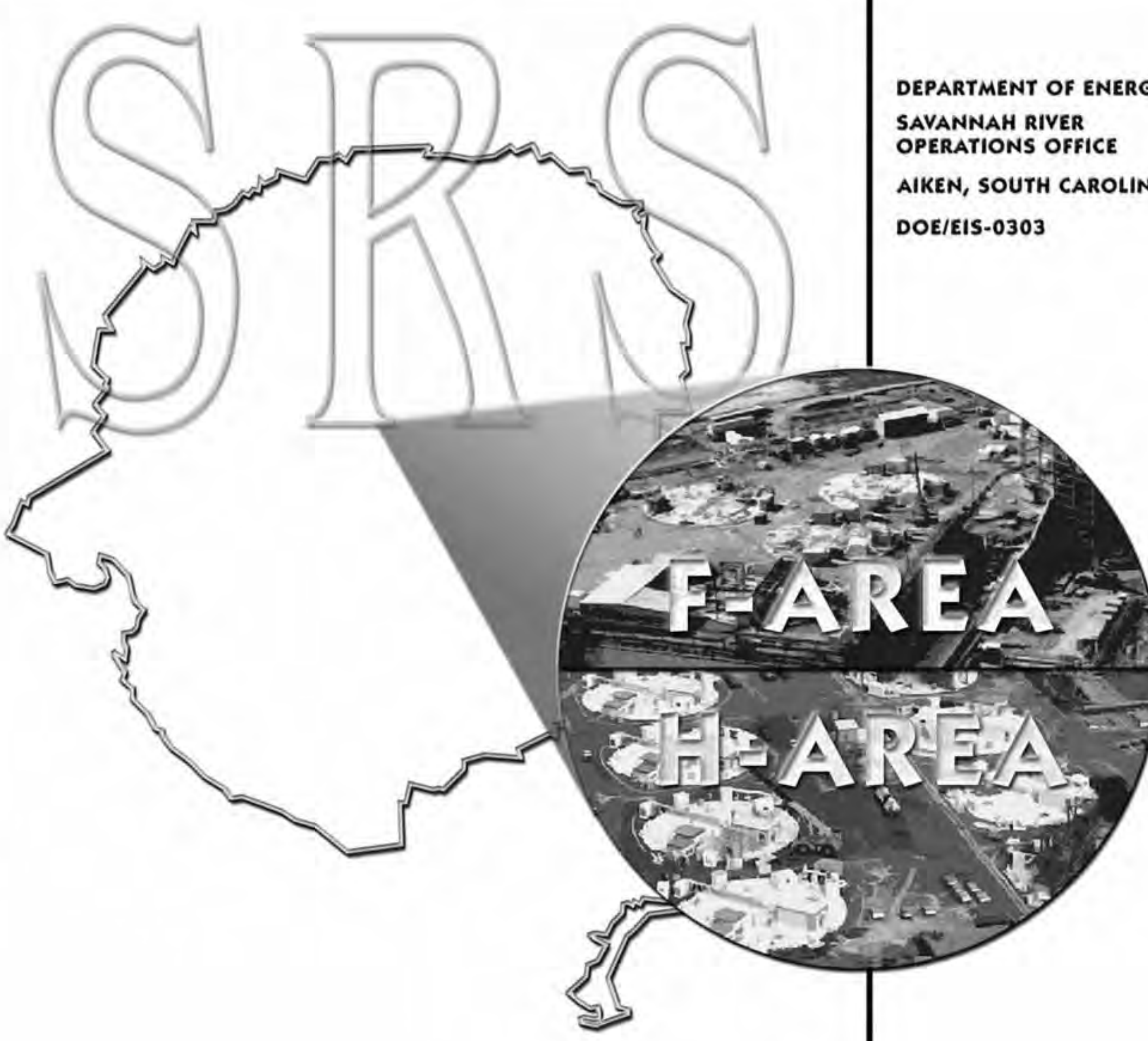
Savannah River Site

HIGH- LEVEL WASTE
TANK CLOSURE
Final Environmental Impact Statement



DEPARTMENT OF ENERGY
SAVANNAH RIVER
OPERATIONS OFFICE
AIKEN, SOUTH CAROLINA

DOE/EIS-0303

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COVER SHEET

RESPONSIBLE AGENCY: U.S. Department of Energy (DOE)

TITLE: *Savannah River Site High-Level Waste Tank Closure Environmental Impact Statement* (DOE/EIS-0303), Aiken, South Carolina EC

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ABSTRACT: DOE proposes to close the high-level waste (HLW) tanks at the Savannah River Site (SRS) in accordance with applicable laws and regulations, DOE Orders, and the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems* (approved by the South Carolina Department of Health and Environmental Control), which specifies the management of residuals as waste incidental to reprocessing. The proposed action would begin after bulk waste removal has been completed. This EIS evaluates three alternatives regarding the HLW tanks at the SRS: the Stabilize Tanks Alternative (referred to as the Clean and Stabilize Tanks Alternative in the Draft EIS), the Clean and Remove Tanks Alternative, and the No Action Alternative. Under the Stabilize Tanks Alternative, the EIS considers three options for tank stabilization: Fill with Grout (Preferred Alternative), Fill with Sand, and Fill with Saltstone. TC

Under each alternative (except No Action), DOE would close 49 HLW tanks and associated waste handling equipment including evaporators, pumps, diversion boxes, and transfer lines. Impacts are assessed primarily in the areas of water resources, air resources, public and worker health, waste management, socioeconomic impacts, and cumulative impacts.

PUBLIC INVOLVEMENT: DOE issued the *High-Level Waste Tank Closure Draft Environmental Impact Statement* on November 24, 2000, and held a public comment period on the EIS through January 23, 2001. In preparing the Final EIS, DOE considered comments received via mail, fax, electronic mail, and transcribed comments made at public hearings held on Tuesday, January 9, 2001, in North Augusta, South Carolina and on Thursday, January 11, 2001, in Columbia, South Carolina. Comments received and DOE's responses to those comments are found in Appendix D of the EIS. EC

OPERATIONAL SECURITY: Due to increased concerns about operational security after the events of September 11, 2001, Appendix E, which contains detailed information on the location, dimensions, and contents of the HLW tanks, is for Official Use Only. It will be made available on request to those who have a need to review this information. TC

Change Bars

Changes from the Draft EIS are indicated in this Final EIS by vertical change bars in the margins. The bars are marked TC for technical changes, EC for editorial changes or, if the change was made in response to a public comment, the designated comment number is noted, as listed in Appendix D of the EIS.

EC

FOREWORD

The U.S. Department of Energy (DOE) published a Notice of Intent to prepare this environmental impact statement (EIS) on December 29, 1998 (63 FR 71628). As described in the Notice of Intent, DOE's proposed action described in this EIS is to close the high-level waste (HLW) tanks at the Savannah River Site (SRS) in accordance with applicable laws and regulations, DOE Orders, and the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems* approved by the South Carolina Department of Health and Environmental Control. This closure plan specifies the management of residuals as waste incidental to reprocessing. The proposed action would begin after bulk waste removal has been completed and the tank system is turned over to the tank closure program. This EIS assesses the potential environmental impacts associated with alternatives for closing these tanks, as well as the potential environmental impacts of the residual radioactive and non-radioactive material remaining in the closed HLW tanks.

The Notice of Intent requested public comments and suggestions for DOE to consider in its determination of the scope of the EIS, and announced a public scoping period that ended on February 12, 1999. DOE held scoping meetings in North Augusta, South Carolina, on January 14, 1999, and in Columbia, South Carolina, on January 19, 1999. During the scoping period, individuals, organizations, and government agencies submitted 36 comments that DOE considered applicable to the SRS HLW tank closure program.

A Notice of Availability for the draft EIS appeared in the *Federal Register* on November 24, 2000. Public meetings to discuss and receive comments on the Draft EIS were held on Tuesday, January 9, 2001, in North Augusta, South Carolina and on Thursday, January 11, 2001 in Columbia, South Carolina. The public comment period ended on January 23, 2001. A summary of oral comments, complete written comments, and DOE responses to comments are in Appendix D. EC

Transcripts of public testimony, written comments received, and reference materials cited in the EIS are available for review in the DOE Public Reading Room, University of South Carolina at Aiken, Gregg-Graniteville Library, University Parkway, Aiken, South Carolina.

DOE has prepared this EIS in accordance with the National Environmental Policy Act (NEPA) regulations of the Council on Environmental Quality (40 CFR Parts 1500-1508) and DOE NEPA Implementing Procedures (10 CFR Part 1021). This EIS identifies the methods used for analyses and the scientific and other sources of information consulted. In addition, it incorporates, directly or by reference, available results of ongoing studies. The organization of the EIS is as follows:

- Summary (bound separately). L-1-6

- Chapter 1 provides background information related to SRS HLW tank closures and describes the purpose and need for DOE action regarding HLW tank closure at the SRS.

- Chapter 2 identifies the proposed action and alternatives that DOE is considering for HLW tank closure at the SRS.

- Chapter 3 describes the existing SRS environment as it relates to the alternatives described in Chapter 2.

- Chapter 4 assesses the potential environmental impacts of the alternatives for both the short-term (from the year 2000 through final closure of the existing HLW tanks) and long-term (10,000 years post-closure) timeframes.

- Chapter 5 discusses the cumulative impacts of HLW tank closure actions in relation to impacts of other past, present, and foreseeable future activities at the SRS.

- Chapter 6 identifies irreversible or irretrievable resource commitments.

- Chapter 7 discusses applicable statutory and regulatory requirements, DOE Orders, and agreements.

- Appendix A provides a description of the SRS HLW Tank Farms and the tank closure process.

- Appendix B provides detailed descriptions of accidents that could occur at SRS during HLW tank closure activities.

- Appendix C provides a detailed description of the fate and transport modeling used to estimate long-term environmental impacts.

- Appendix D describes public comments received on the Draft EIS and provides DOE responses. EC

- Appendix E, Description of the Savannah River Site High-Level Waste Tank Farms, which is for Official Use Only, contains detailed information about the location, physical dimensions, and content of the HLW tank systems. Due to increased concerns about operational security following the events of September 11, 2001, Appendix E will be made available upon request to those who have a need to review this information. Please contact Andrew Grainger at the address and telephone number given on the Cover Sheet, to request Appendix E. Consistent with the direction of the Attorney General of the United States, this information is not releasable under the Freedom of Information Act. EC

ACRONYMS, ABBREVIATIONS, AND USE OF SCIENTIFIC NOTATION

Acronyms

AAQS	ambient air quality standard
AEA	Atomic Energy Act of 1954
ALARA	as low as reasonably achievable
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CLSM	controlled low-strength material
CO	carbon monoxide
D&D	decontamination and decommissioning
DBE	design basis event
DOE	U.S. Department of Energy
DWPF	Defense Waste Processing Facility
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FR	Federal Register
HEPA	high-efficiency particulate air (filter)
HLW	high-level waste
IMNM	Interim Management of Nuclear Material
INEEL	Idaho National Engineering and Environmental Laboratory
ISO	International Organization for Standardization
LCF	latent cancer fatality
LEU	low enriched uranium
LWC	lost workday cases
MCL	maximum contaminant level

MEI	maximally exposed (offsite) individual
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Sciences
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NO_X	nitrogen oxides
NRC	U.S. Nuclear Regulatory Commission
O_3	ozone
OSHA	Occupational Safety and Health Administration
PM_{10}	particulate matter less than 10 microns in diameter
PSD	Prevention of Significant Deterioration
ROD	Record of Decision
ROI	Region of Influence
SCDHEC	South Carolina Department of Health and Environmental Control
SO_2	sulfur dioxide
SRS	Savannah River Site
TRC	total recordable cases
TSP	total suspended particulates
WSRC	Westinghouse Savannah River Company

Abbreviations for Measurements

cfm	cubic feet per minute
cfs	cubic feet per second = 448.8 gallons per minute = 0.02832 cubic meter per second
cm	centimeter
gpm	gallons per minute
kg	kilogram
L	liter = 0.2642 gallon
lb	pound = 0.4536 kilogram
mg	milligram
μCi	microcurie
μg	microgram
pCi	picocurie
°C	degrees Celsius = 5/9 (degrees Fahrenheit – 32)
°F	degrees Fahrenheit = 32 + 9/5 (degrees Celsius)

Use of Scientific Notation

Very small and very large numbers are sometimes written using "scientific notation" or "E-notation" rather than as decimals or fractions. Both types of notation use exponents to indicate the power of 10 as a multiplier (i.e., 10^n, or the number 10 multiplied by itself "n" times; 10^{-n}, or the reciprocal of the number 10 multiplied by itself "n" times).

For example: $10^3 = 10 \times 10 \times 10 = 1{,}000$

$$10^{-3} = \frac{1}{10 \times 10 \times 10} = 0.001$$

In scientific notation, large numbers are written as a decimal between 1 and 10 multiplied by the appropriate power of 10:

4,900 is written $4.9 \times 10^3 = 4.9 \times 10 \times 10 \times 10 = 4.9 \times 1{,}000 = 4{,}900$
0.049 is written 4.9×10^{-2}
1,490,000 or 1.49 million is written 1.49×10^6

A positive exponent indicates a number larger than or equal to one; a negative exponent indicates a number less than one.

