treated. Sometimes vacuum is used with heat. The use of vacuum without heat is described here under vacuum extraction.

Thermal desorption is recommended and used because of the wide range of organic contaminants effectively treated, availability and mobility of commercial systems, and the public acceptance of the treatment approach. However, there is a chance that dioxins and other oxidation products can be produced during treatment. Also, this technology is not effective at treating inorganic and metal waste.

Vacuum Extraction[12,13,14]

Soil Vapor Vacuum Extraction is the most successful of all soil treatment methods used in removing VOCs. Soil vapors are removed by inducing a vacuum in the soil, causing the vapors to flow toward the vacuum source. Typically, extraction wells are drilled into the contaminated zone; a blower or vacuum pump is connected to the casings, causing the contaminated soil vapor to flow to the well, where it is removed by the pump or blower. The contaminant-laden air is then released to the atmosphere or treated to capture or destroy the vapors. As the contaminated vapors are removed, fresh air is drawn into the soil causing the contaminants in the soil volatilize further so that more are removed from the soil. The two most important considerations in assessing the applicability of vacuum extraction are contaminant volatility and soil permeability. All VOCs will partition to some degree into the vapor phase when exposed to air. The more volatile the compound, the higher its concentration will be in the vapor phase. Likewise, the more permeable the soil, the higher the air flow rate will be with vacuum.

Advantages of this technology include, relatively low cost, ease of implementation, ability to remove contamination near buildings and other underground structures, high degrees of effectiveness in removing target compounds making it possible to remove the contaminant quickly, minimal disturbance of the soil, and larger volumes of soil can be treated than can be practically excavated. The only perceived disadvantages are that it is limited to the removal of VOCs and that its effectiveness is dependant on the permeability of the soil which effects how quickly fresh air replaces removed air.

Vitrification[13,34,35,36,37,38,39]

Simply put, vitrification is the process of converting hazardous waste (liquid or solid) into a glass and crystalline product by melting it with electrical energy. In situ vitrification is performed subsurface, where the contamination resides. Four electrodes are inserted to the required depth in the ground at the corners of the site to be treated. An electrical current is initiated causing the frit and adjacent soil to fuse and form a melt. The molten zone slowly expands throughout the treatment zone where the electrodes have been placed. Nonvolatile wastes and metals are incorporated in the melt and VOCs are pyrolysed. The pyrolysed products migrate to the surface of the melt and combust in the presence of air. The resulting gasses are collected and treated by an offgas treatment system. Remote vitrification is performed in much the same way except the material to be vitrified is transferred to a location other than where it originally existed. Vitrification of radioactive liquid waste usually occurs through one of two processes: (1) a two-stage process based on rotary calciner/metallic melter; and (2) a liquid-fed ceramic melter process. In both processes the result is a containable glass-like solid.

The advantages of vitrification include it's simplicity and it's ability to treat many types of waste. The non-leachable glass waste product allows for cheaper land disposal of the waste due to waste volume reductions.

7.2 Tables of technologies

The following tables (Table 7-1 and Table 7-2) summarize the use of technologies for each watershed. Details of each technology are provided in Table 7-3.

Table 7-1 Technologies (Remediation) by Watershed - Savannah River Site[a]

Flood Plain Swamp	Four Mile Branch	Lower Three Runs	Pen Branch	Steel Creek	Upper Three Runs
			Air Sparging		
Backfill		Backfill	Backfill		Backfill
					Baroball
Barometric Pumping					Barometric Pumping
	Bioremediation	Bioremediation	Bioremediation		Bioremediation
					Bioventing
					Capping (Geosynthetic and Kaolin)
			Catalytic Oxidation		Catalytic Oxidation
					Grouting
Institutional Controls	Institutional Controls		Institutional Controls		Institutional Controls
		Jet Grouting	Jet Grouting	Jet Grouting	
					Low Permeability Cover
					Natural Attentuation
				Removal	Removal
Removal & Backfill	Removal & Backfill		Removal & Backfill	Removal & Backfill	
					Removal and Capping
		Soil Cover		Soil Cover	
					Soil Mixing
Soil Washing	Soil Washing		Soil Washing	Soil Washing	Soil Washing
					Thermal Desorption
		Vitrification		Vitrification	

Table 7-2 Technologies (Analysis) by Watershed - Savannah River Site[6]

Flood Plain Swamp	Four Mile Branch	Lower Three Runs	Pen Branch	Steel Creek	Upper Three Runs
		Cone Penetrometer Gamma Probe	Cone Penetrometer Gamma Probe		
					Cone Sipper
	Dig Face Monitoring				
Real Time Analysis	Real Time Analysis	Real Time Analysis	Real Time Analysis	Real Time Analysis	Real Time Analysis
				Remote Sampling	
					Simul Probe
					Soil Plugs

The following table shows the ER remedial technologies by major watershed and by subactivity as tabulated in the Unit List.[8] Also shown are the contaminants found as identified on the Unit List[8] or on Fact Sheets released for some subactivities.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Flood Plain Swamp	HWW	Carolina Bay	As	Barometric Pumping takes advantage of natural pressure gradients to cause the flow of contaminant-laden subsurface air from the vadose zone to the surface. The baroball increases the effectiveness of barometric pumping by using a simple valve to prevent the inflow of air into a venting well from the atmosphere but allow gas to flow from the well to the atmosphere.	Low	Can remove residual contamination effectively and efficiently without the need for main-powered vacuum pumps and blowers	None noted.
Flood Plain Swamp	HWW HWW HWW /CW	-D Area Burning/Rubble Pits[40] -Carolina Bay -TNX Burying Ground[41]	-Phenolic compound, Metals -As -Uranyl nitrate	Institutional Controls is controlled entry to minimize possibility that persons will be exposed.	- Low - Low - Low	Simple and inexpensive to initiate.	It may have to be continued indefinitely. Public usually opposes.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[6]	Advantages	Disadvantages
Flood Plain Swamp	HWW HWW /CW	-New TNX Seepage Basin[42] -D Area Ash Basin[43]	-Sodium Nitrate, Glass frit -^{3}H, TCE, Heavy metals	Remove and Backfill results in removing and relocating the contaminant. In some cases when this removal leaves a depression or a ditch, it will be backfilled with available uncontaminated soil.	- Low - Low - High	Simplicity.	Expense and exposures while moving.
Flood Plain Swamp	HWW	D Area Coal Pile Runoff Basin[44]	-Semi-volatiles	Soil Washing removes contaminants from soils in one of two ways: 1) by dissolving or suspending them in the wash solution (which is later treated by conventional wastewater treatment methods) or 2) by concentrating contaminants into a smaller volume of soil.	Medium	Offers the potential for metal recovery and can clean a wide range of organic and inorganic contaminants from course-grained soils.	None noted.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Four Mile Branch	HWW	G Area Oil Seepage Basin[45]	Metals, Chlordane, Volatile organics	Bioremediation uses microorganisms such as bacteria, fungi and yeast, or their extracts, to dissolve and/or degrade organic contaminants such as oil, gasoline, detergents, polychlorinated hydrocarbons, pesticides, and gases or inorganic contaminants in soil and water, and render them harmless.	Low	Cost is roughly one-third to one-half of conventional chemical and physical remediation technologies and the risk worker exposure is significantly reduced.	Microbial activity can be inhibited by factors such as high concentrations of heavy metals. Formation of toxic byproducts.
Four Mile Branch	HWW	Central Shops Burning/Rubble Pit [46,47]	Heavy Metal, Benzene, Toluene, organic solvents	Institutional Controls is controlled entry to minimize possibility that persons will be exposed.	Low	Simple and inexpensive to initiate.	It may have to be continued indefinitely. Public usually opposes.
Four Mile Branch	HWW HWW /CW HWW	-Ford Building Seepage Basin[48] -Ford Building Waste Site[49] -C Area Coal Pile Runoff Basin[44]	-Pb, Cr, Hg -Radioactive bits, Pb, Cd, Hg, Nitrate -Semi-volatiles	Remove and Backfill results in removing and relocating the contaminant. In some cases when this removal leaves a depression or a ditch, it will be backfilled with available uncontaminated soil.	- Medium - Low - Medium	Simplicity.	Expense and exposures while removing.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Four Mile Branch	HWW	C Area Coal Pile Runoff Basin[44]	Semi-volatiles	Soil Washing removes contaminants from soils in one of two ways: (1) by dissolving or suspending them in the wash solution (which is later treated by conventional wastewater treatment methods) or (2) by concentrating contaminants into a smaller volume of soil.	Medium	Offers the potential for metal recovery and can clean a wide range of organic and inorganic contaminants from course-grained soils.	None noted.
Four Mile Branch	HWW	-HP-52 Outfall	-^{137}Cs, ^{90}Sr	Unknown	- High		
	HWW	-C Area Burning/ Rubble Pit[50]	-TCE, Heavy Metals, Phenolic Constituents, Cyanide, Xylene		- Low		
	HWW /CW	-C Reactor Seepage Basins[51]	-^{137}Cs, ^{60}Co, ^{90}Sr, ^{3}H, Al, Pb, TCE		- High		
	HWW /CW	-Road A Chemical Basin[52]	-Pb, Mn, Ra, Chlorinated solvents		- Low		