In some cases, a slightly different notation ("E-notation") is used, where "× 10" is replaced by "E" and the exponent is not superscripted. Using the above examples

$4{,}900 = 4.9 \times 10^3$ = 4.9E+03
$0.049 = 4.9 \times 10^{-2}$ = 4.9E-02
$1{,}490{,}000 = 1.49 \times 10^6$ = 1.49E+06

Metric Conversion Chart

To convert into metric			To convert out of metric		
If you know	**Multiply by**	**To get**	**If you know**	**Multiply by**	**To get**
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
sq. inches	6.4516	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.092903	sq. meters	sq. meters	10.7639	sq. feet
sq. yards	0.8361	sq. meters	sq. meters	1.196	sq. yards
acres	0.0040469	sq. kilometers	sq. kilometers	247.1	acres
sq. miles	2.58999	sq. kilometers	sq. kilometers	0.3861	sq. miles
Volume					
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight					
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.4536	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons
Temperature					
Fahrenheit	Subtract 32 then multiply by 5/9ths	Celsius	Celsius	Multiply by 9/5ths, then add 32	Fahrenheit

Metric Prefixes

Prefix	Symbol	Multiplication Factor
exa-	E	$1\,000\,000\,000\,000\,000\,000 = 10^{18}$
peta-	P	$1\,000\,000\,000\,000\,000 = 10^{15}$
tera-	T	$1\,000\,000\,000\,000 = 10^{12}$
giga-	G	$1\,000\,000\,000 = 10^{9}$
mega-	M	$1\,000\,000 = 10^{6}$
kilo-	k	$1\,000 = 10^{3}$
centi-	c	$0.01 = 10^{-2}$
milli	m	$0.001 = 10^{-3}$
micro-	µ	$0.000\,001 = 10^{-6}$
nano-	n	$0.000\,000\,001 = 10^{-9}$
pico-	p	$0.000\,000\,000\,001 = 10^{-12}$
femto-	f	$0.000\,000\,000\,000\,001 = 10^{-15}$
atto-	a	$0.000\,000\,000\,000\,000\,001 = 10^{-18}$

CHAPTER 1. BACKGROUND AND PURPOSE AND NEED FOR ACTION

1.1 Background

The Savannah River Site (SRS) occupies approximately 300 square miles adjacent to the Savannah River, primarily in Aiken and Barnwell Counties in South Carolina. It is approximately 25 miles southeast of Augusta, Georgia, and 20 miles south of Aiken, South Carolina. The U.S. Atomic Energy Commission, a U.S. Department of Energy (DOE) predecessor agency, established SRS in the early 1950s. Until the early 1990s, the primary SRS mission was the production of special radioactive isotopes to support national programs. More recently, the SRS mission has emphasized waste management, environmental restoration, and decontamination and decommissioning of facilities that are no longer needed for SRS's traditional defense activities.

L-1-10 L-5-2 L-7-22 As a result of its nuclear materials production mission, SRS generated large quantities of high-level radioactive waste (HLW). This waste resulted from dissolving spent reactor fuel and nuclear targets to recover the valuable isotopes.

1.1.1 HIGH-LEVEL WASTE DESCRIPTION

DOE Manual 435.1-1, which provides direction EC for implementing DOE Order 435.1, *Radioactive Waste Management*, (DOE 1999a) defines HLW as "highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation." DOE M 435.1-1 also defines two processes for determining that a specific waste resulting from reprocessing spent nuclear fuel can be considered waste incidental to reprocessing (see Section 7.1.3). Waste resulting from reprocessing spent nuclear fuel that is determined to be incidental to reprocessing does not need to be managed as HLW, and shall be managed under DOE's regulatory authority in accordance with the requirements for transuranic waste or low-level waste, as appropriate.

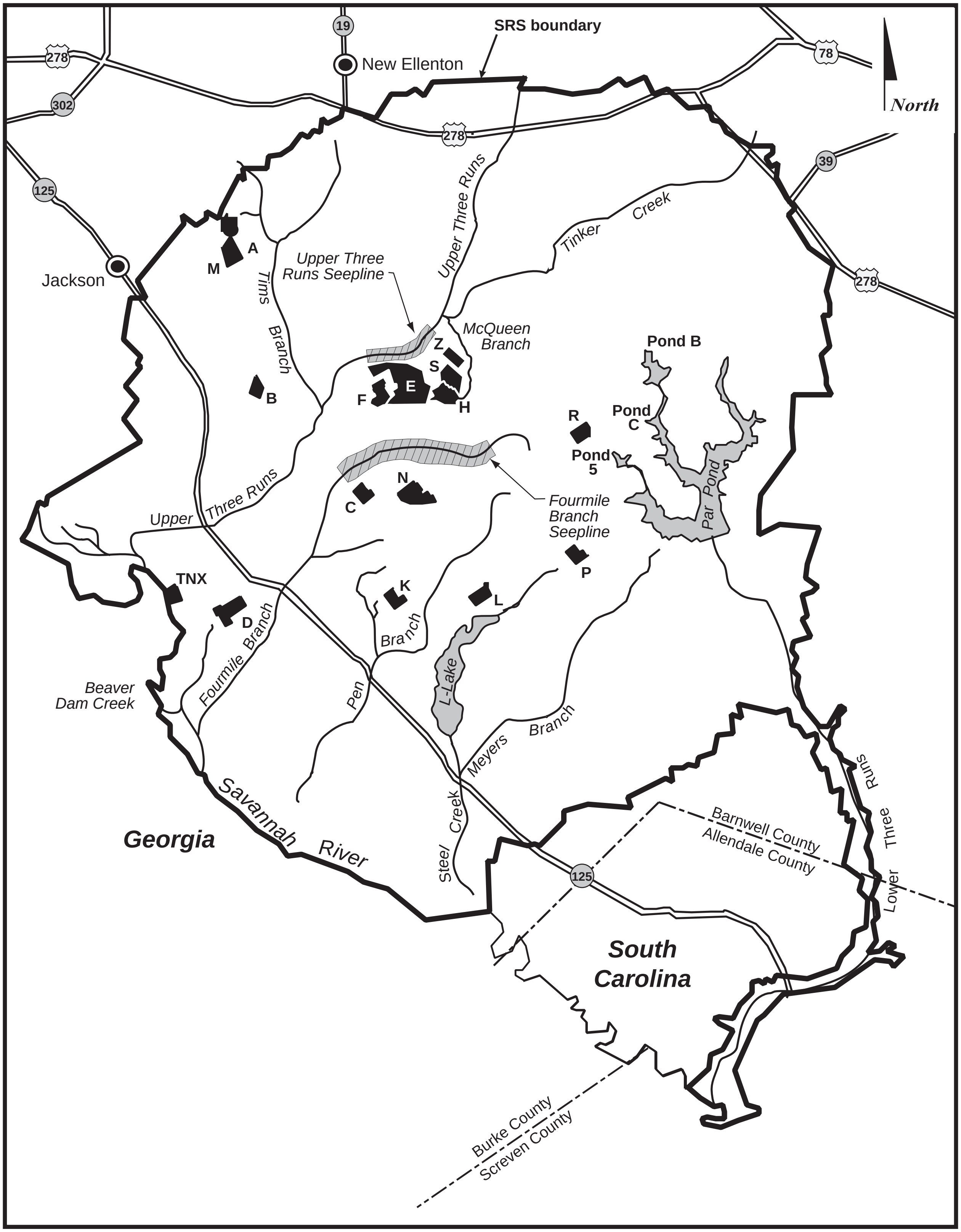
1.1.2 HLW MANAGEMENT AT SRS

At the present time, approximately 37 million TC gallons of HLW are stored in 49 underground tanks in two tank farms, the F-Area Tank Farm and the H-Area Tank Farm. These tank farms are in the central portion of SRS. The sites were chosen in the early 1950s because of their proximity to the F- and H-Area Separations Facilities, and the distance from the SRS EC boundaries. Figure 1-1 shows the setting of the F and H Areas and associated tank farms.

The HLW in the tanks consists primarily of three physical forms: sludge, salt, and liquid. The sludge is solid material that precipitates and settles to the bottom of a tank. The salt is comprised of salt compounds[1] that have crystallized as a result of concentrating the liquid by evaporation. The liquid is highly concentrated salt solution. Although some tanks contain all three forms, many tanks are considered primarily sludge tanks while others are considered salt tanks (containing both salt and salt solution).

The sludge portion of the HLW currently is being transferred to the Defense Waste Processing Facility (DWPF) for vitrification in borosilicate glass to immobilize the radioactive constituents as described in the *Defense Waste Processing Facility Supplemental Environmental Impact Statement* (DOE 1994). (The plan and schedule for managing tank space, mixing waste to create an appropriate feed for

[1] A salt is a chemical compound formed when one or more hydrogen ions of an acid are replaced by metallic ions. Common salt, sodium chloride, is a well-known salt.



TC

Figure 1-1. Savannah River Site map. F and H Areas are in the upper center.

the DWPF, and removing bulk waste is contained in the *High-Level Waste System Plan* [WSRC 1998 and subsequent revisions]). The borosilicate glass is poured into stainless steel canisters that are stored in the Glass Waste Storage Building pending shipment to a geologic repository for disposal. The proposed construction, operation and monitoring, and closure of a geologic repository at the Yucca Mountain site in Nevada is the subject of a separate environmental impact statement (EIS). As part of that process, DOE issued a Draft EIS for a geologic repository at Yucca Mountain, Nevada, in August 1999 (64 Federal Register [FR] 156), and a supplement to the Draft EIS in May 2001 (66 FR 22540). The Final EIS was L-4-13 approved and DOE announced the electronic and reading room availability in February 2002 (67 FR 9048). The President has recommended to the Congress that the Yucca Mountain site is suitable as a geologic repository. If the Yucca Mountain site is licensed by the Nuclear Regulatory Commission (NRC) for development as a geologic repository, current schedules indicate that the repository could begin receiving waste as early as 2010. DOE has not yet developed schedules for sending specific wastes, such as the glass-filled canisters, to the repository.

The salt and liquid portions of the HLW must be separated into high-radioactivity and low- TC radioactivity fractions as part of treatment. As described in DOE (1994), the In-Tank Precipitation process would separate the HLW into high- and low-activity fractions. The high-radioactivity fraction would be transferred to the DWPF for vitrification. The low-radioactivity fraction that meets the Waste Incidental to TC Reprocessing requirements (see Section 1.1.4.2) would be transferred to the Saltstone Manufacturing and Disposal Facility in Z Area TC and mixed with grout to make a concrete-like material to be disposed of in vaults at SRS. Since issuance of that EIS, DOE has concluded that the In-Tank Precipitation process, as currently configured, cannot achieve production goals and meet safety requirements for processing the salt portion of HLW (64 FR L-4-14 8558, February 22, 1999). Therefore, in February 1999, DOE issued a Notice of Intent (64 FR 8558, February 22, 1999) to prepare a second Supplemental EIS (SEIS), *High-Level Waste Salt Processing Alternatives at the Savannah River Site* (DOE/EIS-0082-S2). This SEIS analyzed the impacts of constructing and operating facilities for four alternative processing technologies. The Final Salt Processing Alternatives SEIS was issued in July 2001 (66 FR 37957; July 20, 2001) and the Record of Decision in October 2001 (66 FR L-4-14 52752; October 17, 2001). DOE selected the Caustic Side Solvent Extraction Alternative for separation of radioactive cesium from SRS salt wastes. Selecting a salt processing technology was necessary in order to empty the tanks and allow tank closure to proceed. Figure 1-2 shows the SRS HLW management system as currently configured.

1.1.3 DESCRIPTION OF THE TANK FARMS

The F-Area Tank Farm is a 22-acre site that contains 20 active waste tanks, 2 closed waste tanks (Tanks 17 and 20), evaporator systems, transfer pipelines, diversion boxes, and pump pits. Figure 1-3 shows the general layout of the F-Area Tank Farm. The H-Area Tank Farm is a 45-acre site that contains 29 active waste tanks, EC evaporator systems (including the new Replacement High-level Waste Evaporator), the Extended Sludge Processing Facility, transfer pipelines, diversion boxes, and pump pits. Figure 1-4 shows the general layout of the H-Area Tank Farm.

The F- and H-Area Tank Farms were constructed to receive high-level radioactive waste generated by various SRS production, processing, and laboratory facilities. The use of the tank farms isolates these wastes from the environment, SRS workers, and the public. In addition, the tank farms enable radioactive decay by aging of the waste, clarification of waste by gravity settling, and removal of soluble salts from waste by evaporation. The tank farms also pretreat the accumulated sludge and salt solutions (supernate) to enable the management of these wastes at other SRS treatment facilities (i.e., DWPF and Z-Area Saltstone EC Manufacturing and Disposal Facility). These