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[6]	Advantages	Disadvantages
Lower Three Runs	CW	108-4R Overflow Basin	^{137}Cs	Bioremediation uses microorganisms such as bacteria, fungi and yeast, or their extracts, to dissolve and/or degrade organic contaminants such as oil, gasoline, detergents, polychlorinated hydrocarbons, pesticides, and gases or inorganic contaminants in soil and water, and render them harmless.	High	Cost is roughly one-third to one-half of conventional chemical and physical remediation technologies and the risk worker exposure is significantly reduced.	Microbial activity can be inhibited by factors such as high concentrations of heavy metals. Formation of toxic byproducts.
Lower Three Runs	CW	R Reactor Seepage Basin[53]	^{137}Cs	Jet Grouting involves the injection of various grouting agents into soil/waste matrices that result in forming a soil/waste/grout mixture which cements the waste in place.	High	This technology has the potential to significantly reduce worker exposure. It is compatible with complex mixtures of various contaminants; and applicable to various waste forms and surrounding materials.	None noted.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Lower Three Runs	HWW	P Area Acid Caustic Basin	As	Remove and Backfill results in removing and relocating the contaminant. In some cases when this removal leaves a depression or a ditch, it will be backfilled with available uncontaminated soil.	Low	Simplicity.	Expense and exposures while moving.
Lower Three Runs	CW	P Area Bingham Pump Outage Pits	Rad Waste	Soil Cover (Remove and Backfill) results in removing and relocating the contaminant. In some cases when this removal leaves a depression or a ditch, it will be backfilled with available uncontaminated soil.	Low	Simplicity.	Expense and exposures while moving.
Lower Three Runs	CW	R Reactor Seepage Basin[53]	^{137}Cs	Vitrification is the process of converting hazardous waste (liquid or solid) into a glass and crystalline product by melting it with electrical energy.	High	Simplicity ; its ability to treat many types of waste; and the fact that it allows cheaper land disposal of the waste due to waste volume reduction.	None noted.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Lower Three Runs	HWW	- P Area Burning/Rubble Pit[54]	- TCE, Heavy metals	Unknown	- Low		
	HWW /CW	- Pond Sludge Land Application Site[55,56]	- Alpha Chlordane, Metals		- Low		
	HWW	- R Area Acid/Caustic Basin	- Metals		- Low		
	HWW	- R Area Burning/Rubble Pits[57]	-Chlorinated solvents		- Low		
Pen Branch	HWW	CMP Pits[58]	TCE, PCE, Volatile Organic Compounds	In Air Sparging, air is injected into contaminated wet ground water and displacing the water in the soil pore spaces and causes the soil contaminants to desorb, volatilize, and enter the saturated zone vapor phase.	Medium	It increases biodegradation by increasing the oxygen content of the groundwater.	There is little fundamental knowledge of the process because of limited scientific research.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Pen Branch	HWW /CW HWW	- Central Shops Sludge Lagoon[59] - Hydrofluoric Acid Spill[60]	- Alpha Chlordane, Heavy metals - Lindane, Heavy metals	Bioremediation uses microorganisms such as bacteria, fungi and yeast, or their extracts, to dissolve and/or degrade organic contaminants such as oil, gasoline, detergents, polychlorinated hydrocarbons, pesticides, and gases or inorganic contaminants in soil and water, and render them harmless.	- Low - Low	Cost is roughly one-third to one-half of conventional chemical and physical remediation technologies and the risk worker exposure is significantly reduced.	Microbial activity can be inhibited by factors such as high concentrations of heavy metals. Formation of toxic byproducts.
Pen Branch	HWW	CMP Pits[58]	TCE, PCE, Volatile Organic Compounds	Catalytic Oxidation promotes the destruction of contaminants in the exhaust gas from air strippers and SVE systems.	Medium	The addition of a catalyst accelerates the rate of oxidation and enables the oxidation reaction to occur at much lower temperatures.	None noted.
Pen Branch	HWW CW	- Central Shops Burning/Rubble Pits[46,47] - K Area Bingham Pump Outage Pits	- Heavy metal, Pesticides, PCBs, Semi- volatiles - Rad waste	Institutional Controls is controlled entry to minimize possibility that persons will be exposed.	- Low - Low	Simple and inexpensive to initiate.	It may have to be continued indefinitely. Public usually opposes.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Pen Branch	HWW /CW	K Area Reactor Bingham Pump Outage Pits	LLRad contaminates, TCE, PCE	Jet Grouting involves the injection of various grouting agents into soil/waste matrices that result in forming a soil/waste/grout mixture which cements the waste in place.	Low	This technology has the potential to significantly reduce worker exposure. It is compatible with complex mixtures of various contaminants; and applicable to various waste forms and surrounding materials.	None noted.
Pen Branch	HWW HWW	- K Area Acid caustic Basin - K Area Coal Pile Runoff Basin[44]	- As - Semi-volatiles	Remove and Backfill results in removing and relocating the contaminant. In some cases when this removal leaves a depression or a ditch, it will be backfilled with available uncontaminated soil.	- Low - Medium	Simplicity.	Expense and exposures while moving.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Pen Branch	HWW	K Area Coal Pile Runoff Basin[44]	Semi-volatiles	Soil Washing removes contaminants from soils in one of two ways: (1) by dissolving or suspending them in the wash solution (which is later treated by conventional wastewater treatment methods) or (2) by concentrating contaminants into a smaller volume of soil.	Medium	Offers the potential for metal recovery and can clean a wide range of organic and inorganic contaminants from course-grained soils.	None noted.
Pen Branch	HWW HWW /CW	- K Area Rubble Pile[61] - K Area Sludge Land Application Site	- As, Cr, Pb, Waste oils - Alpha Chlordane	Unknown	- Low - Low		
Steel Creek	HWW HWW /CW	None listed.	- TCEs - TCE, PCE, Rad Wastes	Jet Grouting involves the injection of various grouting agents into soil/waste matrices that result in forming a soil/waste/grout mixture which cements the waste in place.	- High - High	This technology has the potential to significantly reduce worker exposure. It is compatible with complex mixtures of various contaminants; and applicable to various waste forms and surrounding materials.	None noted.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Steel Creek	HWW	L Area Rubble Pile[62]	TCEs	Removal means removing the contaminant to another location.	Low	Simplicity.	May require processing or shipment.
Steel Creek	HWW	P Area Coal Pile Runoff Basin[44]	Semi-volatiles	Remove and Backfill results in removing and relocating the contaminant. In some cases when this removal leaves a depression or a ditch, it will be backfilled with available uncontaminated soil.	Low	Simplicity.	Expense and exposures while moving.
Steel Creek	CW	L Area Bingham Pump Outage Pits	Rad waste	Soil Cover (Remove and Backfill) results in removing and relocating the contaminant. In some cases when this removal leaves a depression or a ditch, it will be backfilled with available uncontaminated soil.	Low	Simplicity.	Expense and exposures while moving.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[6]	Advantages	Disadvantages
Steel Creek		None listed.	None listed.	Soil Washing removes contaminants from soils in one of two ways: (1) by dissolving or suspending them in the wash solution (which is later treated by conventional wastewater treatment methods) or (2) by concentrating contaminants into a smaller volume of soil.	Low	Offers the potential for metal recovery and can clean a wide range of organic and inorganic contaminants from course-grained soils.	None noted.
Steel Creek	HWW HWW /CW	- L Area Acid/Caustic Basin[63] - L Area Oil/Chemical Basin[64]	- TCEs - TCE, PCE, Rad Wastes	Vitrification is the process of converting hazardous waste (liquid or solid) into a glass and crystalline product by melting it with electrical energy.	- High - High	Simplicity ; its ability to treat many types of waste; and the fact that it allows cheaper land disposal of the waste due to waste volume reduction.	None noted.
Steel Creek	HWW HWW	- L Area Burning/Rubble Pit[65] -L Area Rubble Pit[65]	- TCEs - Pb	Unknown	- Low - Low		

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Upper Three Runs	HWW /CW	A Area Burning/ Rubble Pit[67]	TCE, Ra, VOCs, Hg	Air stripping is a full-scale technology in which VOCs are separated from groundwater by greatly increasing the surface area of the contaminated water exposed to air. This process is generally conducted in a packed tower or an aeration tank.	Low	None noted.	It is ineffective for inorganic contaminants.
Upper Three Runs	HWW	SRL Oil Test Site[66]	Phosphorous	Baroball (Barometric Pumping) takes advantage of natural pressure gradients to cause the flow of contaminant-laden subsurface in air from the vadose zone to the surface. The baroball increases the effectiveness of barometric pumping by using a simple valve to prevent the inflow of air into a venting well from the atmosphere but allow gas to flow from the well to the atmosphere.	Low	Can remove residual contamination effectively and efficiently without the need for main-powered vacuum pumps and blowers	None noted.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Upper Three Runs	HWW	Misc Chemical Basin/Metals Burning Pits[69]	TCEs	Barometric Pumping takes advantage of natural pressure gradients to cause the flow of contaminant-laden subsurface air from the vadose zone to the surface. The baroball increases the effectiveness of barometric pumping by using a simple valve to prevent the inflow of air into a venting well from the atmosphere but allow gas to flow from the well to the atmosphere.	Low	Can remove residual contamination effectively and efficiently without the need for main-powered vacuum pumps and blowers	None noted.
Upper Three Runs	HWW HWW /CW	- SRL Oil Test Site[66] - A Area Burning/ Rubble Pit[67]	Phosphorous - TCE, Ra, VOCs, Hg	Bioremediation uses microorganisms such as bacteria, fungi and yeast, or their extracts, to dissolve and/or degrade organic contaminants such as oil, gasoline, detergents, polychlorinated hydrocarbons, pesticides, and gases or inorganic contaminants in soil and water, and render them harmless.	- Low - Low	Cost is roughly one-third to one-half of conventional chemical and physical remediation technologies and the risk worker exposure is significantly reduced.	Microbial activity can be inhibited by factors such as high concentrations of heavy metals. Formation of toxic byproducts.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Upper Three Runs	HWW HWW	- D Area Oil Seepage Basin - A Area Rubble Pit[68]	- TCEs - Pb, Methane, Octane, Propane, Propylene, Ethane, Pentane	Bioventing is an adaptation of soil vapor extraction to treat relatively non-volatile materials, such as diesel fuel oil in soil.	- High - Low	Equipment is simple and the recirculation of extracted soil gas to injection wells can greatly reduce air pollution abatement costs.	There is a slightly increased risk of spreading volatiles through the soil gas to previously uncontaminated areas and it only works for cleaning up hazardous material that is readily biodegradable.
Upper Three Runs	CW	SRL Seepage Basins	-^3H	Capping utilizes a variety of materials from low permeability soil to stabilize the waste and stop infiltration of rainwater.	High	None noted.	None noted.
Upper Three Runs	HWW	Misc Chemical Basin/Metals Burning Pits[69]	-TCEs	Catalytic Oxidation is used for destroying contaminants in the exhaust gas from air strippers and SVE systems.	Low	The addition of a catalyst accelerates the rate of oxidation and enables the oxidation reaction to occur at much lower temperatures.	None noted.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[6]	Advantages	Disadvantages
Upper Three Runs	HWW /CW HWW	- Low Level Radioactive Waste Disposal Facility - Non-rad Waste Disposal Facility[70]	- LL Rad Waste - Asbestos	Geosynthetic Capping utilizes a variety of materials from low permeability soil to stabilize the waste and stop infiltration of rainwater.	- High - Low	None noted.	None noted.
Upper Three Runs	HWW HWW	- Silverton Road Waste Site - 716A Motor Shop Seepage Basin[71]	- TCEs - TCE, VOCs, Metals	Institutional Controls is controlled entry to minimize possibility that persons will be exposed.	- Low - Low	Simple and inexpensive to initiate.	It may have to be continued indefinitely. Public usually opposes.
Upper Three Runs	CW CW HWW /CW HWW	- H Area Retention Basin - F Area Retention Basin - Old F Area Seepage Basin[75] - Old Burial Ground	- ^{3}H, ^{137}Cs - LL Rad Water - Hg, Rad waste - Benzene	Low Permeability Cover utilizes a variety of materials from low permeability soil to stabilize the waste and stop infiltration of rainwater.	- Medium - Medium to High - High - High	None noted.	None noted.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Upper Three Runs	HWW HWW	- D Area Oil Seepage Basin -A Area Rubble Pit[68]	- TCEs - Pb, Methane, Octane, Propane, Propylene, Ethane, Pentane	For Natural Attentuation, natural subsurface processes -- such as dilution, volatilization, biodegradation, absorption, and chemical reactions with subsurface materials -- are allowed to reduce contaminant concentrations levels.	- High - Low	Simplicity and inexpensive.	May take time and may be considered as "no action" by some.
Upper Three Runs	HWW HWW HWW HWW CW HWW /CW	- D Area Oil Seepage Basin -A Area Rubble Pit[68] - F Area Acid Caustic Basin - H Area Acid Caustic Basin - SRL Seepage Basins - Old TNX Seepage Basin[72]	- TCEs - Pb, Methane, Octane, Propane, Propylene, Ethane, Pentane - As - As - ^{3}H - TCE, LL Rad wastes	Remove and Backfill results in removing and relocating the contaminant. In some cases when this removal leaves a depression or a ditch, it will be backfilled with available uncontaminated soil.	- High - Low - Low - Low - High - Low	Simplicity.	Expense and exposures while moving.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Upper Three Runs	HWW /CW	F Area Burning/Rubble Pits[73]	- ^{3}H, Ra, TCE, Heavy metals	Remove and Cap involves removing and relocating the contaminant. This removal did not bring the level of contamination to the desired point, so it was necessary to cap the remaining waste.	Low	Simplicity.	Expense and exposures while moving/capping.
Upper Three Runs	CW	- H Area Retention Basin	- ^{3}H, ^{137}Cs	Soil Mixing is when soils are mixed with a single-blade auger or with a combination of augers ranging in diameter from 3 to 12 feet. Cement grout is typically mixed with soil to create a foundation system or barrier wall.	- Medium	Contaminants are either removed from the soils or stabilized in place.	None noted.
	CW	- F Area Retention Basin	- LL Rad Water		- Medium to High		
	HWW /CW	- Old F Area Seepage Basin[74]	- Hg, Rad waste		- High		
	HWW	- Misc Chemical Basin/Metals Burning Pits[69]	- TCE, VOCs, PCBs, Dioxins/Furans		- Low		
	HWW	- Burial Ground Complex[75]	- Benzene, Heavy metals, Chlorinated and organic solvents, toluene		- High		