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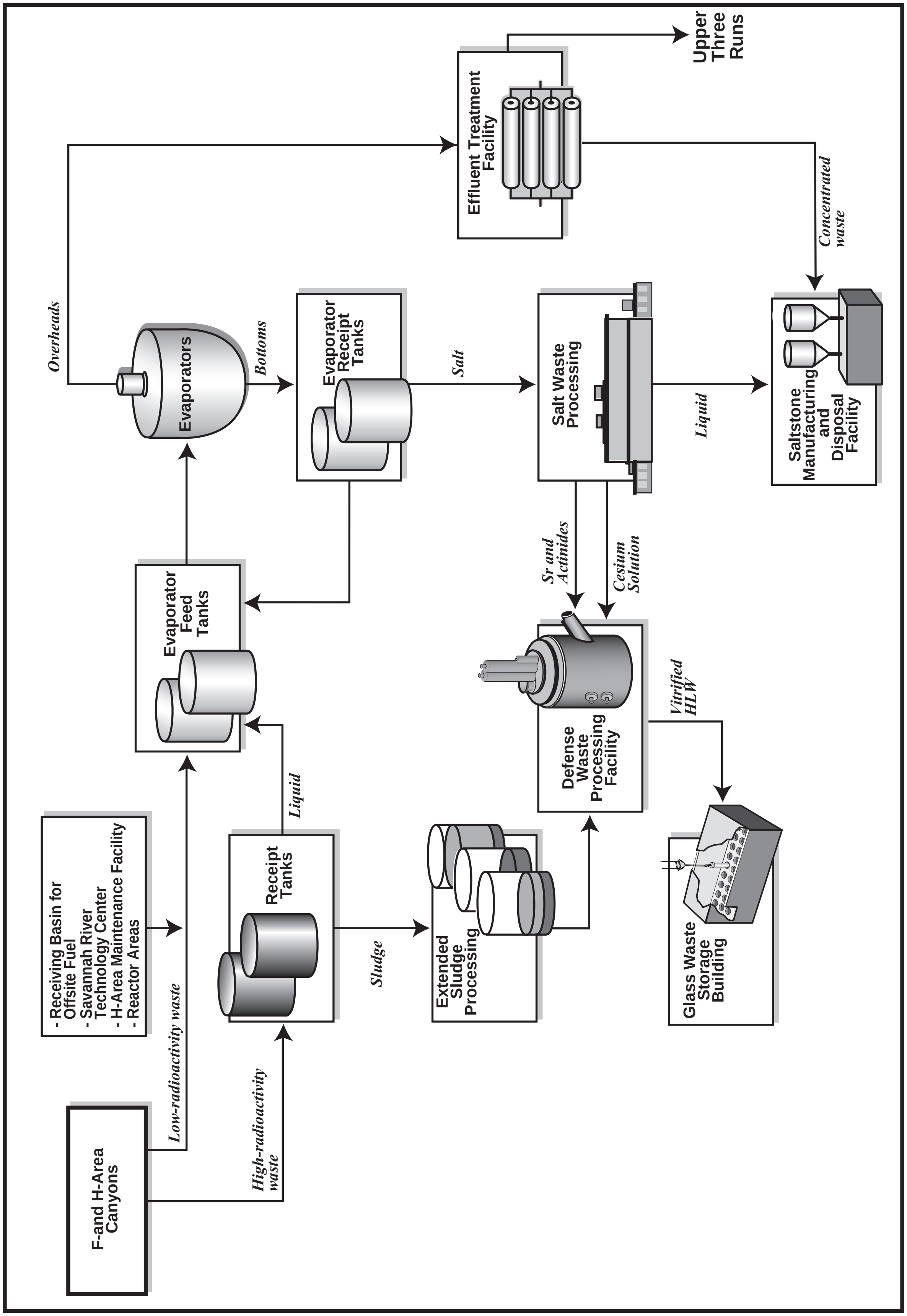

Figure 1-2. Process flows for Savannah River Site high-level waste management system.

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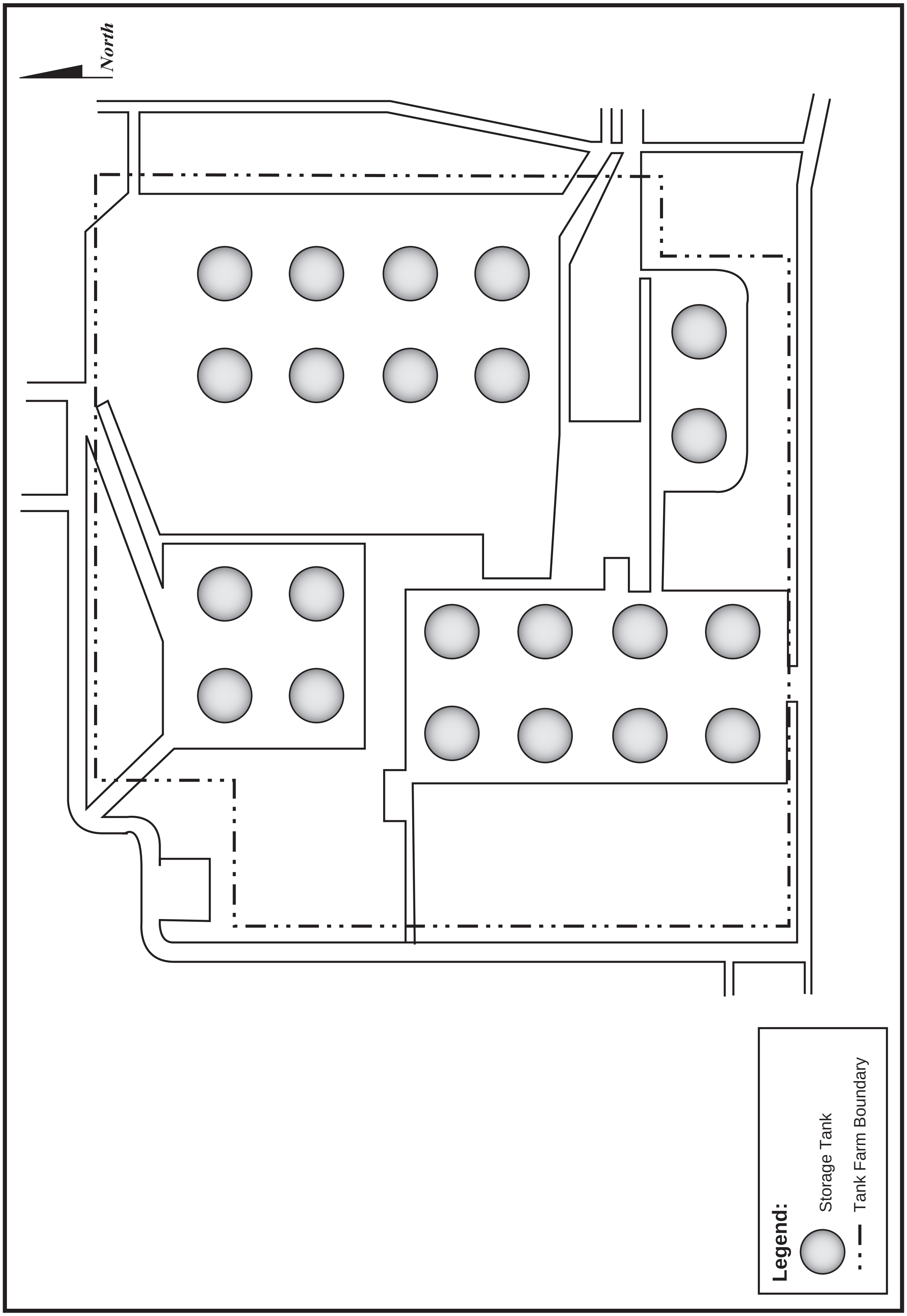

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Figure 1-3. General layout of F-Area Tank Farm.

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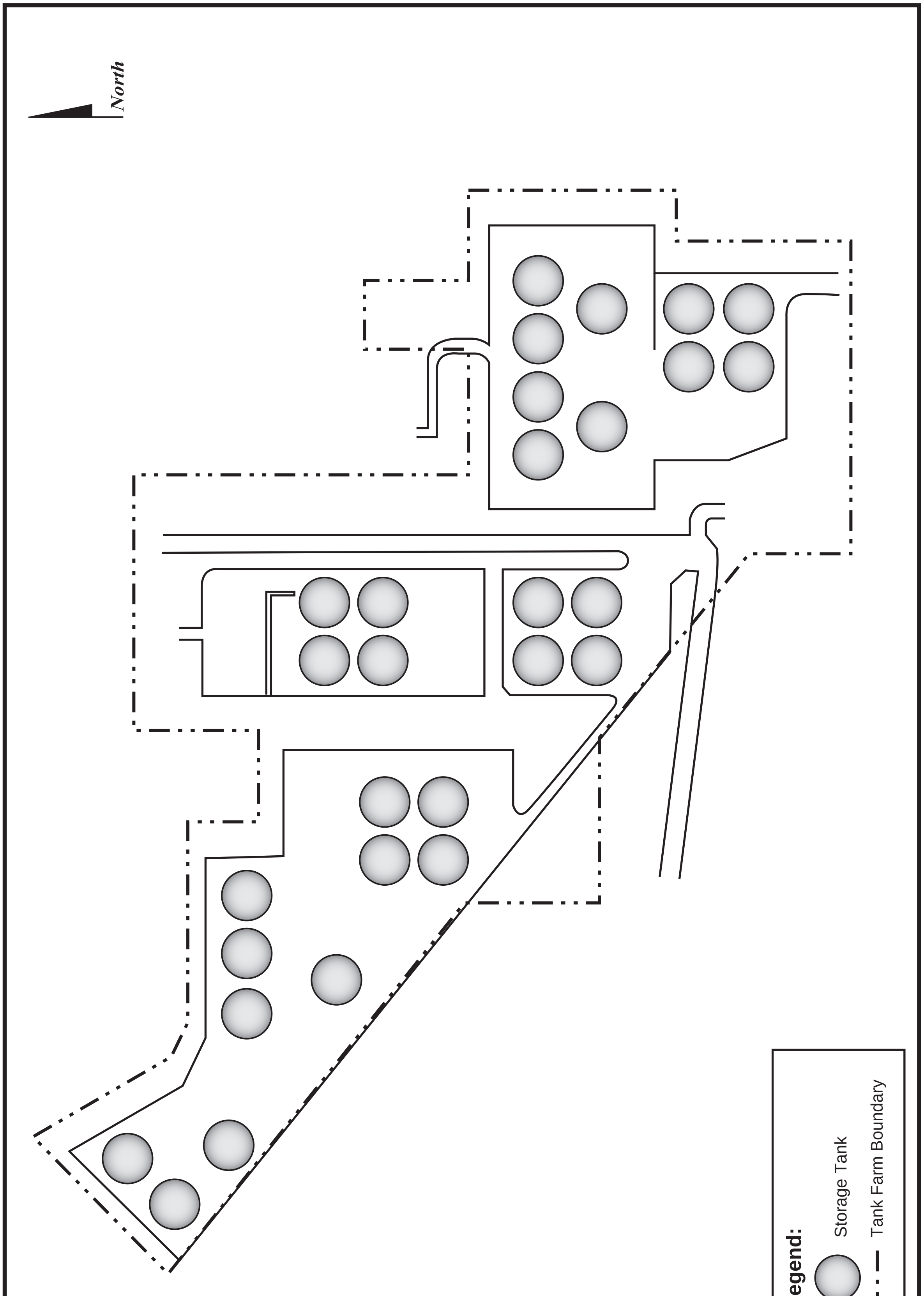

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Figure 1-4. General layout of H-Area Tank Farm.

treatment facilities convert the sludge and supernate to more stable forms suitable for permanent disposal.

To accomplish the system operational objectives described above, the following units were assembled in the tank farms:

- Fifty-one large underground waste tanks to receive and age the waste, and allow it to settle
- Five existing evaporator systems to concentrate soluble salts and reduce the waste volume
- Transfer system (i.e., transfer lines, diversion boxes, and pump pits) to transfer supernate, sludge, and other waste (e.g., evaporator condensate) between tanks and treatment facilities
- TC Salt processing system to separate the salt solution into high- and low-activity fractions for immobilization at the DWPF Vitrification Facility and Z-Area Saltstone Manufacturing and Disposal Facility, TC respectively
- Sludge washing system (i.e., Extended Sludge Processing) to pre-treat the accumulated sludge prior to immobilization at the DWPF Vitrification Facility.

Tanks

The F- and H-Area tanks are of four different designs, all constructed of carbon-steel inside reinforced concrete containment vaults. Two EC designs (Types I and II) have secondary annulus pans and active cooling (Figure 1-5). (An annulus is the space between two walls of a double-walled tank.)

The 12 Type I Tanks (Tanks 1 through 12) were EC built in 1952 and 1953, 7 of these (Tanks 1, 5, 6, and 9 through 12) have known leak sites in which waste leaked from the primary containment to the secondary containment. The leaked waste is kept dry by air circulation, and there is no evidence that the waste has leaked from the secondary containment. The level of the waste in these tanks has been lowered to below these leak sites. The tank tops are below TC grade. The bottoms of Tanks 1 through 8, in F Area, are situated above the seasonal high water table. The bottoms of Tanks 9 through 12 TC in the H-Area Tank Farm are in the water table.

The four Type II tanks (Tanks 13 through 16) were built in 1956 in the H-Area Tank Farm (Figure 1-5). All four have known leak sites in which waste leaked from primary to secondary containment. In Tank 16, tens of gallons of TC waste overflowed the annulus pan (secondary containment) in 1962. L-7-23 Most of the waste was still contained in the concrete encasement that surrounds the tank, but surveys indicated that some waste leaked into the soil, presumably through a construction joint on the side of the encasement that is located near the top of the annulus pan, about 25 feet below grade. Based on soil borings around the tank, it is estimated that some tens of gallons of waste leaked into the soil. Much of the leaked waste was removed from the annulus during the period from 1976 to 1978; however, several thousand gallons of dry TC waste remain in the annulus. Waste removal from the Tank 16 primary vessel was completed in 1980. Assuming that the waste did leak from the construction joint, the leaked waste is in the vicinity of the seasonal water table and is at times below the water table.

The cracks in the Types I and II tanks were due to nitrate-induced stress corrosion cracking. The cracks generally occurred in the heat-affected zones adjacent to tank welds. These zones have high tensile stresses and are susceptible to the corrosive effects of the high concentrations of nitrates that occur in SRS wastes. Nitrate-induced stress corrosion cracking is inhibited by sodium hydroxide and sodium nitrite, but the L-7-11 initial wastes added to these tanks did not have sufficient inhibitors to prevent cracking. Since the time of the initial cracks, considerable research has been done to determine inhibitor levels that will prevent stress corrosion cracking and other types of corrosion that could affect the SRS tanks. (There are other types of corrosion, such as pitting that have not caused leaks, but are a potential threat.) SRS tanks are routinely

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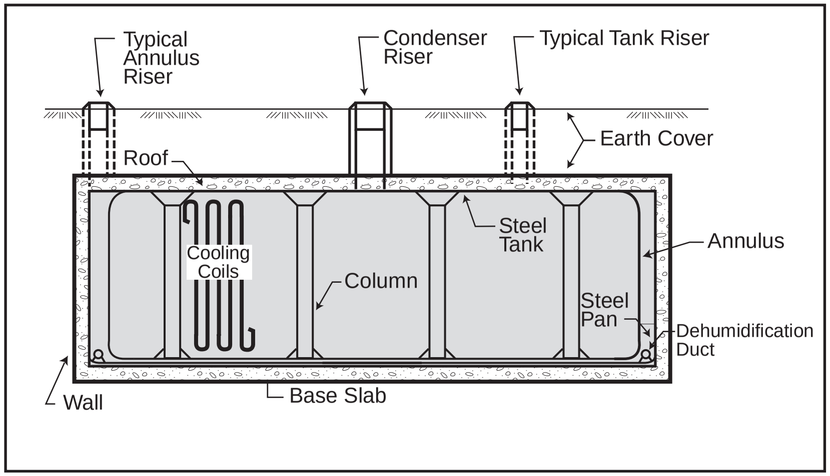

Figure 1-5.A. Cooled Waste Storage Tank, Type I

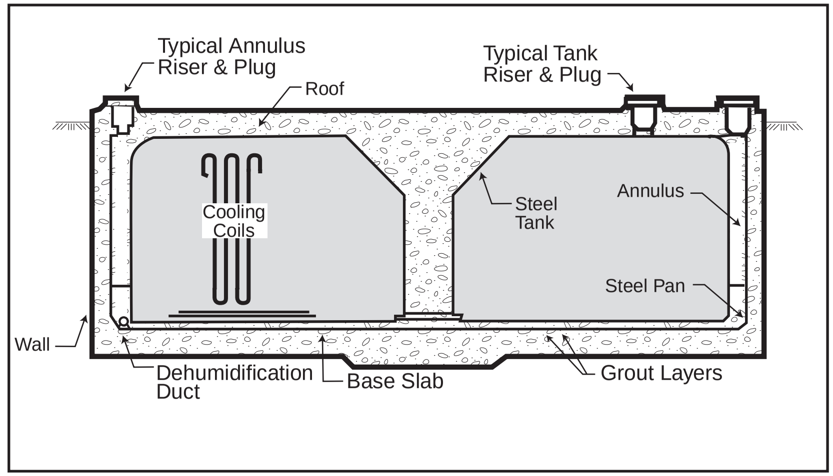

Figure 1-5.B. Cooled Waste Storage Tank, Type II

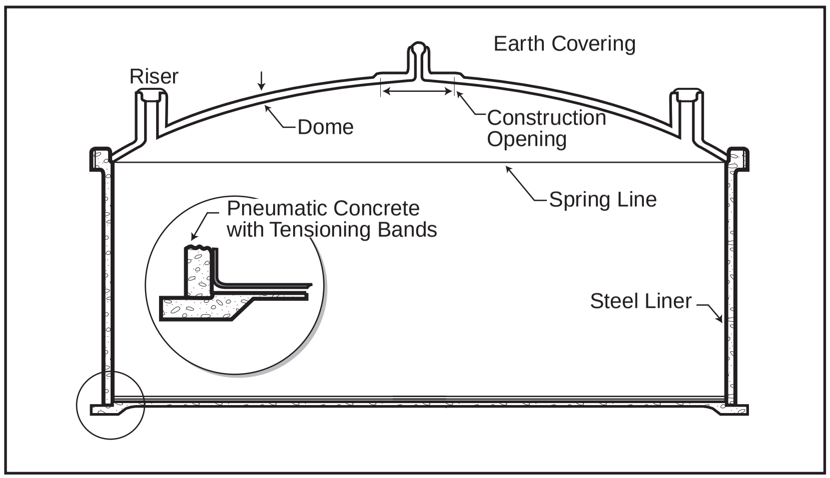

Figure 1-5.C. Uncooled Waste Storage Tank, Type IV (Prestressed concrete walls)

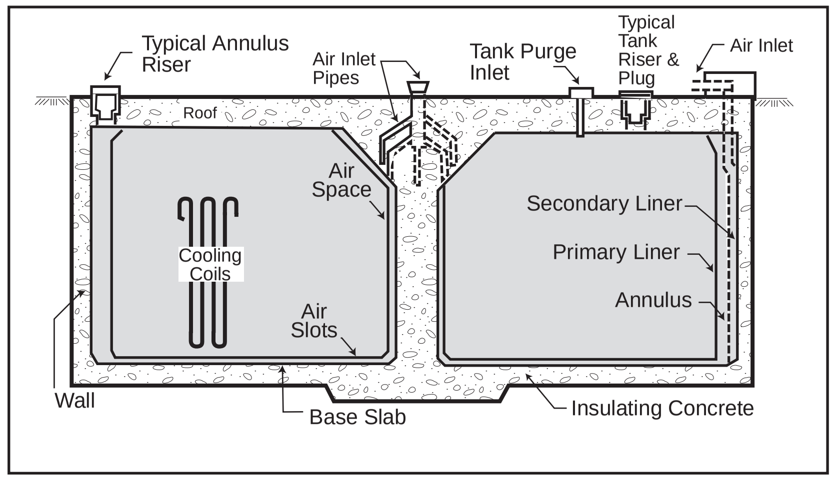

Figure 1-5.D. Cooled Waste Storage Tank, Type III (Stress Relieved Primary Liner)

NW TANK/Grfx/1-5 Tank config.ai

Figure 1-5. Tank configurations.

L-7-11 sampled to determine inhibitor levels, and additional inhibitors are added if concentrations are not sufficient to prevent corrosion. In addition, the newest tanks (the Type III tanks) were stress relieved (heat-treated to remove residual stresses in the metal introduced during the manufacturing process) to eliminate the high stresses that promote cracking.

The eight Type IV tanks (Tanks 17 through 24) were built between 1958 and 1962. These tanks have a single steel wall and do not have active cooling (Figure 1-5). Tanks 17 through 20 are in the F-Area Tank Farm and Tanks 21 through 24 are in H Area. Tanks 19 and 20 have known cracks that are believed to have been caused by corrosion of the tank wall from occasional groundwater inundation from fluctuation in the water table. L-7-12 Interior photographic inspections have indicated that small amounts of groundwater have leaked into these tanks; there is no evidence that waste ever leaked out. TC The level of the waste in Tank 19, which is the next tank scheduled to be closed, is below these cracks. Tanks 17 through 20 are slightly above the water table. Tanks 21 through 24 are above the groundwater table; however, they are in a perched water table caused by the original construction of the tank area. Tanks 17 and 20 have already been closed in a manner described TC in the Fill with Grout option of the Stabilize Tanks Alternative evaluated in this EIS (see Section 2.1.1).

The newest design (Type III) has a full-height secondary tank and active cooling (Figure 1-5). All of the Type III tanks (25 through 51) are above the water table. These 27 tanks were placed in service between 1969 and 1986, with 10 in the F Area and 17 in the H Area Tank Farms. None of them has known leak sites.

By 2022, DOE is required to remove from service and close all the remaining tank systems that have experienced leaks or do not have full-height secondary containment. The 24 Types I, II, and IV tanks have been or will be removed from service before the 27 Type III tanks. Type III tanks will remain in service until there is no further need for the tanks, which DOE currently anticipates would occur before the year 2030.

Summary information on the F-and H-Area HLW tanks is presented in Table 1-1.

Evaporator Systems

The tank farms had five evaporators that concentrated waste following receipt from the canyons. At present, three evaporators are operational, one in F-Area Tank Farm and two in H-Area Tank Farm. L-7-25 L-7-68 Each operational evaporator is made of stainless steel and operates at near-atmospheric pressure under alkaline conditions. Because of the radioactivity emitted from the waste, the evaporator systems are either shielded (i.e., lead, steel, or concrete

Table 1-1. Summary of high-level waste tanks.

Tank type	Number of tanks	Area	Tank numbers	Year constructed	Year first used
I[a]	12	F	1 - 8	1952	1954-64
		H	9 - 12	1953	1955-56
II[a]	4	H	13 - 16	1956	1957-60
III	27	F	25 - 28	1978	1980
			33 - 34	1969, 1972	1969, 1972
			44 - 47	1980	1980-82
		H	29 - 32	1970	1971-74
			35 - 43	1976-79	1977-86
			48 - 51	1981	1983-86
IV[a]	8	F	17 - 20[b]	1958	1958-61
		H	21 - 24	1961-62	1961-65

EC

a. Twenty-four Type I, II, and IV HLW tanks will be removed from service by 2022.
b. Two tanks (Tanks 17 and 20) have been closed.

vaults) or placed underground. The process equipment is designed to be operated and maintained remotely.

Waste supernate is transferred from the evaporator feed tanks and heated to the aqueous boiling point in the evaporator vessel. The evaporated liquids (overheads) are condensed and, if required, processed through an ion-exchange column for cesium removal. The overheads are transferred to the F/H Effluent Treatment Facility for final treatment before being discharged to Upper Three Runs. The overheads can be recycled back to a waste tank if evaporator process upsets occur. Supernate can be reduced to about 25 percent of its original volume and immobilized as crystallized salt by successive evaporations of liquid supernate.

Transfer System

A network of transfer lines is used to transfer wastes between the waste tanks, process units, and various SRS areas (i.e., F Area, H Area, S Area, and Z Area). These transfer lines have diversion boxes that contain removable pipe segments (called jumpers) to complete the desired transfer route. Jumpers of various sizes and shapes can be fabricated and installed to enable the transfer route to be changed. The use of diversion boxes and jumpers allows flexibility in the movement of wastes. The diversion boxes are usually underground, constructed of reinforced concrete, and either sealed with waterproofing compounds or lined with stainless steel.

Pump pits are intermediate pump stations in the F- and H-Area Tank Farm transfer systems. These pits contain pump tanks and hydraulic pumps or jet pumps. Many pump pits are associated with diversion boxes. The pits are constructed of reinforced concrete and have a stainless-steel liner.

1.1.4 HLW TANK CLOSURE

1.1.4.1 Closure Process

After the majority of the waste has been removed from the HLW tanks for treatment and disposal, the tank systems (including the tanks, evaporators, transfer lines, and other ancillary equipment) would become part of the HLW tank closure project, the potential environmental impacts of which are the subject of this EIS. In accordance with the SRS Federal Facility Agreement (EPA 1993), DOE intends to remove the tanks from service as their missions are completed. For 24 tanks that do not meet the U.S. Environmental Protection Agency's (EPA's) secondary containment standards under the Resource Conservation and Recovery Act (RCRA), DOE is obligated to close the tanks by 2022. The proposed closure process specified by the Federal Facility Agreement is described in Appendix A beginning in Section A.4.

The process of preparing to close tanks began in 1995. DOE prepared the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems* (DOE 1996a) that describes the general protocol for closing the tanks. This document (referred to as the General Closure Plan) was developed with extensive interaction with the State of South Carolina and EPA. Concurrent with the General Closure Plan, DOE prepared the *Environmental Assessment for the Closure of the High Level Waste Tanks in F- and H-Areas at the Savannah River Site* (DOE 1996b). In a Finding of No Significant Impact published on July 31, 1996, DOE concluded that closure of the HLW tanks in accordance with the General Closure Plan would not result in significant environmental impacts.

Accordingly, DOE began to close Tank 20, from which the bulk waste had already been removed. In accordance with the General Closure Plan, DOE prepared a tank-specific closure plan (DOE 1997a) that outlined the specific steps for Tank 20 closure and presented the long-term environmental impacts of the closure. The State of South Carolina approved the Closure Module, and Tank 20 closure was completed on July 31, 1997. Later in 1997, following preparation and approval of a tank-specific Closure Module, Tank 17 was closed.

DOE decided to prepare this EIS before any additional HLW tanks are closed at SRS. This decision is based on several factors, including the desire to further explore the environmental impacts from closure and to open a new round of information sharing and dialogue with stakeholders. SRS is committed in the Federal Facility Agreement to close another HLW tank by Fiscal Year 2003. DOE has reviewed bulk waste removal of waste from the HLW tanks in the *Waste Management Operations, Savannah River Plant EIS* (ERDA-1537) and the *Long-term Management for Defense High-Level Radioactive Wastes (Research and Development Program for Immobilization) Savannah River Plant EIS* (DOE/EIS-0023). In addition, the EC SRS Waste Management EIS discusses HLW management activities as part of the No Action Alternative (continuing the present course of action), and the *Defense Waste Processing Facility Savannah River Plant EIS* (DOE/EIS-0082) and the *Final Supplemental Environmental Impact Statement Defense Waste Processing Facility* (DOE/EIS-0082S) discuss EC management of HLW after it is removed from the tanks.

EC The National Research Council released a study (National Research Council, 1999) examining the technical options for HLW treatment and tank closure at the Idaho National Engineering and Environmental Laboratory (INEEL). The Council concluded that clean closure is impractical and some residual radioactivity will remain but, with rational judgment and prudent management, it is reasonable to expect that all options will result in very low risks. EC Recommendations made by the U.S. Nuclear Regulatory Commission (NRC) included: (1) establish closure criteria, (2) develop an innovative sampling plan based on risks, and (3) conduct testing to anticipate possible process failure. The SRS General Closure Plan had anticipated and includes points similar to those raised by the Council.

L-4-12 Several issues related to the HLW tank closure program will be resolved after DOE selects an overall tank closure approach based on this EIS. These issues will be addressed during the tank-by-tank implementation of the closure decision, and include: (1) performance objectives for each tank that allow the cumulative closure to meet the overall performance standard; (2) the regulatory status of residual waste in each tank, through a determination whether it is "waste incidental to reprocessing;" (3) use of cleaning methods, such as spray water washing or oxalic acid cleaning, if needed to meet a tank's performance objective; and (4) cleaning methods for tank secondary containment (annulus), if needed. These issues are discussed in greater detail below. (In addition, DOE is assessing the contributions to risk from non-tank sources in the H-Area Tank Farm. Although the long-term L-4-12 impacts presented in this EIS consider the contributions of non-tank sources, further characterization and modeling of contributions from other sources may result in the refinement of performance objectives. An issue to be addressed after tank closure is the long-term management of the area, which DOE will consider under the RCRA/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) processes as part of its environmental restoration program).