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Upper Three Runs	HWW HWW HWW	- A Area Coal Pile Runoff Basin[44] -F Area Coal Pile Runoff Basin[46] -H Area Coal Pile Runoff Basin[46]	- Semi-volatiles - Semi-volatiles - Semi-volatiles	Soil Washing removes contaminants from soils in one of two ways: (1) by dissolving or suspending them in the wash solution (which is later treated by conventional wastewater treatment methods) or (2) by concentrating contaminants into a smaller volume of soil.	- Medium - Medium - Medium	Offers the potential for metal recovery and can clean a wide range of organic and inorganic contaminants from course-grained soils.	None noted.
Upper Three Runs	HWW /CW	F Area Burning/Rubble Pits[74]	- ^{3}H, Ra, TCE, Heavy metals	In Thermal Desorption separation occurs by heating the mixed waste to low level temperatures of 100°C to 287°C. The contaminated material is heated, usually in phases, and the volatiles and water vapor are collected and treated.	Low	It is effective for a wide range of organic contaminants.	There is a chance that dioxins and other oxidation products can be produced during treatment. This technology is not effective at treating inorganic and metal waste.

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Upper Three Runs	HWW /CW	A Area Burning/ Rubble Pit[67]	TCE, Ra, VOCs, Hg	Vacuum Extraction removes soil vapors by inducing a vacuum in the soil, causing the vapors to flow toward the vacuum source. The contaminant-laden air is then released to the atmosphere or treated to capture or destroy the vapors.	Low	Relatively low cost, ease of implementation, ability to remove contamination near buildings and other underground structures, high degrees of effectiveness.	Limited to the removal of VOCs and that it all is dependant on the permeability of the soil which effects how quickly fresh air replaces removed air.
Upper Three Runs	CW	- Warners Pond	- Rad waste	Unknown	- High		
	HWW	- A Area Misc Rubble Pile[68]	- Construction debris		- Low		
	HWW	- West of SREL "Georgia Fields" Site	- Trichloromethane		- Low		
	HWW /CW	- F Area Inactive Process Sewer Line[76]	- Radionuclides, Metals, Nitrates		- Medium		
	HWW /CW	- H Area Inactive Process Sewer Line[76]	- Radionuclides, Metals, Nitrates		- Medium		

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[B]	Advantages	Disadvantages
Unknown	DeW/DiW	SR-ER09	^{3}H	Decontamination involves a large number of technologies ranging from very simple procedures to highly technical processes. Examples include brushing, washing, steaming, grinding, blasting, dissolving, extraction, and electrical migration.	Low	Many technologies used for decontamination are common industrial procedures requiring little special training or equipment.	Additional controls may be required to protect workers from spray or dust generated. May be more costly than disposal
	DeW/DiW	SR-FA03	Radiological and Industrial Hazards		Low		
	DeW/DiW	SR-FA06	Pu		Low		
	DeW/DiW	SR-FA07	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA09	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA10	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA11	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA15	Uranium, Asbestos, PCBs		Low		
	DeW/DiW	SR-FA18	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA20	^{3}H, Fission products, Asbestos		Low		

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[6]	Advantages	Disadvantages
Unknown	DeW/DiW	SR-ER09	^{3}H	Demolition (Conventional) involves destruction of concrete and other structural materials using wrecking balls and hydraulic or pneumatic hammers.	Low	An accepted, mature technology requiring commonly available equipment.	Impractical to contain dust, and reinforcing steel has to be cut by other means.
	DeW/DiW	SR-FA03	Radiological and Industrial Hazards		Low		
	DeW/DiW	SR-FA06	Pu		Low		
	DeW/DiW	SR-FA07	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA09	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA10	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA11	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA15	Uranium, Asbestos, PCBs		Low		
	DeW/DiW	SR-FA18	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA20	^{3}H, Fission products, Asbestos		Low		

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[8]	Advantages	Disadvantages
Unknown	DeW/DiW	SR-ER09	^{3}H	Dismantlement includes a variety of disassembly activities for the purpose of removing contaminated structures, parts, or materials, in some cases separating these from uncontaminated structures, parts, or materials.	Low	Salvage of uncontaminated structures, parts, or materials may be possible.	May present high potential for exposures. May be more costly than total disposal.
	DeW/DiW	SR-FA03	Radiological and Industrial Hazards		Low		
	DeW/DiW	SR-FA06	Pu		Low		
	DeW/DiW	SR-FA07	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA09	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA10	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA11	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA15	Uranium, Asbestos, PCBs		Low		
	DeW/DiW	SR-FA18	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA20	^{3}H, Fission products, Asbestos		Low		

Table 7-3 SRS Remediation Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Exposure Potential[a]	Advantages	Disadvantages
Unknown	DeW/DiW	SR-ER09	^{3}H	Equipment Removal (Conventional Disassembly) includes sawing with tooth or abrasive blades and dismantling by removing fasteners. Cutting can be done in air or under a liquid, using power or hand tools.	Low	An accepted technology requiring inexpensive equipment., and there is little danger of equipment contamination.	Adaption for use by remote manipulation will be required for certain equipment and facilities.
	DeW/DiW	SR-FA03	Radiological and Industrial Hazards		Low		
	DeW/DiW	SR-FA06	Pu		Low		
	DeW/DiW	SR-FA07	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA09	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA10	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA11	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA15	Uranium, Asbestos, PCBs		Low		
	DeW/DiW	SR-FA18	^{3}H, PCBs, Pu		Low		
	DeW/DiW	SR-FA20	^{3}H, Fission products, Asbestos		Low		

The following table represents a listing of Analytical Technologies that were used for each watershed activity.

Table 7-4 SRS Analytical Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Advantages	Disadvantages
Flood Plain Swamp	HWW/CW HWW	- D Area Ash Basin[41] - D Area Coal Pile Runoff Basin[44]	- ^{3}H, TCE, Heavy metals -Semi-volatiles	Real Time Analysis is an analyses for which the results are available simultaneously with the measurement.	Done remotely and will reduce exposures.	Relatively expensive.
Four Mile Branch	HWW/CW	Ford Building Waste Site	Radioactive bits, Pb, Cd, Hg, Nitrate	Dig Face Monitoring (Description not available)		

Table 7-4 SRS Analytical Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Advantages	Disadvantages
Four Mile Branch	HWW	- G Area Oil Seepage Basin[45]	- Metals, Chlordane, Volatile organics	<u>Real Time Analysis</u> is an analyses for which the results are available simultaneously with the measurement.	Done remotely and will reduce exposures.	Relatively expensive.
	HWW	- Central Shops Burning/Rubble Pit[46,47]	- Heavy metal, Benzene, Toluene, Organic solvents			
	HWW	-Ford Building Seepage Basin[48]	- Pb, Cr, Hg			
	CW	- HP - 52 Outfall	- ^{137}Cs ^{90}Sr			
	HWW	- C Area Burning/ Rubble Pit[50]	- TCE, Heavy metals, Phenolic Constituents, Cyanide, Xylene			
	HWW/CW	- C Reactor Seepage Basins[51]	- ^{137}Cs, Cobalt, ^{90}Sr, ^{3}H, Aluminum, Pb, TCE			
	HWW	- Road A Chemical Basin[47]	- Pb, Manganese, Ra, Chlorinated Solvents			

Table 7-4 SRS Analytical Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Advantages	Disadvantages
Lower Three Runs	CW	R Reactor Seepage Basins[53]	^{137}Cs	Cone Penetrometer Gamma Probe consists of an apparatus of a penetrometer for penetrating the soil and gamma detectors for detecting gamma emitters in this subsurface.	They provide valuable information about the hazardous components of the subsurface and also provides physical, geochemical, and geophysical information about the subsurface.	None detected as of present time.
Lower Three Runs	HWW HWW/CW HWW HWW	- P Area Burning/ Rubble Pit[54] - Par Pond Sludge Land Application Site[55] - R Area Acid/Caustic Basin - R Area Burning/ Rubble Pits[57]	- TCE, Heavy metals - Alpha Chlordane, Metals - Metals - Chlorinated solvents	Real Time Analysis is an analyses for which the results are available simultaneously with the measurement.	Done remotely and will reduce exposures.	Relatively expensive.
Pen Branch	HWW/CW	K Area Reactor Seepage Basin	LL Rad Contaminates, TCE, PCE	Cone Penetrometer consists of an apparatus of a penetrometer for penetrating the soil and detectors for measuring the contaminant of interest.	They provide valuable information about the hazardous components of the subsurface and also provides physical, geochemical, and geo physical information about the subsurface.	None detected as of present time.