1.1.4.2 Waste Incidental to Reprocessing

An important issue associated with tank closure, and a subject of controversy, is the regulatory status of the residual waste in the tanks. TC Before bulk waste removal, the content of the tanks is HLW. The goal of the bulk waste removal and subsequent cleaning of the tanks is to remove as much waste as can reasonably be removed.

In July 1999, DOE issued Order 435.1, Radioactive Waste Management, and the associated Manual and Implementation Guide. DOE Manual 435.1-1 prescribes two processes, by citation or by evaluation (see text box), for determining that waste resulting from reprocessing spent nuclear fuel can be considered "waste incidental to reprocessing."

According to Order 435.1, waste resulting from reprocessing spent nuclear fuel that is determined to be incidental to reprocessing is not HLW, and shall be managed under DOE's regulatory authority in accordance with requirements for transuranic waste or low-level waste, and all other Federal or state regulations TC

EC

> **Waste Incidental to Reprocessing Determination**
>
> The two processes for determining that waste can be considered incidental to reprocessing are "citation" and "evaluation." Waste incidental to reprocessing by "citation" includes spent nuclear fuel processing plant wastes that meet the description included in NRC's Notice of Proposed Rulemaking (34 FR 8712; June 3, 1969) for promulgation of proposed Appendix D, 10 CFR Part 50, Paragraphs 6 and 7 that later came to be referred to as "waste incidental to reprocessing." These radioactive wastes are the result of processing plant operations, such as but not limited to, contaminated job wastes such as laboratory items (clothing, tools, and equipment).
>
> The DOE Radioactive Waste Manual (DOE M 435.1-1, Chapter II, B(2)) states: "Determinations that any waste is incidental to reprocessing by the evaluation process shall be developed under good record-keeping practices, with an adequate quality assurance process, and shall be documented to support the determinations. Such wastes may include, but are not limited to, spent nuclear fuel reprocessing plant wastes that:
>
> (a) Will be managed as low-level waste and meet the following criteria:
>
> 1. Have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; and
> 2. Will be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR Part 61; and
> 3. Are to be managed, pursuant to DOE's authority under the *Atomic Energy Act of 1954*, as amended, and in accordance with the provisions of Chapter IV of this Manual, provided the waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10 CFR 61.55, *Waste Classification*; or will meet alternative requirements for waste classification and characterization as DOE may authorize.
>
> (b) Will be managed as transuranic waste and meet the following criteria:
>
> 1. Have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; and
> 2. Will be incorporated in a solid physical form and meet alternative requirements for waste classification and characteristics, as DOE may authorize; and
> 3. Are managed pursuant to DOE's authority under the *Atomic Energy Act of 1954*, as amended, in accordance with the provisions of Chapter III of this Manual, as appropriate."

EC

as appropriate.[2] Section 7.1.3 of this EIS discusses the waste incidental to reprocessing process in more detail.

1.2 Purpose and Need for Action

DOE needs to reduce human health and safety risks at and near the HLW tanks, and to reduce the eventual introduction of contaminants into the environment. If DOE does not take action after bulk waste removal, the tanks would fail, and contaminants would be released to the environment. Failed tanks would present the risk of accidents to individuals and could lead to surface subsidence, which could open the tanks to intrusion by water or plants and animals. Release of contaminants to the environment would present human health risks, particularly to individuals who might use contaminated water, in addition to adverse impacts to the environment.

L-2-4
L-2-9

1.3 Decisions to be Based on this EIS

This EIS provides an evaluation of the environmental impacts of several alternatives for closure of the HLW tanks at the SRS. The closure process will take place over a period of up to 30 years. The EIS provides the decision makers with an assessment of the potential environmental, health, and safety effects of each alternative. The selection of one or more tank closure alternatives, following completion of this EIS, will guide the selection and implementation of a closure method for each HLW tank at the SRS. Within the framework of the selected alternative(s), and the

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[2] The Natural Resources Defense Council (NRDC) has filed a Petition in the Idaho District Court on August 15, 2001, asking the Court to review DOE Order 435.1 and claiming the Order is "arbitrary, capricious, and contrary to law." NRC, in responding recently to a separate petition from the NRDC, has concluded that DOE's commitments to (1) clean up the maximum extent technically and economically practical, and (2) meet performance objectives consistent with those required for disposal of low-level waste, if satisfied, should serve to provide adequate protection of public health and safety (65 FR 62377, October 18, 2000).

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environmental impact of closure described in the EIS, DOE will select and implement a closure method for each tank.

In addition to the closure methods and impacts described in this EIS, the tank closure program will operate under a number of laws, regulations, and regulatory agreements described in Chapter 7 of this EIS. In addition to the General Closure Plan (a document prepared by DOE based on responsibilities under the Atomic Energy Act (AEA) and other laws and regulations and approved by the South Carolina Department of Health and Environmental Control (SCDHEC) and EPA Region-IV), the closure of individual tanks will be performed in accordance with a tank-specific Closure Module. Each Closure Module will incorporate a specific plan for tank closure and modeling of impacts based on that plan. The module will also contain the measured inventory of residual material in the tank at the time of closure and an estimate of the volume of this material. Through the process of preparing and approving each Closure Module, DOE will select a closure method that is consistent with the closure alternative(s) selected after completion of this EIS. The selected closure method for each tank will result in the closure of all tanks with impacts on the environment equal to or less than those described in this EIS. If a tank closure that meets the performance objectives of the closure module cannot be accomplished using the selected alternative, DOE would evaluate the impacts of the technology against those presented in this EIS prior to implementing closure of the tank.

During the expected 30-year period of tank closure activities, new technologies for tank cleaning or other aspects of the closure process may become available. In a tank-specific Closure Module, DOE would evaluate the technical, regulatory, and performance implications of any proposal to use a new technology.

1.4 EIS Overview

1.4.1 SCOPE

This EIS analyzes the environmental impacts of cleaning, isolating, and stabilizing the HLW tanks and related systems such as evaporators, transfer piping, sumps, pump pits, diversion boxes, filtration systems, sludge washing equipment, valve boxes, and the condensate transfer system. Before tank closure can be accomplished, DOE must remove the waste stored in the tanks, a process called bulk waste removal. Bulk waste removal is discussed as part of the No Action Alternative (i.e., a continuation of the normal course of action) in the *Savannah River Site Waste Management EIS* (DOE/EIS-0217). If DOE proposes changes in the bulk waste removal program, DOE will determine the need to supplement the Waste Management EIS. Bulk waste removal means pumping out all the waste that is possible with existing equipment. Bulk waste removal leaves residual contamination on the tank walls and internal hardware such as cooling coils. A heel of liquid, salt, sludge, or other material remains in the bottom of the tank and cannot be removed without using special means. Removal of this residual material is part of the cleaning stage of the proposed action.

Upon completion of closure activities for a group of tanks (and their related piping and ancillary equipment) in a particular section of a tank farm, the tanks and associated equipment in the group would transition to the SRS environmental restoration program. The environmental restoration program would conduct soil assessments and remedial actions to address any contamination in the environment (including previously known leaks) and develop a post-closure strategy. Consideration of alternative remedial actions under the remediation program is outside the scope of this EIS and would be conducted under the CERCLA process. DOE, however, has established a formal process to ensure that tank closure activities are coordinated with the environmental restoration program. This process is described in the *High-Level Waste Tank Closure Program Plan* (DOE 1996c). This process requires that, once a group of tanks in a particular section of a tank farm is closed, the HLW operations organization and the environmental restoration organization would establish a Co-occupancy Plan to ensure safe and efficient soils assessment and remediation.

The HLW organization would be responsible for operational control and the environmental restoration organization would be responsible for environmental restoration activities. The primary purpose of the Co-occupancy Plan is to provide the two organizations with a formal process to plan, control, and coordinate the environmental restoration activities in the tank farm areas. The activities of the environmental restoration program would be governed by the CERCLA, RCRA corrective action, and the Federal Facility Agreement between DOE, SCDHEC, and EPA. As such, it is beyond the scope of this EIS.

1.4.2 ORGANIZATION

TC This EIS has seven chapters. The first chapter provides background information, describes the purpose and need for action, and describes the NEPA process. Chapter 2 describes the
EC proposed action and alternatives for carrying it out. Chapter 3 discusses the SRS and describes the site and surrounding environment that the alternatives could impact. Chapter 4 presents the estimated impacts from tank closure. Chapter 5 discusses the cumulative impacts of this project, plus other existing or planned projects that affect the environment. Chapter 6 presents resource commitments. Chapter 7 discusses applicable laws, regulations, and permit requirements.

EC This EIS also contains five appendices. Appendix A describes HLW management at SRS with an emphasis on the tank farms and the closure alternatives. Appendix B provides information on accident scenarios. Appendix C describes long-term closure modeling, and Appendix D describes public input received on the Draft EIS and provides DOE responses. Appendix E, Description of the Savannah River Site High-Level Waste Tank Farms, which is for Official Use Only, contains detailed information about the location, physical dimensions, and content of the HLW tank systems. Due to increased concerns about operational security following the events of September 11, 2001, Appendix E will be made available upon request to those who have a need to review this information. Consistent with the direction of the Attorney General of the United States, this information is not releasable under the Freedom of Information Act. TC

1.4.3 STAKEHOLDER PARTICIPATION

On December 29, 1998, DOE announced in the *Federal Register* (63 FR 71628) its intent to prepare an EIS on the proposed closure of HLW EC tanks at SRS near Aiken, South Carolina. DOE proposes to close the tanks to protect human health and the environment and to promote safety. With the Notice, DOE established a public comment period that lasted through February 12, 1999.

DOE invited SRS stakeholders and other interested parties to submit comments for consideration in the preparation of the EIS.

DOE held scoping meetings on the EIS in North Augusta, South Carolina, on January 14, 1999, and in Columbia, South Carolina, on January 19, 1999. Each meeting included presentations on the NEPA process in relation to the proposed action, on the plan for closure of the tanks, and on the alternatives presented in this EIS. The meetings also offered opportunities for public comment and general questions and answers. DOE considered comments received during the scoping period in preparing this EIS. TC

The public and the State of South Carolina have been and continue to be involved in the closure of HLW facilities at the SRS. Additional public meetings were conducted in North Augusta, South Carolina (January 9, 2001) and Columbia, South Carolina (January 11, 2001) to present the Draft EIS for public comments. The public TC

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comment period ended on January 23, 2001. DOE received 18 letters on the Draft EIS. Court reporters documented comments and statements made during two public meetings, at which eight individuals asked questions, provided comments, or made statements. These comments have been addressed in the Final EIS and the comments, along with DOE's responses, are given in Appendix D of this EIS.

L-2-1
L-2-14
L-2-18
L-2-19
L-2-20
L-7-30

The Citizens Advisory Board (CAB) for SRS is very interested in the closure of HLW facilities. As such, the CAB has been briefed quarterly and the CAB Waste Management Committee is briefed bi-monthly on closure activities. The CAB has issued several recommendations related to HLW tank closure. DOE has carefully reviewed these recommendations in establishing and implementing the SRS HLW tank closure program, and will continue to do so in the future.

L-5-3

The SRS CAB recommendation (January 23, 2001) regarding annulus cleaning stated the Board's concern that SRS appears to be placing a low priority on annulus cleaning. DOE responded to this recommendation (February 8, 2001) stating, "the Savannah River Operations Office considers the issue of removal of waste from the tank annulus to be important to the long-term success of the HLW Tank Closure Program." The response further states, "However, the development of methods for removal of waste from the tank annulus as part of the longer term effort to close Tank 14 reflects a balanced and responsive approach to solving this important challenge." This conclusion is valid for closure of all tanks that have annuli.

1.4.4 RELATED NEPA DOCUMENTS

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This EIS makes use of information contained in other DOE NEPA documents related to HLW management and tank closure. It is also designed to be consistent with the recently completed EIS on HLW Salt Processing Alternatives, which is related to activities in the H-Area Tank Farm. The NEPA documents related to this HLW Tank Closure EIS are briefly described below.

Environmental Assessment for the Closure of the High-Level Waste Tanks in the F- and H-Areas at the Savannah River Site – DOE prepared an environmental assessment (DOE 1996b) to evaluate the impacts of closing HLW tanks at the SRS after removal of the bulk waste. The proposed action was to remove the residual waste from the tanks and fill them with a material to prevent future collapse and bind up residual waste, to decrease human health risks, and to increase safety in the area of the tank farms. After closure, the tank system would be turned over to the SRS environmental restoration program for environmental assessment and remedial actions as necessary. A Finding of No Significant Impact was determined based on the analyses in the environmental assessment, and DOE subsequently closed Tanks 17 and 20. DOE has now decided to prepare an EIS for the proposal to close the remaining HLW tanks.

Final Defense Waste Processing Facility Supplemental Environmental Impact Statement – DOE prepared a Supplemental EIS to examine the impacts of completing construction and operating the DWPF at the SRS. This document (DOE 1994) assisted DOE EC in deciding whether and how to proceed with the DWPF project, given the changes to processes and facilities that had occurred since 1982, when it issued the original *Defense Waste Processing Facility EIS*.

The Record of Decision (60 FR 18589) announced that DOE would complete the construction and startup testing of DWPF and would operate the facility, using the In-Tank Precipitation process, after the satisfactory completion of startup tests.

The alternatives evaluated in this EIS could generate radioactive waste that DOE would have to handle or treat at facilities described in the *Defense Waste Processing Facility Supplemental EIS* and the *SRS Waste Management EIS* (see next paragraph). The *Defense Waste Processing Facility Supplemental EIS* is also relevant to the assessment of cumulative impacts (see Chapter 5) that could occur at SRS.

Savannah River Site Waste Management Final Environmental Impact Statement – DOE issued the *SRS Waste Management EIS* (DOE 1995) to provide a basis for selection of a site-wide approach to managing present and future (through 2024) wastes generated at SRS. These wastes would come from ongoing operations and potential actions, new missions, environmental restoration, and decontamination and decommissioning programs.