Table 7-4 SRS Analytical Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Advantages	Disadvantages
Pen Branch	HWW	- Central Shops Sludge Lagoon[59]	- Alpha Chlordane, Heavy metals	Real Time Analysis is an analyses for which the results are available simultaneously with the measurement.	Done remotely it will reduce exposures.	Relatively expensive.
	HWW	- Hydrofluoric Acid Spill[60]	-Lindane, Heavy metals			
	HWW	- Central Shops Burning/Rubble Pits[46,47]	- Heavy metals, Pesticides, PCBs, Semi-volatiles			
	CW	- K Area Bingham Pump Outage Pits	- Rad waste			
	HWW	- K Area Rubble Pile	- As, Cr, Pb, Waste oils			
	HWW	- K Area Sludge Land Application Site	- Alpha Chlordane			
Pen Branch	HWW	CMP Pits[58]	TCE, PCE, Volatile Organic Compounds	Real Time VOC Analysis is analyses for which the results are available simultaneously with the measurement.	Done remotely it will reduce exposures.	Relatively expensive.
Steel Creek	HWW	- L Area Rubble Pile[64]	- TCEs	Real Time Analysis is analyses for which the results are available simultaneously with the measurement.	Done remotely and will reduce exposures.	Relatively expensive.
	HWW	- L Area Burning/ Rubble Pit[65]	- TCEs			
	HWW	- L Area Rubble Pit[77]	- TCEs			

Table 7-4 SRS Analytical Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Advantages	Disadvantages
Steel Creek	HWW HWW/CW	- L Area Acid/Caustic Basin[62] - L Area Oil/Chemical Basin[63]	- TCEs - TCEs, PCEs, Rad wastes	Remote Sampling is the process of conducting sampling from a remote/distant location.	Low potential for exposure.	None noted.

Table 7-4 SRS Analytical Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Advantages	Disadvantages
Upper Three Runs	HWW	- SRL Oil Test Site[66]	- Phosphorous	Real Time Analysis is analyses for which the results are available simultaneously with the measurement.	Done remotely and will reduce exposures.	Relatively expensive.
	HWW	- D Area Oil Seepage Basin	- TCEs			
	HWW	- A Area Rubble Pit[68]	- Pb, Methane, Octane, Propane, Propylene, Ethane, Pentane			
	HWW	- Silverton Road Waste Site	- TCEs			
	HWW	- 716A Motor Shop Seepage Basin[72]	- TCE, VOCs, Metals			
	CW	- SRL Seepage Basin	- ^{3}H			
	CW	- H Area Retention Basin	- ^{3}H, ^{137}Cs			
	CW	- F Area Retention Basin	- LL Rad water waste			
	HWW/CW	- Old F Area Seepage Basin	- Hg, Rad wastes			
	HWW	- A Area Coal Pile Runoff Basin[44]	- Semi-volatiles			

Table 7-4 SRS Analytical Technologies by Major Watershed, Worker Category, and Subactivity

Major Watershed	Category	Subactivity	Contaminants	Technology and Description	Advantages	Disadvantages
Upper Three Runs	HWW HWW CW HWW HWW	- F Area Coal Pile Runoff Basin - H Area Coal Pile Runoff Basin - Warners Pond - A Area Misc Rubble Pile[68] - West of SREL "Georgia Fields" Site	- Semi volatiles - Semi volatiles - Rad wastes - Construction debris - Trichloromethane	Real Time Analysis is analyses for which the results are available simultaneously with the measurement.	Done remotely and will reduce exposures.	Relatively expensive.
Upper Three Runs	HWW/CW HWW/CW	- F Area Inactive Process Sewer Line - H Area Inactive Process Sewer Line	- Radionuclides, Metals, Nitrates - Radionuclides, Metals, Nitrates	Simul Probe (Information not available).		
Upper Three Runs	HWW	Misc Chemical Basin/Metals Burning Pits	TCE, VOCs, PCBs, Dioxins/furans	Soil Plugs involves the analyses of core samples	None noted.	None noted.
Upper Three Runs	HWW	Misc Chemical Basin/Metals Burning Pits	TCE, VOCs, PCBs, Dioxins/furans	Cone Sipper (Information not available.)		

The following decontamination technologies, some of which will become major technologies at Savannah River as they move into the stabilization and decontamination and decommissioning phase of their waste abatement activities, have been researched and/or developed at their waste minimization facility:

CO^2 Blasting

CO^2 blasting is a process in which dry ice particles are propelled at high velocities to impact and clean a surface. The particles are accelerated by compressed air, just as with other blasting systems. Today, most applications are able to use standard shop air, in the 80-100 psi range. If higher pressures are required, equipment capable of blasting up to 300 psi is available.

An advantage to CO^2 blasting is that there is no excess waste generated. The CO^2 pellets sublimate after contact with the part, dissipating as CO^2 gas. First generation systems were slow but recent modifications have improved the speed. CO^2 blasting is gentle on substrates but it is not cheap.

Kelly Vacuuming

The Kelly Vacuum Decon System is a variation of the baseline high pressure water cleaning system. The kinetic energy of a pressurized super heated water stream provides the mechanism for removal of contamination from surfaces sprayed with the water. The Kelly system differs from the baseline system in that it provides a superheated (up to 300°F), pressurized (250 psi) stream of water. The key difference, however, is that most of the cleaning heads for this system integrate a vacuum hood and return line which readily captures and controls the stream, water droplets, and dislodged contaminates generated when the water spray impacts on the surface being cleaned.

Plastic Blasting

Plastic blasting is the process for the super-efficient removal of coatings, for deflashing, for mold cleaning, and for nearly every kind of industrial cleaning application. Plastic blasting performs like chemical stripping, sand blasting and other abrasive blast media, but does not use excessively harsh abrasives or high pressures, so it does not present such health hazards as brain damage by toxic fumes and silicosis by stray dust. It has been proven to effectively remove coatings from steel, plastics, aluminum, fiberglass, brass, and a variety of other materials in a wide range of industries.

Vacuum Blasting

Vacuum blasting immediately captures abrasives and contaminated material thus reducing potential exposure to workers as well as the environment. This is a healthy practice regardless of the material being removed. Debris is not left in the environment to contaminate ground, water, or air.

8.0 Exposures

8.1 Potential exposures

Of the 64 Environmental Fact Sheets found in the ER section of the SRS home page, 53 of them matched with the subactivities listed in the ER Unit List.[8] The Environmental Concern Sections of these Fact Sheets listed contaminants found to be present within the watersheds as shown below. These environmental concerns and others as listed on the unit list have been tabulated based on the subactivity and may be found in the Technology Section in Tables 7-3 and 7-4 above.

Flood Plain Swamp

VOCs, TCE, CCl_4, Fe, Pb, Mn, As, Ba, Cr, Cu, Hg, Ni, Se, semi-VOCs, and uranyl nitrate.

Four Mile Branch

Trans-1,2-dichloroethylene, tetrachloroethylene, radioactivity, ^{137}Cs, sulfur compounds, and acids.

Lower Three Runs

Radioactivity, ^{137}Cs, ^{3}H, Hg, and other radionuclides.

Pen Branch

VOCs, trichloroethylene, tetrachloroethylene, ^{3}H, solvents, PCBs, As, Cr, Pb, waste oils, and other radionuclides (^{137}Cs, ^{90}Sr, ^{60}Co).

Steel Creek

^{3}H, ^{60}Co, ^{90}Sr, ^{129}I, ^{137}Cs, ^{152}Eu, ^{155}Eu, ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Am, TCE, PCE, and minor concentrations of metals.

Upper Three River

VOCs, PCBs, dioxins/furans, radioactivity, ^{3}H, ^{129}I, ^{234}U, ^{235}U, ^{238}U, Hg, ^{137}Cs, ^{60}Co, chlorinated and organic solvents, toluene, benzene, Pb, Cd, nitrates, metals, halogenated and non-halogenated solvents, cyanide, trichloroethylene, chlorinated degreasing solvents, Hg, waste oil, and Ra.

8.2 Actual exposures

Dose Information on the Internet

A source of radiation dose information was found on the Internet under REMS (Radiation Exposure Monitoring System)[78] at address http://rems.eh.doe.gov. This information is available for all persons who work for DOE contractors or subcontractors and who are monitored for either internal or external radiation exposure. Information on specific employees would be available to NIOSH for epidemiology studies through special arrangements with REMS personnel.

The information contained in the system is as follows:

Employee Identification
- Name
- Social Security Number

Dose Information (Entered as available)
- TEDE Total Effective Dose Equivalent
- Year
- Occupation
- Occupation code

DOE Operation Office for the facility at which he/she works.
- Site at which he/she works
- Reporting Organization (i.e., the organizations that report the information)
- Facility types

SRS did report some of their employees under the Waste Process/Management facility type.

The tables below show the distribution of worker classification (Process/Management facilities type employees) for the last 5 years along with radiation dosimetry information. Although it was requested, no information on the chemical exposure was forthcoming. SRS industrial hygiene personnel did not appear to believe that such information was available.