The *SRS Waste Management EI*S includes the treatment of wastewater discharges in the Effluent Treatment Facility, F- and H-Area tank operations and waste removal, and construction and operation of a replacement HLW evaporator in the H-Area Tank Farm. In addition, it evaluates the Consolidated Incineration Facility for the treatment of mixed waste. The Record of Decision (60 FR 55249) stated that DOE will configure its waste management system according to the moderate treatment alternative described in the EIS. The *SRS Waste Management EIS* is relevant to this *HLW Tank Closure EIS* because it evaluates management alternatives for various types of waste that actions proposed in this EIS could generate. The *Waste Management EIS* is also relevant in the assessment of cumulative impacts that could occur at the SRS (see Chapter 5).

Final Waste Management Programmatic Environmental Impact Statement for Managing, Treatment, Storage, and Disposal of Radioactive and Hazardous Waste – DOE published this EIS as a complex-wide study of the environmental impacts of managing five types of waste generated by past and future nuclear defense and research activities, including HLW at four sites (DOE 1997c). This NEPA analysis was the first time DOE had examined in an integrated fashion the impacts of complex-wide waste management alternatives and the cumulative impacts from all waste management activities at a specific site.

The EIS evaluated four alternatives, including the No Action Alternative, for managing immobilized HLW until such time as a geologic repository is available to receive the waste. The preferred alternative was for each site to store its immobilized waste onsite. The Record of Decision to proceed with DOE's preferred alternative of decentralized storage for immobilized HLW was issued August 26, 1999 (64 FR 46661). TC

Supplemental Environmental Impact Statement for High-Level Waste Salt Processing Alternatives at the Savannah River Site – On February 22, 1999, DOE published a Notice of Intent to prepare a Supplemental EIS for alternatives to the In-Tank Precipitation process at SRS (64 FR 8558). The In-Tank Precipitation process was intended to separate soluble, high-activity radionuclides from HLW before vitrifying the high-activity portion of the waste in the DWPF and disposing of the low-activity fraction as saltstone grout in vaults at SRS. However, the In-Tank Precipitation process, as presently configured, cannot achieve production goals and safety requirements for processing HLW. The Supplemental EIS evaluates the impacts of alternatives to the In-Tank Precipitation process for separating the high- and low-activity fractions of the HLW currently stored in tanks at SRS. Although the *Salt Disposition Alternatives Supplemental EIS* addresses subject matter and some equipment in common with this EIS, the actions proposed in each EIS are independent and are thus appropriately considered in separate EISs. The Final *Salt Processing Alternatives EIS* was issued in July 2001 (66 FR 37957; July 20, 2001), and the Record of Decision in October 2001 (66 FR 52752; October 17, 2001). TC

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CHAPTER 2. PROPOSED ACTION AND ALTERNATIVES

2.1 Proposed Action and Alternatives

EC The U.S. Department of Energy (DOE) proposes to close the high-level waste (HLW) tanks at Savannah River Site (SRS) in accordance with applicable laws and regulations, DOE Orders, and the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems* (DOE 1996) (the General Closure Plan) approved by the South Carolina Department of EC Health and Environmental Control (SCDHEC), which specifies the management of residuals as waste incidental to reprocessing. The proposed action would begin when bulk waste removal has been completed. Under each alternative except No Action, DOE would close 49 HLW tanks and associated waste handling equipment including evaporators, pumps, diversion boxes, and transfer lines.

DOE is evaluating three alternatives in this EIS. As described above, all of the alternatives would start after bulk waste removal occurs.

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- Stabilize Tanks Alternative. DOE considers three options for tank stabilization:
  - Fill with Grout (Preferred Alternative)
  - Fill with Sand
  - Fill with Saltstone
- Clean and Remove Tanks Alternative
- No Action Alternative (evaluation required EC by Council on Environmental Quality [CEQ] regulations)

<u>HLW Tank Cleaning</u>

TC Following bulk waste removal, DOE would clean the tanks, if necessary, to meet the performance objectives contained in the General Closure Plan and the tank-specific Closure Module. In accordance with the General Closure Plan, the need for and the extent of any tank cleaning would be determined based on the analysis presented in the tank-specific Closure Module. DOE estimates that bulk waste removal would result in removal of 97 percent of the total radioactivity in the tanks.

On a tank-by-tank basis, using performance and historical data, DOE would determine whether bulk waste removal, with water washing as appropriate, would meet Criterion 1 for removal of key radionuclides to the extent "technically and economically practical" (DOE Manual 435.1-1). If any criterion could not be met, cleaning methods, such as spray water washes or oxalic acid cleaning, could be employed. As part of each tank-specific closure module, DOE will evaluate the long-term human health impacts of further waste removal versus the additional economic costs. TC

Tank cleaning by spray water washing involves washing each tank, using hot water in rotary spray jets. EC The spray nozzles can remove waste near the edges of the tank that is not readily removed by slurry pumps. After spraying, the contents of the tank would be agitated with slurry pumps and the subsequent liquid pumped EC out of the tank. This process has been demonstrated on Tanks 16 (which has not been closed) and 17 (which has been closed). The amount of waste left after spray washing was EC estimated at about 4,000 gallons in Tank 17, and about 1,000 gallons in Tank 20 (WSRC 1995; L-7-31 d'Entremont and Hester 1997). If modeling evaluations showed that performance objectives could not be met after an initial spray water washing, additional spray water washes would be used prior to employing other cleaning techniques.

If Criteria 2 and 3 could not be met using spray water washing, other cleaning techniques could be employed. These techniques could include mechanical methods, oxalic acid cleaning, or other chemical cleaning methods. In the oxalic acid cleaning process, after the spray washing is complete, hot oxalic acid (80°-90°C) would be sprayed through the spray nozzles that were used for spray water washing. This process has been demonstrated only on Tank 16. A number of TC

TC potential cleaning agents for sludge removal were studied. Oxalic acid was chosen as the preferred cleaning agent because it dissolves sludge and is only moderately aggressive against carbon steel, the material used in the construction of the waste tanks.

Bradley and Hill (1977) describes the study that led to the selection of oxalic acid as the preferred chemical cleaning agent. The study examined cleaning agents that would not aggressively attack carbon steel and were EC compatible with HLW processes. The studies included tests with waste stimulants and also tests with actual Tank 16 sludge. The agents tested were disodium salt EDTA, glycolic acid, formic acid, sulfamic acid, citric acid, dilute sulfuric acid, alkaline permanganate, and oxalic acid. None of these agents completely dissolved the sludge, but oxalic acid was shown to dissolve about 70 percent of the sludge in a well-EC mixed sample at 25°C, which was the highest of any of the cleaning agents tested.

Oxalic acid has been demonstrated in Tank 16 TC only and shown to provide cleaning that is much more effective than spray water washing for removal of radioactivity (see Table 2-1). However, oxalic acid cleaning costs far more than water washing, and there are important technical constraints on its use. Use of oxalic acid in an HLW tank would require a successful demonstration that it would not create a potential for a nuclear criticality. The *Liquid Radioactive Waste Handling Facility Safety Analysis Report* (WSRC 1998) specifically states that oxalic acid cleaning of any waste tank is prohibited. This prohibition was established because of concern that oxalic acid could dissolve a sufficient quantity of fissile materials to create the potential for nuclear criticality.

An earlier study (Nomm 1995) had concluded EC that criticality in the HLW tanks is "beyond extremely unlikely" because neutron-absorbing substances present in the sludge would prevent criticality. However, the study assumed the waste would remain alkaline and did not address the possibility that chemicals would be used that would dissolve sludge solids. Therefore, to ensure that no criticality could occur in tank cleaning, DOE would need to prepare a formal Nuclear Criticality Safety Evaluation (i.e., a study of the potential for criticality) before deciding to use oxalic acid in cleaning a tank. If the new evaluation found that oxalic acid could be used safely, the *Liquid Radioactive Waste Facility Safety Analysis Report* would be revised and DOE could permit its use. If not, DOE would need to investigate other cleaning technologies, such as mechanical cleaning.

If oxalic acid cleaning were performed infrequently, there would be minimal impact on the downstream waste processing operations (Defense Waste Processing Facility (DWPF) and EC salt disposition). The oxalic acid used to clean a tank would be neutralized with sodium hydroxide, forming sodium oxalate. The sodium oxalate would follow the same treatment path as other salts in the tank farm inventory.

Extensive use of oxalic acid cleaning could result in conditions that, if not addressed by checks within the DWPF feed preparation process, could allow carryover of sodium oxalate to the vitrification process. The presence of oxalates in the waste feed to DWPF that would result from oxalic acid cleaning would adversely affect the quality of the HLW glass produced at DWPF. To prevent that from occurring, special batches of the salt treatment process would be scheduled in which the sodium oxalate concentrations would be controlled to not exceed their solubility limit in the low-radioactivity fraction. TC

Nine HLW tanks have leaked measurable amounts of waste from primary containment to secondary containment, with only one leaking to the soil surrounding the tanks. For these tanks, the waste would be removed from the secondary containment using water and/or steam. Such cleaning has been attempted at SRS on only one tank (Tank 16), and the operation was only about 70 percent completed, because salts mixed with sand (from sandblasting of tank welds) made salt removal more difficult.

Cleaning of the secondary containment is not a demonstrated technology and new techniques L-7-34

Table 2-1. Tank 16 waste removal process and curies removed with each sequential step.

Sequential Waste Removal Step	Curies Removed	Percent of Curies Removed	Cumulative Curies Removed	Cumulative Percent Curies Removed
Bulk Waste Removal	2.74×10^6	97%	2.74×10^6	97%
Spray Water Washing	2.78×10^4	0.98%	2.77×10^6	97.98%
Oxalic Acid Wash & Rinse	5.82×10^4	2%	2.83×10^6	99.98%

L-7-16

L-7-17

may need to be developed. Most likely, the waste would be removed from the annulus using water and/or steam sprays, perhaps combined with a chemical cleaning agent, such as oxalic acid. The amount of waste that would remain in secondary containment after bulk waste removal and cleaning is small, so the environmental risk of this waste is very small compared to the amount of residual waste that would be contained inside the tanks after bulk waste removal and cleaning.

2.1.1 STABILIZE TANKS ALTERNATIVE

TC

In the Draft EIS this Alternative was called the Clean and Stabilize Tanks Alternative. In order to provide flexibility for the closure process, DOE has changed the name to the Stabilize Tanks Alternative. If bulk waste removal is effective in removing waste from the tanks to the extent that performance objectives could be met and the Waste Incidental to Reprocessing process could be completed, DOE would not spray water wash the tanks, or use enhanced cleaning methods. A decision to forego cleaning would require the agreement of the South Carolina Department of Health and Environmental Control in the form of an approved tank closure module.

Following bulk waste removal, DOE would remove the majority of the waste from the tanks and fill the tanks with a material to prevent future collapse and to bind up residual waste. A detailed description of this alternative can be found in Appendix A.

Tank Closure Alternatives

Implementation of each alternative would start following bulk waste removal and SCDHEC approval of a tank-specific Closure Module that is protective of human health and the environment.

- Fill the tanks with grout (Preferred Alternative). The use of sand or saltstone as fill material would also be considered. TC
- Clean and remove the tanks for disposal in the SRS waste management facilities.
- No Action. Leave the tank systems in place without cleaning or stabilizing following bulk waste removal.

In the evaluation phase, each tank system or group of tank systems, as appropriate, would be evaluated to determine the inventory of radiological and nonradiological contaminants remaining after bulk waste removal. This information would be used to conduct a performance evaluation as part of the preparation of a Closure Module. In this evaluation, DOE would consider (1) the types of contamination in the tank and the configuration of the tank system, and (2) the hydrogeologic conditions at and near the tank location, such as distance from the water table and distance to nearby streams. The performance evaluation would include modeling the projected contamination pathways for selected closure methods and comparing the modeling results with the performance objectives developed in the General Closure Plan (DOE 1996). These performance objectives are described in Section 7.1.2 of this EIS. If the modeling shows that performance objectives would be met, the Closure Module would be submitted to SCDHEC for approval.

TC

TC

If the modeling shows that the performance objectives would not be met, cleaning steps TC (such as spray water washing, oxalic acid cleaning, or other cleaning techniques) would be taken until enough residual waste had been TC removed such that performance objectives could be met.

Tank Stabilization

EC After DOE demonstrates that performance objectives could be met, SCDHEC would approve a Closure Module. The tank stabilization process would then begin. Each tank system (including the secondary containment, for those that have one) would be filled with a pumpable, self-leveling backfill L-4-4 material (grout or saltstone) or sand.

DOE's Preferred Alternative is to use grout, a concrete-like material, as backfill. The grout would be trucked to an area near the tank farm, batched if necessary, and pumped to the tank. The grout would be high enough in pH to be compatible with the carbon steel walls of the waste tank. Although the details of each individual closure would vary, any tank system closure under this alternative would have the following characteristics:

- The grout would be pumpable, self-leveling, designed to prevent future subsidence of the tank, and able to fill voids to the extent practical, including equipment and secondary containment.
- The grout would be poured in three distinct layers, as illustrated in Figure 2.1-1. The bottom-most layer would be a specially formulated reducing grout to retard the migration of important contaminants and which provides some mixing and TC encapsulation of the residual material. The middle layer would be a low-strength material designed to fill most of the volume of the tank interior. The final layer would be a high-strength grout to deter inadvertent intrusion from drilling. DOE is also considering an all-in-one grout that would provide the same performance as the three separate layers of grout. If this all-in-one TC grout provides the same performance and protection at a lesser cost, DOE may choose to use the all-in-one grout. For those tanks that have annuli, the grout would also be M-07 pumped into the tank annulus space.

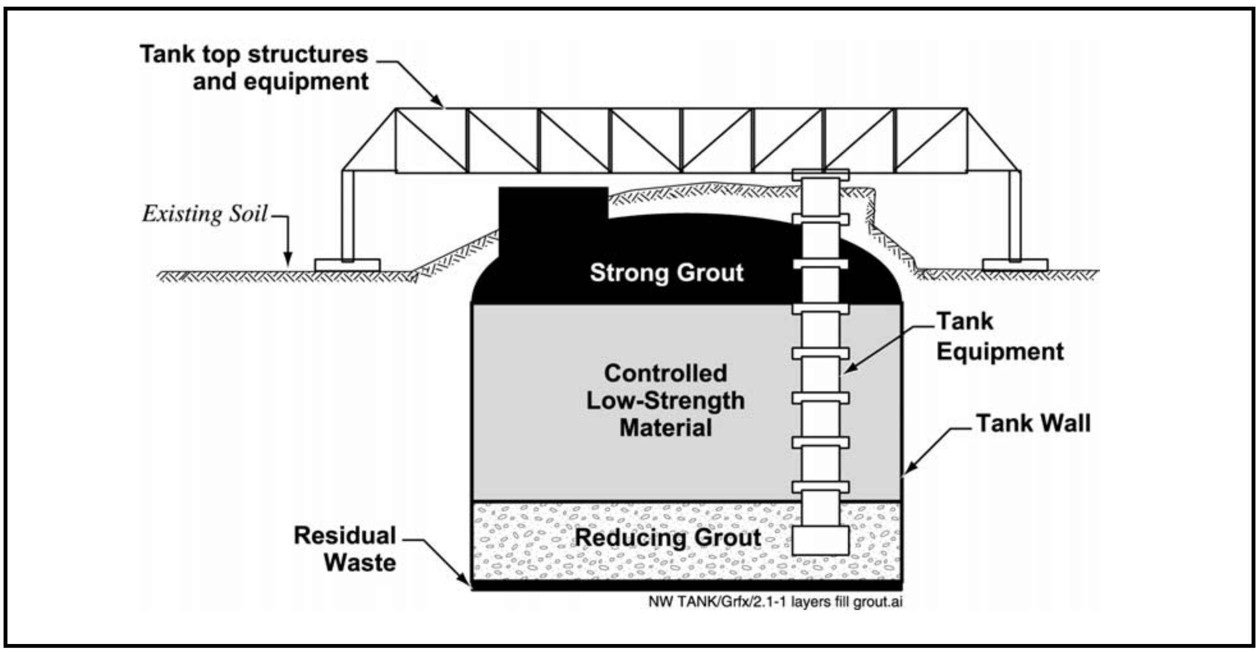

Figure 2.1-1. Typical layers of the Fill with Grout Option.

- The final closure configuration would meet performance objectives established by SCDHEC and the U.S. Environmental Protection Agency (EPA).

If DOE were to choose another fill material (e.g., sand, saltstone) for a tank system, all other aspects of the closure process would remain the same, as described above.

Sand is readily available and inexpensive. However, its emplacement is more difficult than grout because it does not flow readily into voids. Any equipment or piping left on or inside the tank, that might require filling to eliminate voids inside the device, might not be adequately filled. Over time, the sand would tend to settle in the tank, creating additional void spaces. The dome might then become unsupported and sag and crack. The sand would tend to isolate the contamination from the environment to some extent, limit the amount of settling of the tank top after failure, and prevent winds from spreading the contaminants. Nevertheless, water would flow readily through the sand. Sand is relatively inert and could not be formulated to retard the migration of radionuclides. Thus, the expected contamination levels in groundwater and surface streams resulting from migration of residual contaminants would be higher than the levels for the Preferred Option.

Saltstone could also be used as fill material. Saltstone is the low-radioactivity fraction mixed with cement, flyash, and slag to form a concrete-like mixture. Saltstone is normally disposed of as low-level waste (LLW) in the SRS Saltstone Disposal Facility. See Appendix A for a description of the Saltstone Manufacturing and Disposal Facility and its function within the HLW system.

This alternative would have the advantage of reducing the amount of Saltstone Disposal Facility area that would be required and reducing the time and cost of transporting the material to the Satlstone Manufacturing Facility. Any saltstone sent to a waste tank would not require disposal space in the Saltstone Disposal Facility.

The total amount of saltstone required to stabilize the low-activity fraction would probably be greater than 160 million gallons, which is considerably in excess of the capacity of the HLW tanks. Therefore, disposal of saltstone in the Saltstone Disposal Facility would still be required. Because saltstone sets up quickly and is radioactive, it would be impractical to ship by truck or pump to the tank farms. Thus, a Saltstone Mixing Facility would need to be constructed in F Area, another facility would be built in H Area, and the existing Saltstone Manufacturing and Disposal Facility in Z Area would still be operated.

Filling the tank with saltstone, which is contaminated with radionuclides, would considerably complicate the project and increase worker radiation exposure, increasing risk to workers and adding to the cost of closure. In addition, the saltstone would contain large quantities of nitrate that would not be present in the tank residual. Because nitrates are very mobile in the environment, these large quantities of nitrate would adversely impact the groundwater near the tank farms in the long term (i.e., nitrate concentrations could exceed the SCDHEC Maximum Contaminant Level).

For any of the above options, four tanks in F Area and four in H Area would require backfill soil to be placed over the top of the tanks. The backfill soil would bring the ground surface at these tanks up to the surrounding surface elevations to prevent water from collecting in the surface depressions. This action would prevent ponding conditions over these tanks that could facilitate degradation of the tank structure.

2.1.2 CLEAN AND REMOVE TANKS ALTERNATIVE

The Clean and Remove Tanks Alternative would include cleaning the tanks, cutting them up in situ, removing them from the ground, and transporting tank components for disposal in an engineered disposal facility at another location on the SRS. This alternative has not been demonstrated on HLW tanks.

For the Clean and Remove Tanks Alternative, DOE would have to perform enhanced cleaning TC until tanks were clean enough to be safely removed and could meet waste acceptance criteria at SRS Low-Level Waste Disposal Facilities. Worker exposure would have to be As Low As Reasonably Achievable to ensure protection of the individuals required to perform tank removal operations. This might require the use of cleaning technologies such as oxalic acid cleaning, mechanical cleaning, and additional steps as yet undefined on most of the tanks.

Following bulk waste removal and cleaning, the steel components of the tank would be cut up, removed, placed in radioactive waste transport containers, and transported to SRS radioactive EC waste disposal facilities for disposal (assuming these components are considered waste incidental to reprocessing). During tank removal activities, the top of a tank would have EC high-efficiency particulate air (HEPA)-filtered enclosures or airlocks. The tank would remain under negative pressure during cutting operations, and the exhaust would be filtered through HEPA filtration. This alternative would TC require the construction of approximately 16 new low-activity waste vaults at SRS for disposal of LLW disposal boxes containing the tank components from all 49 tanks. This number of new low-activity waste vaults is within the range that DOE previously analyzed in the *Savannah River Site Waste Management Final Environment Impact Statement* (DOE 1995). That EIS analyzed a range of waste treatment alternatives that resulted in the construction of up to 31 new low-activity waste vaults. In that EIS, potential impacts of releases from disposal facilities over the long term were evaluated by calculating the concentration of radionuclides in groundwater at a hypothetical well 100 meters (328 feet) downgradient from the vaults. Modeling results for that well L-7-6 predicted that drinking water doses from radioactive constituents would not exceed 4 millirem per year (the drinking water maximum contaminant level [MCL] for the beta-and gamma-emitting radionuclides) at any time after disposal. This dose, and therefore the resulting health impacts, is much smaller than any of the 100-meter-well doses calculated for the Stabilize Tanks Alternative or the No Action Alternative, as presented in Section 4.2. Other L-7-6 long-term human health and safety impacts from disposal of tanks in the vaults under the Clean and Remove Tanks Alternative would be small. This alternative has the advantage of allowing disposal of the contaminated tank system in a waste management facility that is already approved for receiving LLW. EC

With removal of all the tanks, backfilling of the excavations left after removal would be required. The backfill material would consist of a soil type similar to the soils currently surrounding the tanks.

2.1.3 NO ACTION

For HLW tanks, the No Action Alternative would involve leaving the tank systems in place EC after bulk waste removal from each tank has taken place and the storage space is no longer needed. Even after bulk waste removal, each tank would contain residual waste and, in those tanks that reside in the water table, ballast water, which is required to prevent the tank from "floating" out of the ground. Tanks would not be backfilled.

After some period of time, the reinforcing bar in the roof of the tank would rust and the roof of the tank would fail, causing the structural integrity of the tank to degrade. Similarly, the floor and walls of the tank would degrade over time. Rainwater would readily pour into the exposed tank, flushing contaminants from the residual waste in the tank and eventually carrying these contaminants into the groundwater. Contamination of the groundwater would happen much more quickly than it would if the tank were backfilled and residual wastes were bound with the fill material.

No Action would be the least costly of the alternatives (less than $100,000 per tank), require the fewest worker hours and exposure to radiation (about two person-rem), and would require fewer workers per tank system than either the Stabilize Tanks Alternative or the L-4-6 Clean and Remove Tanks Alternative. There would be ongoing maintenance and no interruption of operations in the tank farms.

Future inhabitants of the area would be exposed to the contamination in a tank, and injuries or fatalities could occur if an intruder ventured into the area of the tank and the roof were to collapse due to structural failure. Also, movement of contaminants into the groundwater would be more rapid compared to the other alternatives; expected contamination levels in groundwater and surface streams would be higher than for the Stabilize Tanks Alternative because there would be no material to retard movement of the radionuclides. This alternative would be the least protective of human health and safety and of the environment.

2.1.4 ALTERNATIVES CONSIDERED, BUT NOT ANALYZED

2.1.4.1 Management of Tank Residuals as High-Level Waste

The alternative of managing the tank residuals as HLW is not appropriate in light of the provisions of the DOE Order 435.1 and State-approved General Closure Plan for a regulatory approach based on the designation of the residuals as waste incidental to reprocessing.

The waste incidental to reprocessing designation does not create a new radioactive waste type. The terms "incidental waste" or "waste incidental to reprocessing" refer to a process for identifying waste streams that might otherwise be considered HLW due to their origin, but are actually low-level or transuranic waste, if the waste incidental to reprocessing requirements contained in DOE Manual 435.1-1 are met. The goal of the waste incidental to reprocessing determination process is to safely manage a limited number of reprocessing waste streams that do not warrant geologic repository disposal because of their low threat to human health or the environment. Although the technical alternatives of managing tank residuals under the General Closure Plan would likely be the same as those that would apply to managing residuals as HLW, the application of regulatory requirements would be different.

As described in the General Closure Plan, DOE will determine whether the residual waste meets the waste incidental to reprocessing requirements of DOE Manual 435.1-1, which entail a step for removing key radionuclides to the extent that is technically and economically practical, a step for incorporating the residues into a solid form, and a process for demonstrating that appropriate disposal performance objectives are met. The technical alternatives evaluated in the EIS represent a range of stabilization and tank cleaning techniques. The radionuclides in residual waste would be the same whether the material is classified as HLW, LLW, or transuranic waste; however, the regulatory regime would be different.

DOE must demonstrate its ability to meet certain performance objectives before SCDHEC will approve a Closure Module. Appendix C of the General Closure Plan describes the process DOE used to determine the performance objectives (dose limits and concentrations established to be protective of human health) incorporated in the General Closure Plan. As described in Chapter 7 of this EIS, DOE will establish performance standards for the closure of each HLW tank. In the General Closure Plan, DOE considered dose limits and concentrations found in current (40 CFR 191, 10 CFR 60) and proposed (40 CFR 197, 10 CFR 63) HLW management requirements in defining the performance standards. DOE considered the HLW management dose limits and concentrations as performance indicators of the ability to protect human health and the environment, even though the residual would not be considered HLW. That evaluation (described in Appendix C of the General Closure Plan) identified numerical performance standards (concentrations or dose limits for specific radiological or chemical constituents released to the environment) based on the requirements and guidance. Those numerical standards apply to all exposure pathways and to specific media (air, groundwater, and surface water), at different points of compliance, and over various periods during and after closure.

If DOE determines through the waste incidental to reprocessing process that the tank residues cannot be managed as LLW (as expected) or alternatively as transuranic waste, the residues would be managed as HLW. The technical alternatives for managing the residues as HLW, however, would be the same as those for managing the residues under the LLW requirements. Thus, DOE expects the potential environmental impacts that could result from managing the residues under the LLW requirements would be representative of the impacts if the HLW standards were applicable. For these reasons, this EIS does not present the management of tank residues as HLW as a separate alternative.

2.1.4.2 <u>Other Alternatives Considered, but Not Analyzed</u>

DOE considered the alternative of delaying closure of additional tanks, pending the results of research. For the period of delay, the impacts of this approach would be the same as the No Action Alternative and continues to conduct research and development efforts aimed at improving closure techniques. DOE has evaluated the No Action Alternative, thereby evaluating the impacts of delaying closure.

DOE also considered an alternative that would represent grouting of certain tanks and removal of others and has examined the impacts of both tank removal and grouting. Depending on the ability of cleaning to meet performance requirements for a given tank, the decision makers may elect to remove a tank if it is not possible to meet the performance requirements by using another method. This EIS captures the environmental and health and safety impacts of both options.

2.2 Other Cleaning Technologies

The approved General Closure Plan contemplates cleaning the tanks with hot water streams, as described in the Stabilize Tanks Alternative. Several cleaning technologies have been investigated, but are not considered reasonable alternatives to hot water cleaning at this time. However, DOE continues to research cleaning methods and should a particular method prove practical and be required to meet the performance criteria for a specific tank, its use would be proposed in the Closure Module for that tank.