Table 8-1 SRS Occupational and Dose Information (1992)

					Radiation Dose (mrem)	
Occ Code	Occupation	Employing Organization	Total Monitored	No. With Measured Dose	Total Collective Dose (TEDE)	Average Measured Dose (TEDE)
160	Engineer	WSRC	2	1	65	65
	Miscellaneous	WSRC	2	2	10	5
690	Operators, Plant/System/Utili	WSRC	2	0	0	0

Table 8-2 SRS Occupational and Dose Information (1993)

					Radiation Dose (mrem)	
Occ Code	Occupation	Employing Organization	Total Monitored	No. With Measured Dose	Total Collective Dose (TEDE)	Average Measured Dose (TEDE)
450	Admin Support and Clerical Se	BSRI	27	5	84	17
642	Carpenters*	BSRI	82	34	1,759	52
643	Electricians*	BSRI	65	21	540	26
160	Engineer	BSRI	206	24	225	9
830	Equipment Operators*	BSRI	50	9	152	17
850	Handlers/Laborers/Helpers*	BSRI	139	72	3,788	53
710	Machine Setup/Operators	BSRI	8	3	25	8
110	Manager - Administrator	BSRI	29	2	13	7
660	Misc. Repair/Construction*	BSRI	77	25	843	34
390	Misc. Technicians*	BSRI	27	22	1,652	75
	Miscellaneous*	BSRI	177	57	4,039	
644	Painters*	BSRI	21	8	185	23
682	Sheet Metal Workers*	BSRI	14	3	105	35
820	Truck Drivers*	BSRI	36	2	16	8
771	Welders and Solderers*	BSRI	9	6	307	51

Table 8-2 SRS Occupational and Dose Information (1993)

					Radiation Dose (mrem)	
Occ Code	Occupation	Employing Organization	Total Monitored	No. With Measured Dose	Total Collective Dose (TEDE)	Average Measured Dose (TEDE)
200	Misc. Professional	WSRC Subcontractors	80	12	292	24
660	Misc. Repair/Construction*	WSRC Subcontractors	53	4	70	18
450	Admin. Support and Clerical Se	WSRC	15	4	23	6
160	Engineer	WSRC	301	27	227	8
370	Engineering Technicians	WSRC	302	137	4,984	36
184	Health Physicist*	WSRC	38	10	564	56
110	Manager - Administrator	WSRC	38	8	128	16
610	Mechanics/Repairers*	WSRC	28	2	27	14
200	Misc. Professional	WSRC	37	8	86	11
660	Misc. Repair/Construction*	WSRC	1	0	0	0
525	Misc. Service*	WSRC	32	5	35	7
	Miscellaneous*	WSRC	752	258	13,432	52
690	Operators, Plant/System/Utili*	WSRC	254	67	2,593	39
383	Radiation Monitors/Techs.*	WSRC	124	103	9,470	92
380	Science Technicians	WSRC	25	6	57	10
170	Scientist	WSRC	23	2	10	5
820	Truck Drivers*	WSRC	1	0	0	0

*indicates the occupation may be associated with CW, DeW, DiW, and HWW

Table 8-3 SRS Occupational and Dose Information (1994)

					Radiation Dose (mrem)	
Occ Code	Occupation	Employing Organization	Total Monitored	No. With Measured Dose	Total Collective Dose (TEDE)	Average Measured Dose (TEDE)
450	Admin Support and Clerical Se	BSRI	20	10	109	11
642	Carpenters*	BSRI	67	48	1,529	32
643	Electricians*	BSRI	66	38	581	15
160	Engineer	BSRI	188	87	927	11
830	Equipment Operators*	BSRI	45	13	155	12
850	Handlers/Laborers/Helpers*	BSRI	123	97	3,484	36
710	Machine Setup/Operators*	BSRI	11	7	259	37
110	Manager - Administrator	BSRI	18	6	72	12
660	Misc. Repair/Construction*	BSRI	67	46	1,210	26
390	Misc. Technicians*	BSRI	22	18	2,355	131
	Miscellaneous*	BSRI	101	63	1,632	26
644	Painters*	BSRI	21	12	133	11
682	Sheet Metal Workers*	BSRI	13	8	111	14
820	Truck Drivers*	BSRI	39	15	143	10
771	Welders and Solderers*	BSRI	12	5	69	14
260	Doctors and Nurses	WSRC	2	0	0	0
643	Electricians*	WSRC	7	1	7	7

Table 8-3 SRS Occupational and Dose Information (1994)

Occ Code	Occupation	Employing Organization	Total Monitored	No. With Measured Dose	Radiation Dose (mrem) Total Collective Dose (TEDE)	Radiation Dose (mrem) Average Measured Dose (TEDE)
160	Engineer	WSRC	414	154	1,283	8
370	Engineering Technicians	WSRC	339	191	8,418	44
850	Handlers/Laborers/Helpers*	WSRC	3	0	0	0
184	Health Physicist*	WSRC	47	30	977	33
110	Manager - Administrator	WSRC	44	14	134	10
610	Mechanics/Repairers*	WSRC	2	0	0	0
200	Misc. Professional	WSRC	50	37	444	12
200	Misc. Professional	WSRC Subcontractors	223	101	1,807	18
660	Misc. Repair/Construction*	WSRC Subcontractors	3	0	0	0
450	Admin. Support and Clerical Se	WSRC	25	9	105	12
525	Misc. Service*	WSRC	17	2	10	5
	Miscellaneous*	WSRC	729	365	21,444	59
690	Operators, Plant/System/Utili*	WSRC	211	104	3,688	35
383	Radiation Monitors/Techs.*	WSRC	114	100	8,631	86
380	Science Technicians	WSRC	21	4	30	8
170	Scientist	WSRC	21	7	55	8

*indicates the occupation may be associated with CW, DeW, DiW, and HWW

Table 8-4 SRS Occupational and Dose Information (1995)

					Radiation Dose (mrem)	
Occ Code	Occupation	Employing Organization	Total Monitored	No. With Measured Dose	Total Collective Dose (TEDE)	Average Measured Dose (TEDE)
642	Carpenters*	BSRI	52	37	1,603	43
643	Electricians*	BSRI	104	47	1,325	28
160	Engineer	BSRI	161	41	533	13
830	Equipment Operators*	BSRI	41	15	197	13
850	Handlers/Laborers/Helpers*	BSRI	108	80	4,091	51
710	Machine Setup/Operators*	BSRI	11	4	103	26
110	Manager - Administrator	BSRI	4	1	7	7
660	Misc. Repair/Construction*	BSRI	54	42	1,354	32
390	Misc. Technicians*	BSRI	35	24		39
	Miscellaneous*	BSRI	144	84	7,448	89
644	Painters*	BSRI	9	6	145	24
682	Sheet Metal Workers*	BSRI	16	11	462	42
820	Truck Drivers*	BSRI	24	4	42	11
771	Welders and Solderers*	BSRI	7	5	581	116
200	Misc. Professional	WSRC Subcontractors	187	48	1,190	25
660	Misc. Repair/Construction*	Westinghouse S.R. Subcontractors	5	2	16	8
	Miscellaneous	WSRC Subcontractors			1,569	
450	Admin. Support and Clerical Se	WSRC	5	1	14	14
260	Doctors and Nurses	WSRC	1	0	0	0
160	Engineer	WSRC	556	91	972	11

Table 8-4 SRS Occupational and Dose Information (1995)

					Radiation Dose (mrem)	
Occ Code	Occupation	Employing Organization	Total Monitored	No. With Measured Dose	Total Collective Dose (TEDE)	Average Measured Dose (TEDE)
370	Engineering Technicians	WSRC	386	204	6,195	30
184	Health Physicist*	WSRC	41	16	307	19
110	Manager - Administrator	WSRC	42	9	72	8
610	Mechanics/Repairers*	WSRC	1	0	0	0
200	Misc. Professional	WSRC	129	58	860	15
660	Misc. Repair/Construction*	WSRC	1	0	0	0
525	Misc. Service*	WSRC	10	2	32	16
	Miscellaneous*	WSRC	1,074	292	15,057	52
690	Operators, Plant/System/Utili*	WSRC	201	71	2,505	35
383	Radiation Monitors/Techs.*	WSRC	137	112	10,894	97
380	Science Technicians	WSRC	26	6	90	15
170	Scientist	WSRC	24	11	131	12

*indicates the occupation may be associated with CW, DeW, DiW, and HWW

Table 8-5 SRS Occupational and Dose Information (1996)

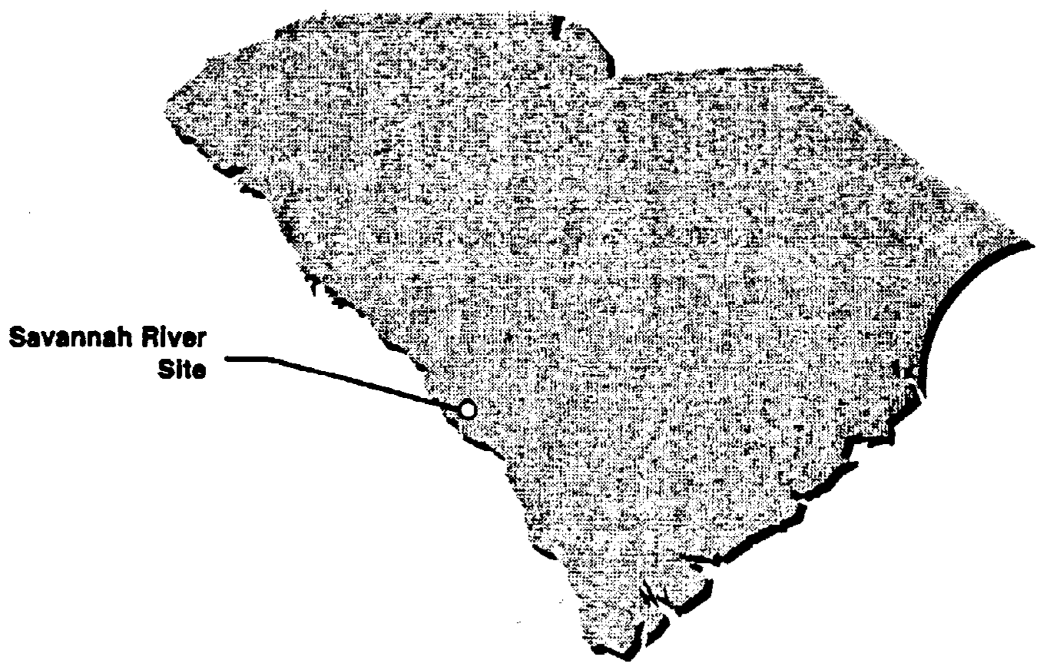
					Radiation Dose (mrem)	
Occ Code	Occupation	Employing Organization	Total Monitored	No. With Measured Dose	Total Collective Dose (TEDE)	Average Measured Dose (TEDE)
450	Admin Support and Clerical Se	BSRI	6	3	48	16
642	Carpenters*	BSRI	34	23	1,217	53
643	Electricians*	BSRI	100	52	796	15
160	Engineer	BSRI	145	31	468	15
830	Equipment Operators*	BSRI	24	10	138	14
850	Handlers/Laborers/Helpers*	BSRI	80	56	2,665	48
641	Masons*	BSRI	4	2	28	14
660	Misc. Repair/Construction*	BSRI	57	44	1,120	25
840	Misc. Transport*	BSRI	19	2	95	48
644	Painters*	BSRI	9	4	54	14
645	Pipe Fitter*	BSRI	84	34	2,026	60
682	Sheet Metal Workers*	BSRI	8	5	487	97
660	Misc. Repair/Construction*	WSRC Subcontractors	6	1	8	8
	Miscellaneous*	WSRC Subcontractors	212	94		17
450	Admin. Support and Clerical Se	WSRC	98	30	1,245	42
260	Doctors and Nurses	WSRC	1	0	0	0
160	Engineer	WSRC	851	183	3,154	17
184	Health Physicist*	WSRC	38	17	371	22
110	Manager - Administrator	WSRC	78	23	316	14
610	Mechanics/Repairers*	WSRC	360	165	9,365	57

Table 8-5 SRS Occupational and Dose Information (1996)

					Radiation Dose (mrem)	
Occ Code	Occupation	Employing Organization	Total Monitored	No. With Measured Dose	Total Collective Dose (TEDE)	Average Measured Dose (TEDE)
200	Misc. Professional	WSRC	359	45	464	10
390	Misc. Technician*	WSRC	3	0	0	0
840	Misc. Transport*	WSRC	1	0	0	0
	Miscellaneous*	WSRC	419	153	2,096	14
690	Operators, Plant/System/Utili*	WSRC	361	182	11,807	65
383	Radiation Monitors/Techs.*	WSRC	114	93	7,362	79
170	Scientist	WSRC	24	2	14	7
350	Technician*	WSRC	58	6	45	8
820	Truck Drivers*	WSRC	12	4		
*indicates the occupation may be associated with CW, DeW, DiW, and HWW						

9.0 Site Maps

Fig. 9-1 Map of South Carolina showing location of Savannah River Site within state



SOUTH CAROLINA

Fig. 9-2 Map of Savannah River Site relative to Aiken, SC and Augusta, GA

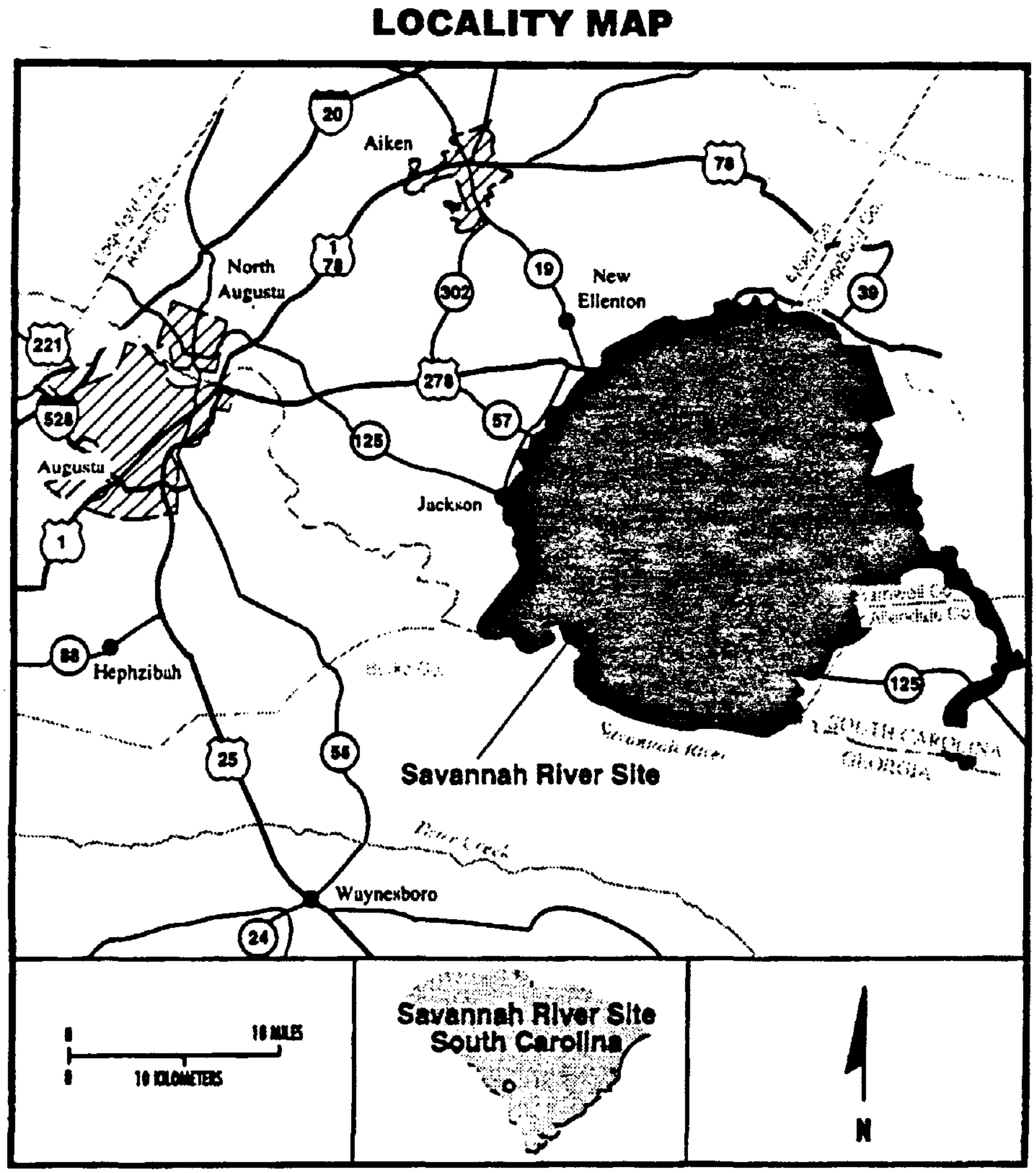


Fig. 9-3 Map of major operations areas within Savannah River Site

SITE MAP

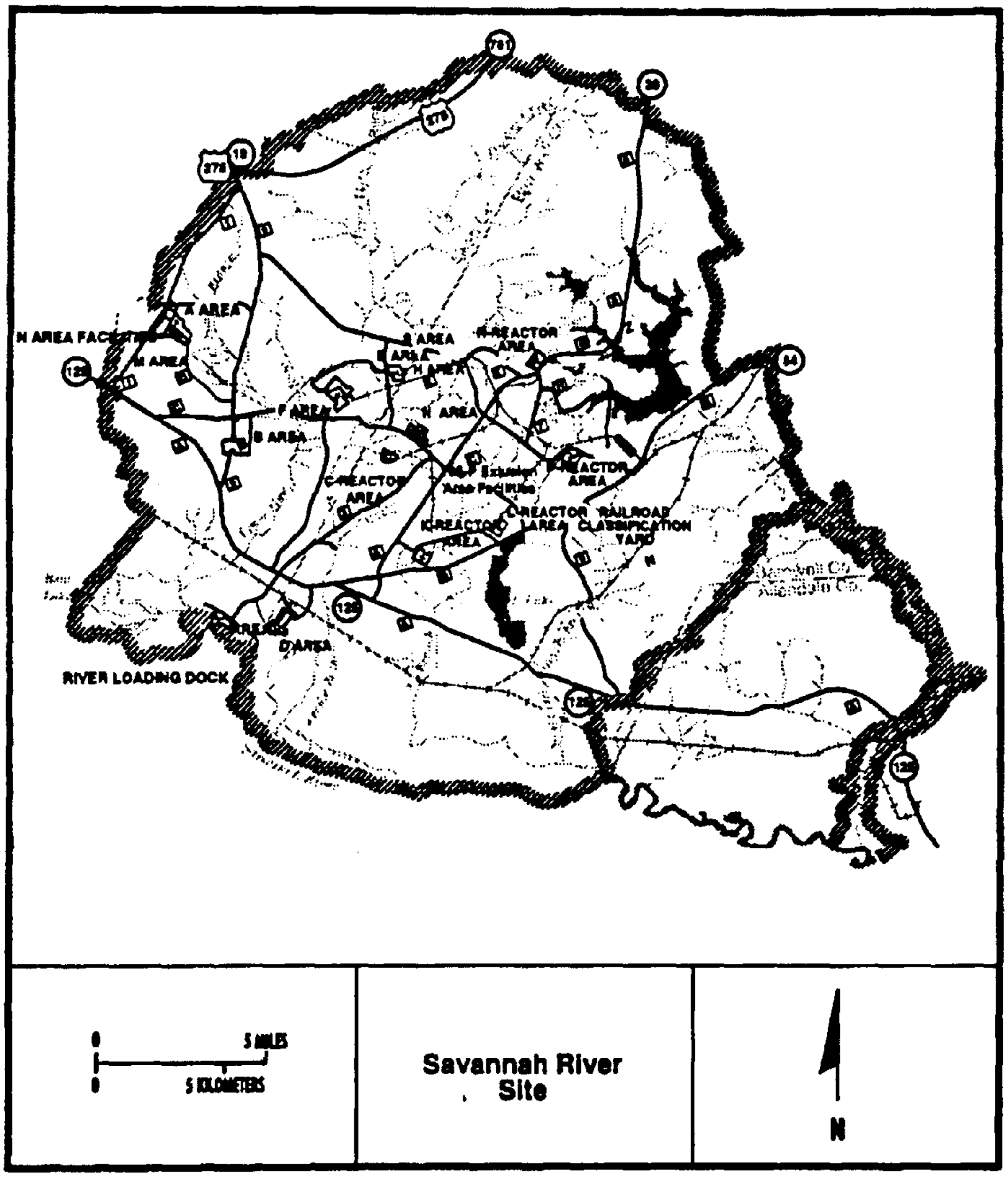


Fig. 9-4 Map of watersheds for remediation activities within Savannah River Site

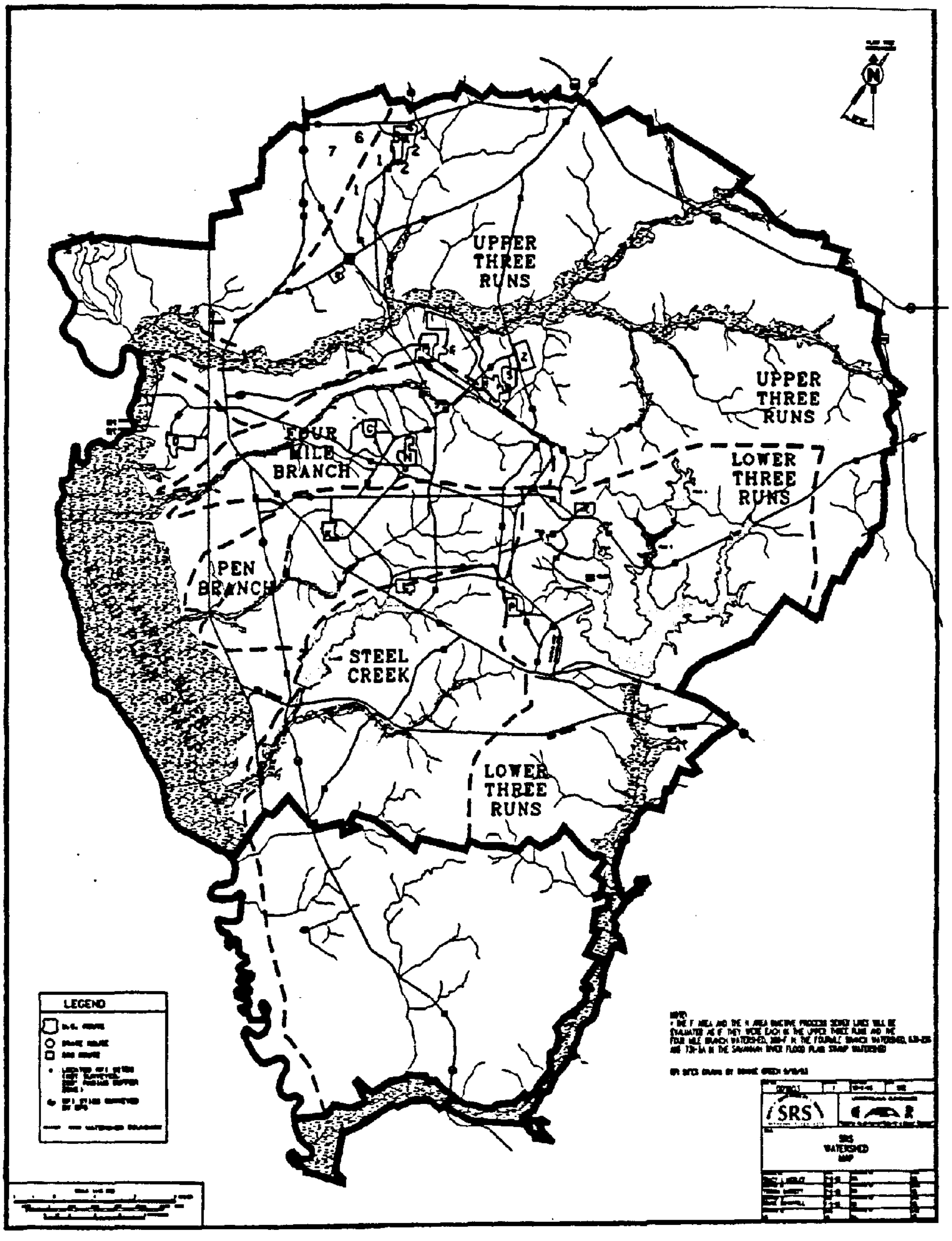


Fig. 9-5 Nuclear material and facility stabilization map

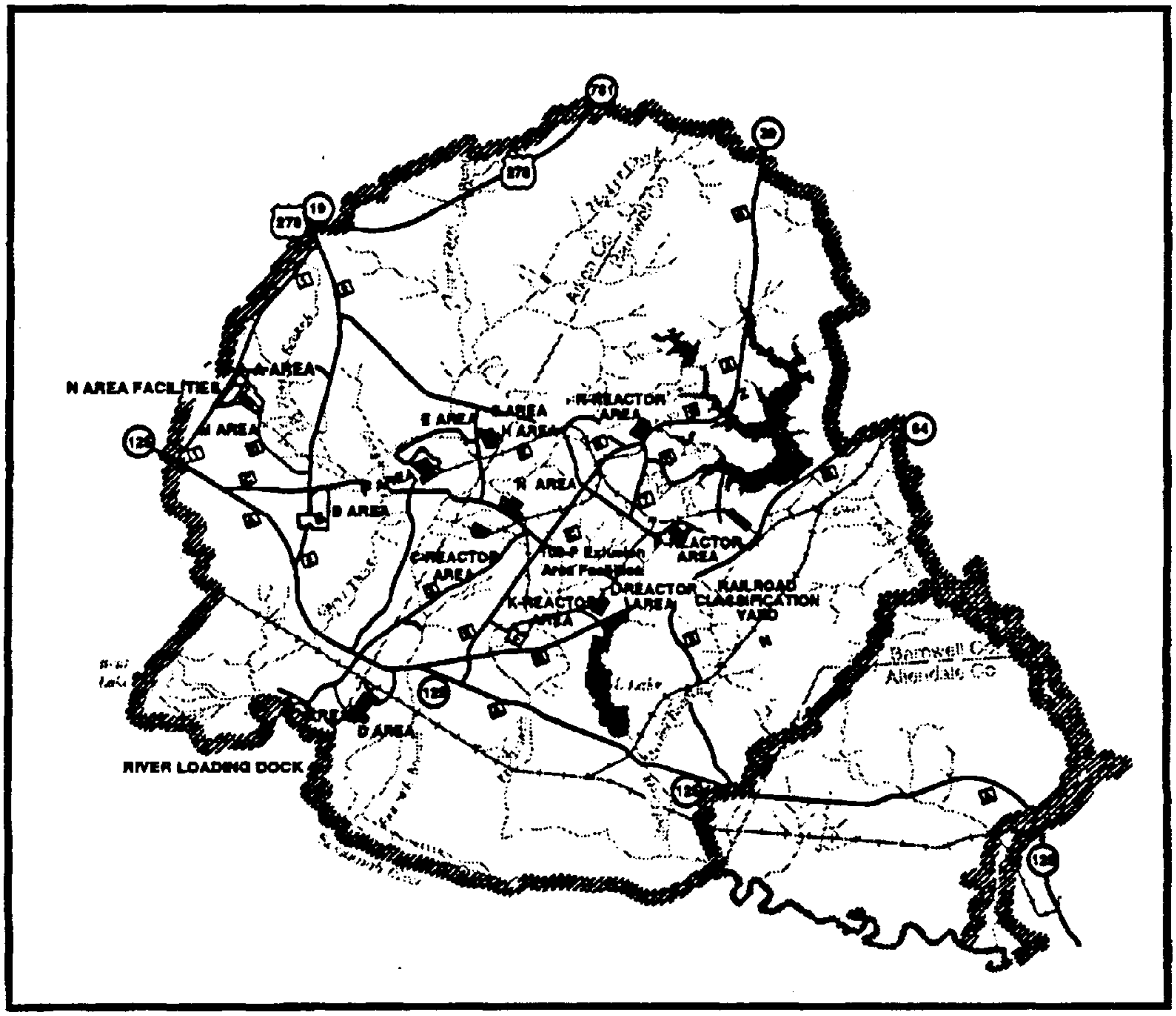
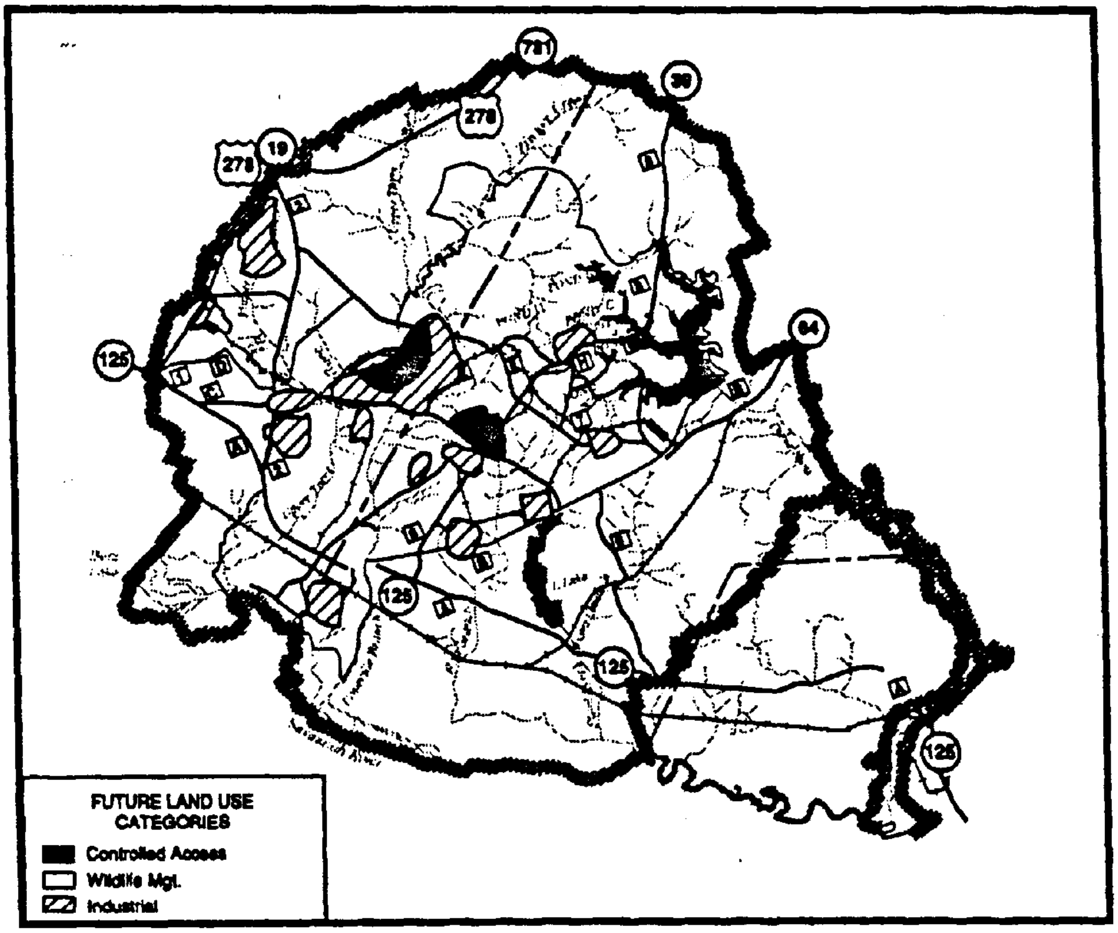


Fig. 9-6 Map showing intended future use of Savannah River Site land

FUTURE USE MAP



10.0 Contacts

Table 10-1 Organizational List of Contacts

Point of Contact	Organization and Address	Telephone No.	Facsimile No.	Area of Expertise
Bill Austin	WSRC/Facilities Decommissioning william.austin@srs.gov	803-725-4543	803-725-4095	D&D
Robert O. Baker	DOE, Bldg 703-A, Room E203N, Aiken, SC	803-725-1432	803-725-7548	General engineer
Mary Bales	RAPIC; 138 Mitchell Road Oak Ridge, TN 37830 RAPIC@ornl.gov	423-576-6500	423-576-6547	Environmental restoration reports
Gene Bonnette	BSRI/Transportation	803-208-0236	N/A	Union member/ Transportation
Charles Borup	DOE; Bldg 703-46A, Room 252 Aiken, SC 29808 charles.borup@srs.gov	803-725-1579	803-725-5968	Environmental/ Physical scientist
Keith Collinsworth	SRS, ER Division of DOE Oversight Dept	803-896-4055	803-896-4001	Environmental restoration oversight
Kenneth W. Crase	WSRC/Health Physics kenneth.crase@srs.gov	803-725-1382	803-725-3272	Health physics
DOE EM Hotline	Central Environmental Management Information P.O. Box 23769 Washington, DC 20026-3769	800-736-3282	202-554-3267	DOE (Environmental Management) publications
Lola Estes	RAPIC; 138 Mitchell Road Oak Ridge, TN 37830 RAPIC@ornl.gov	423-576-6500	423-576-6547	Environmental restoration reports

Table 10-1 Organizational List of Contacts

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James E. Hedges	WSRC; Bldg 147, Room 719-4A Aiken, SC james.hedges@srs.gov	803/725-4691	803-725-8781	Human Resources (WSRC staffing)
Robert Hucks	Department of Health and Environmental Control Columbia, SC hucksrl@columb34.dhec. state.sc.us	803-896-4086	803-896-4001	SC environmental issues
Peter Hugus	BSRI; Bldg 773-52A, Room 104 Aiken, SC peter.hugus@srs.gov	803-725-4660	803-725-4360	Site Records Manager
Thomas Jenkins	BSRI; Aiken, SC 29808	803-557-5237	N/A	Union member/ carpenter
Gail Jernigan	SRS, Citizens Advisory Board Bldg 730-2B, Rm 1037 Aiken, SC 29808 gail.jernigan@srs.gov	803-952-6969	803-952-6826	SC citizens representative
Ed Kahal	WSRC; Bldg 730-4B, Room 3129 Aiken, SC 29808 ed.kahl@srs.gov	803-952-9932	803-952-6826	Industrial Hygiene
Steve King	WSRC; Bldg 730-2B, Room 3016 Aiken, SC 29808	803-952-6372	803-952-6403	ER data manager
Clayton Lanier	BSRI; Aiken, SC 29808	803-557-5543	N/A	Union member/ iron worker

Table 10-1 Organizational List of Contacts

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Craig McMullin	BSRI; Bldg 730M, Room 157 Aiken, SC 29808 craig.mcmullin@srs.gov	803-725-1521	N/A	Environmental management
K.L. McTeer	BSR; Aiken, SC 29808	803-208-0872	N/A	Teamster/Transportation
Kay Moody	ORISE employee at SRS kay.moody@srs.gov	803-725-5795	803-725-0228	Research
Park Owens	RAPIC; 138 Mitchell Road Oak Ridge, TN 37830 RAPIC@ornl.gov	423-576-6500	423-576-6547	Manager of RAPIC project
John Pescosolido	SRS Operations Office, Chief Financial Officer-	803-725-5590	803-725-7565	DOE SR operations
Diane Rayer	Public Environmental Information Center; Harrison, OH	513-648-7496	513-648-7490	DOE public records and reports
Reading Room	DOE Public Information Resource, Univ SC	803-641-3320	803-641-3302	Public information
Leo Rees	WSRC; Bldg 719-18A, Room 1 Aiken, SC 29808 leo.rees@srs.gov	803-725-8766	803-725-8048	Program integration
Remedial Action Program Information Center (RAPIC)	RAPIC; 138 Mitchell Road Oak Ridge, TN 37830 RAPIC@ornl.gov	423-576-6500	423-576-6547	Environmental restoration reports

Table 10-1 Organizational List of Contacts

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Saleem Salaymeh	WSRC/SAES; Aiken, SC 29808	803-725-1628	803-725-4553	WSRC safety analysis engineering
L.P. Singh	DOE/SRO; Aiken, SC 29808	803-725-3962	803-725-2276	DOE SR operations
Lisa J. Skinner	WSRC/Safety and Health lisa.skinner@srs.gov	803-725-0650	803-725-4095	Industrial hygiene
Debbie Slater	SRS, Secretary to Kim Weirzbicki	803-952-6460	803-952-6403	Administrative support
Eddy Smith	BSRI; Aiken, SC 29808	803-557-5138	N/A	Union member/ Heavy equipment
Kevin Smith	WSRC/Safety Hazards Department kevin.smith@srs.gov	803-952-9924	803-952-6826	Industrial hygiene
SRS Library	SRS, Technology Center jel@srs.gov)	803-725-2739	803-725-1169	General information
SRS Operator	SRS (Nancy Hart) nancy.hart@srs.gov	803-725-6211	803-725-1327	WSRC telephone information services
John Strickland	WSRC/Medical; Bldg 719A, Room 64, Aiken, SC 29808 john02.strickland@srs.gov	803-725-1267	803-725-3486	WSRC medical services administration
L.H. (Kay) Strickland	BSRI; Aiken, SC 29808	803-557-5395	803-557-5395	Labor relations

Table 10-1 Organizational List of Contacts

Point of Contact	Organization and Address	Telephone No.	Facsimile No.	Area of Expertise
Larry Thebo	WSRC; Bldg 730-2B, Room 3014 Aiken, SC 29808 thebo.larry@srs.gov joaney@aol.com	803-952-8730	803-643-1075	Environmental Restoration
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Shanta Young	SRS, Law Library	803-725-3551	803-725-7544	Research
Dave Zimmerman	WSRC; Bldg 724-7R, Room 108 Aiken, SC 29808 zimmerman.dave@srs.gov	803-952-3714	803-952-4405	Nuclear materials stabilization
Matt Zimmerman	WSRC; Bldg 719-18A Aiken, SC 29808 mathew.zimmerman@srs.gov	803-725-7674	803-725-8048	Baseline and program integration

11.0 Data Sources and Repositories

(1) DOE PUBLIC READING ROOM

LOCATION: Federal Building, Oak Ridge, TN

HOURS OF OPERATION: 8:00 - 11:30 a.m. and 12:00 - 4:30 p.m. Monday-Friday

MANAGER: Amy Rothrock

ATTENDANT: Sheila Perry

COLLECTION: Documents are obtained from FOIA requests, DOE, and site documents provided for public use. The documents collection includes Human Radiation Studies, epidemiology studies by ChemRisk, and documents from Martin Marietta Energy Systems and Oak Ridge Operations Office. The collection includes the following variety of documents: proposed site treatment plans, contracts, Programmatic Environmental Impact Statements, Tiger Team Reports, DOE Orders, DOE Labor Standard Reports, and Daily Operation Reports. Indexes are available for the collection. A public computer is available to search the indexes.

(2) INFORMATION RESOURCE CENTER

LOCATION: 105 Broadway, Oak Ridge, TN

HOURS OF OPERATION: 7:30 - 5:30 p.m. Monday - Friday

ATTENDANT: Peggy Sands

COLLECTION: This facility is established by law and maintains technical documents, remedial investigations, records of decision, and site evaluations on the three Oak Ridge sites. Documents are supplied from DOE and Martin Marietta Energy Systems. Documents are kept in closed files; patrons may review a document prior to requesting copies. Copying costs for each 14-day period are as follows: 0-399 pages--no charge; 400 pages--$15.00 plus 5 cents for each additional page. Paper indexes are located in the reception area; they are updated periodically.

(3) REMEDIAL ACTION PROGRAM INFORMATION CENTER (RAPIC)

LOCATION: 138 Mitchell Road, Oak Ridge, TN 37830-7918

PHONE: (423) 576-6500

MANAGER: Park T. Owen

COLLECTION: RAPIC's long-term mission is to provide comprehensive information services to all programs under the auspices of U.S. DOE Office of Environmental Restoration (EM-40). The objectives of the program are to (1) provide a focal point for collecting, analyzing, abstracting and indexing, and archiving information related to ER program interests; (2) develop computerized information resources to provide an information base for EM-40; (3) respond to requests for information assistance from program participants; and (4) facilitate information transfer initiatives as directed by program sponsors. RAPIC is a comprehensive information broker and archivist for the DOE ER community. Specific information activities include: (1) maintaining a computerized bibliographic database of technical literature; (2) publishing an annual bibliography of documents identified as pertinent to the ER programs; (3) providing copies of requested documents or assisting in locating documents not currently available from RAPIC; (4) performing manual and computerized searches of the technical literature upon request; and (5) maintaining a database of individuals involved with ER work.

(4) DOCUMENT MANAGEMENT CENTER

LOCATION: Y-12 Plant, Building 9115, Room 140

MANAGERS: C.R. Martin; J.E. Powell

CONTACT: Steve Wiley, (423) 576-0263

COLLECTION: Contains some very old environmental documents and some ER and subcontractor documents. As documents are generated from the Environmental Management Group, they are given a document number and added to the collection. There is a computer system for searching the collection and a hard copy list is available. The collection is in the process of being scanned for optical disk technology storage.

(5) EMEF DOCUMENT MANAGEMENT CENTER

LOCATION: Building 1002, East Tennessee Technology Park (K-25 Site)

MANAGER: Karen Andrews, 241-6112

CONTACT: Steve Wiley, (423) 576-0263

COLLECTION: The EMEF Document Management Center is the site for environmental management and ER documents (many of the old ER documents are located here). The center contains approximately 40,000 active documents which are individually managed; 2,000 boxes of special collections are located at the center and managed at the box level; approximately 15,000 cu ft of inactive records are located at the site records center. Work is underway to merge other document centers with this facility. Approximately 400 documents are added to the collection per month. The active documents are indexed on the Documentum data base. Generally, there is no charge for copies of documents.

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13.0 Submitted Materials

The list of materials to be delivered to NIOSH as part of the product of this study will be provided upon completion of the study.

A total of 239 documents were collected and/or reviewed for this project. The documents include journal articles, technical reports, book excerpts, and information from the internet. Many of the documents are specific to one site (SRS or ORR) and appear only in the bibliography of one report. Other documents, however, are more general and were used to produce both reports.

A linkage tool (reference table) was developed to identify all the reference documents and show how they were used in the project. The table lists the references for all project documents in alphabetical order. The table shows (a) the site(s) to which the reference applies; (b) how the references are used in the report(s): as a general source of information (bibliography) or as a specific citation within the report(s) (work cited); and (c) whether the document is included in the shipment of documents to NIOSH. Documents cited in the report(s) are indicated in the table along with the citation number. Labels appear on the cited documents identifying the citation number(s) used.

A total of 152 documents (six cubic feet) are being shipped to NIOSH. The documents are arranged in the record boxes in the same alphabetical arrangement as listed in the reference table. The documents are being shipped in official record boxes as prescribed in the approved work plan.