Mechanical and chemical cleaning by using advanced techniques has not been demonstrated in actual HLW tanks. A number of techniques have been studied involving such technologies as robotic arms, wet-dry vacuum cleaners, and remote cutters. However, none of these techniques have been demonstrated for this application. For example, no robotic arms have been demonstrated that could navigate through the cooling coils that are found in most SRS waste tanks. These techniques could be applied for specific tank closures, based on the waste characteristics (e.g., presence of zeolite or insoluble materials) and other circumstances (e.g., cooling coils or other obstructions) for specific SRS tank closures.

There are more aggressive cleaning agents than oxalic acid. However, in addition to the same safety questions involving the use of oxalic acid (see Section 2.1), these cleaning agents have an unacceptable environmental risk because they attack the carbon steel wall of the waste tank, causing deterioration of the metal and reducing the intact containment life of the tank. This would result in much more rapid release of contaminants to the environment.

2.3 Considerations in the Decision Process

This EIS evaluates the environmental impacts of several alternatives for closure of the HLW tanks at SRS. The closure process would take place over a period of up to 30 years. The selection of a tank closure alternative, following completion of this EIS, would guide the selection and implementation of a closure method for each HLW tank at SRS. Within the framework of the selected alternative(s), and the environmental impacts of closure described in the EIS, DOE will select and implement a closure method for each tank.

The tank closure program will operate under a number of laws, regulations, and regulatory agreements described in Chapter 7 of this EIS. In addition to the General Closure Plan, a document prepared by DOE and based on responsibilities under the Atomic Energy Act, and other laws and regulations, the closure of individual tanks will be performed in accordance with a tank-specific Closure Module. The Closure Module incorporates a specific plan for tank closure and modeling of impacts based on that plan. Through the process of preparing and approving the Closure Module, DOE will select a closure method that is consistent with the closure alternative(s) selected following completion of this EIS. The selected closure method will result in a closure that has impacts on the environment equal to or less than those described in this EIS.

During the expected 30-year period of tank closure activities, new technologies for tank cleaning or other aspects of the closure process may become available. If DOE elects to use such a technology, DOE would evaluate the impacts of the technology against those presented in this EIS prior to implementing closure of the tank using the new technology.

During scoping for this EIS, a commenter suggested that DOE should consider the alternative of delaying closure of additional tanks pending the results of research. For the period of delay, the impacts of this approach would be the same as the No Action Alternative. DOE continues to conduct research and development efforts aimed at improving closure techniques. DOE has evaluated the No Action Alternative, thereby evaluating the impacts of the alternative suggested by the commenter.

A comment was made that tank removal and grouting should be combined as an alternative. DOE has examined the impacts of both tank removal and grouting. Depending on the ability of cleaning to meet the performance requirements for a given tank, the decision maker may elect to remove a tank if it is not possible to meet the performance requirements by another method. This EIS captures the environmental and health and safety impacts of both options.

As stewards of the Nation's financial resources, DOE decision makers must also consider cost of the alternatives. DOE has prepared rough order-of-magnitude estimates of cost for each of the alternatives (DOE 1997). These costs, which are presented on a per tank basis, are as follows:

No Action Alternative: <$100,000 (over the 30-year action period)

Stabilize Tanks Alternative:

- Fill with Grout Option:
  $3.8 - 4.6 million

- Fill with Sand Option:
  $3.8 - 4.6 million

- Fill with Saltstone Option:
  $6.3 million

Clean and Remove Tanks Alternative: >$100 million

2.4 Comparison of Environmental Impacts Among Alternatives

Closure of the HLW tanks would affect the environment and human health and safety during the period of time when work is being done to close the tanks, and after the tanks have been closed. For purposes of analysis in this EIS, DOE has defined the period of short-term impacts to be from the year 2002 through about 2030, when all of the existing HLW tanks are proposed to be closed. Long-term impacts would be those resulting from the eventual release of residual waste contaminants from the stabilized tanks to the environment. In this EIS, DOE has estimated these impacts over a period of 10,000 years.

Chapter 4 presents estimates of the potential short-term and long-term environmental impacts associated with each tank closure alternative, as well as the No Action Alternative. Section 2.4.1 summarizes the short-term impacts and accident scenarios, while Section 2.4.2 summarizes the long-term impacts.

2.4.1 SHORT-TERM IMPACTS

Section 4.1 presents the potential short-term impacts (approximately the years 2000 to 2030) for each of the alternatives. These potential impacts are summarized in Table 2-2 and discussed in more detail in the following sections.

Geologic and water resources – Each of the tank stabilization options under the Stabilize Tanks Alternative would require an estimated 170,000 cubic meters of soil for backfill. The Clean and Remove Tank Alternative would require more, approximately 356,000 cubic meters. Short-term impacts to surface water and groundwater are expected to be negligible for any of the alternatives.

Nonradiological air quality – Tank closure activities would result in the release of regulated nonradiological pollutants to the surrounding air. The primary source of air pollutants for the Fill with Grout Option would be a portable concrete batch plant and three diesel generators. For the Fill with Sand Option, pollutants would be emitted from operation of a portable sand feed plant and three diesel generators. The Fill with Saltstone Option would require saltstone batching facilities in F and H Areas. Regulated nonradiological air pollutants released as a result of activities associated with the No Action Alternative and Clean and Remove Tanks Alternative would consist largely of emissions from vehicular traffic. All alternatives except the No Action Alternative may include the cleaning of interior tank walls with an enhanced cleaning agent, such as oxalic acid. The acid would be transferred to the HLW tanks through a sealed pipeline. No releases are expected during this procedure. The cleaning process would consist of spraying hot (80 - 90°C) acid using remotely operated water sprayers.

The tanks would be ventilated with 300 - 400 cubic feet per minute of air that would pass thorough a HEPA filter; acid releases from the ventilated air are expected to be minimal. Under all alternatives, the expected emission rate for each source would be less than the Prevention of Significant Deterioration Standards.

Maximum air concentrations at the SRS boundary associated with the release of regulated pollutants would be highest for the Fill with Saltstone Option. However, ambient concentrations for all the pollutants and alternatives would be less than 1 percent of the regulatory limits. Concentrations at the location of the hypothetical noninvolved worker would be highest for the Fill with Saltstone Option. All concentrations, however, would be below the Occupational Safety and Health Administration (OSHA) limits; all concentrations, with the exception of nitrogen oxides (NO_x), would be less than 1 percent of the regulatory limit. Nitrogen dioxide (as NO_x) could reach 8 percent of the regulatory limit for the Fill with Grout and Fill with Sand Options, while NO_x levels under the Fill with Saltstone Option could reach about 16 percent of the OSHA limit. These emissions would be attributable to the diesel generators.

Radiological air quality – Radiation dose to the maximally exposed offsite individual from air emissions during tank closure would be essentially the same for all alternatives and options, 2.5×10^{-5} to 2.6×10^{-5} millirem per year. Estimated dose to the offsite population would also be similar for all alternatives and options, from 1.4×10^{-3} to 1.5×10^{-3} person-rem per year.

Ecological resources – Construction-related disturbance under the Stabilize Tanks Alternative and Clean and Remove Tanks Alternative would result in impacts to wildlife that are small, intermittent, and localized. Some individual animals could be displaced by construction noise and activity, but populations would not be affected.

Land use – From a land use perspective, the F- and H-Area Tank Farms are zoned Heavy Industrial and are within existing heavily industrialized areas. SRS land use patterns are not expected to change over the short term due to closure activities.

Table 2-2. Summary comparison of short-term impacts by tank closure alternative.

Parameter	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	Clean and Remove Tanks Alternative
Geologic Resources					
Soil backfill (m^3)	None	170,000	170,000	170,000	356,000
Water Resources					
Surface Water	None	None	None	None	None
Groundwater		<0.6% of F-Area well production required	<0.6% of F-Area well production required	<0.6% of F-Area well production required	<0.6% of F-Area well production required
Air Resources					
Nonradiological air emissions (tons/yr.):					
Sulfur dioxide (as SO_x)	None	2.2	2.2	3.3	None
Total suspended particulates	None	(a)	(a)	3.0	None
Particulate matter	None	4.5	3.1	1.7	None
Carbon monoxide	None	5.6	5.6	8.0	None
Volatile organic compounds	None	2.3	2.3	3.3	None
Nitrogen dioxide (as NO_x)	None	33	33	38	None
Lead	None	9.0×10^{-4}	9.0×10^{-4}	1.5×10^{-3}	None
Beryllium	None	1.7×10^{-4}	1.7×10^{-4}	2.8×10^{-4}	None
Mercury	None	2.2×10^{-4}	2.2×10^{-4}	4.3×10^{-4}	None
Benzene	None	0.02	0.02	0.43	None
Air pollutants at the SRS boundary (maximum concentrations-$\mu g/m^3$):[b]					
Sulfur dioxide (as SO_x) – 3 hr.	None	0.2	0.0	0.6	None
Total suspended particulates – annual	None	(a)	(a)	0.005	None
Particulate matter – 24 hr.	None	0.08	0.06	0.06	None
Carbon monoxide – 1 hr.	None	1.2	1.2	3.4	None
Volatile organic compounds – 1 hr.	None	0.5	0.5	2.0	None
Nitrogen dioxide (as NO_x) - annual	None	0.03	0.03	0.07	None
Lead – max. quarterly	None	1.2×10^{-6}	1.2×10^{-6}	4.1×10^{-6}	None
Beryllium – 24 hr.	None	3.2×10^{-6}	3.2×10^{-6}	1.1×10^{-5}	None

TC

Table 2-2. (Continued).

TC

Parameter	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	Clean and Remove Tanks Alternative
Mercury – 24 hr.	None	4.0×10^{-6}	4.0×10^{-6}	1.6×10^{-5}	None
Benzene	None	3.8×10^{-4}	3.8×10^{-4}	2.0×10^{-2}	None
Annual radionuclide emissions (curies/year):					
F Area	3.9×10^{-5}	3.9×10^{-5}	3.9×10^{-5}	3.9×10^{-5}	3.9×10^{-5}
H Area	1.1×10^{-4}	1.1×10^{-4}	1.1×10^{-4}	1.1×10^{-4}	1.1×10^{-4}
Saltstone Mixing Facility	Not used	Not used	Not used	0.46	Not used
Annual dose from radiological air emissions:					
Noninvolved worker dose (mrem/yr.)	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}
Maximally exposed offsite individual dose (mrem/yr.)	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	2.6×10^{-5}	2.5×10^{-5}
Offsite population dose (person-rem)	1.4×10^{-3}	1.4×10^{-3}	1.4×10^{-3}	1.5×10^{-3}	1.4×10^{-3}
Ecological Resources	No change	Activity and noise could displace small numbers of wildlife	Activity and noise could displace small numbers of wildlife	Activity and noise could displace small numbers of wildlife	Activity and noise could displace small numbers of wildlife
Land Use	Zoned heavy industrial-no change in SRS land use patterns	Zoned heavy industrial-no change in SRS land use patterns	Zoned heavy industrial-no change in SRS land use patterns	Zoned heavy industrial-no change in SRS land use patterns	Zoned heavy industrial-no change in SRS land use patterns
Socioeconomics (employment – full time equivalents)					
Annual employment	40	85	85	131	284
Life of project employment	980	2,078	2,078	3,210	6,963
Cultural Resources	None	None	None	None	None

Table 2-2. (Continued).

Parameter	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	Clean and Remove Tanks Alternative
Worker and Public Health					
Radiological dose and health impacts to the public and noninvolved workers:					
Maximally exposed offsite individual (mrem/yr.)	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	2.6×10^{-5}	2.5×10^{-5}
Maximally exposed offsite individual estimated latent cancer fatality risk	3.0×10^{-10}	3.0×10^{-10}	3.0×10^{-10}	3.2×10^{-10}	3.0×10^{-10}
Noninvolved worker estimated latent cancer fatality risk	2.5×10^{-8}	2.5×10^{-8}	2.5×10^{-8}	2.6×10^{-8}	2.5×10^{-8}
Estimated increase in number of latent cancer fatalities in population within 50 miles of SRS	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.8×10^{-5}	1.7×10^{-5}
Radiological dose and health impacts to involved workers:					
Closure collective dose (total person-rem)	29.4[c]	1,600	1,600	1,800	12,000
Closure latent cancer fatalities	0.012	0.65	0.65	0.72	4.9
Nonradiological air pollutants at noninvolved worker location (max conc.):					
Sulfur dioxide (as SO_x) – 8 hr.	None	5.0×10^{-3}	5.0×10^{-3}	0.02	None
Total suspended particulates – 8 hr.	None	ND	ND	0.01	None
Particulate matter – 8 hr.	None	9.0×10^{-3}	6.0×10^{-3}	8.0×10^{-3}	None
Carbon monoxide – 8 hr.	None	0.01	0.01	0.04	None
Oxides of nitrogen (as NO_x) - ceiling	None	0.70	0.70	1.40	None
Lead – 8 hr.	None	2.1×10^{-6}	2.1×10^{-6}	6.5×10^{-6}	None

TC
TC
EC

Table 2-2. (Continued).

Parameter	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	Clean and Remove Tanks Alternative
Beryllium – 8 hr.	None	4.1×10^{-7}	4.1×10^{-7}	1.3×10^{-6}	None
Mercury – ceiling	None	4.2×10^{-6}	4.2×10^{-6}	1.4×10^{-5}	None
Benzene – 8 hr.	None	4.8×10^{-5}	4.8×10^{-5}	1.0×10^{-3}	None
Occupational Health and Safety:					
Recordable injuries-closure	110[d]	120	120	190	400
Lost workday cases-closure	60[d]	62	62	96	210
Environmental Justice	No disproportion-ately high and adverse environmental impacts expected for minority or low-income populations	No disproportionately high and adverse environmental impacts expected for minority or low-income populations	No disproportionately high and adverse environmental impacts expected for minority or low-income populations	No disproportionately high and adverse environmental impacts expected for minority or low-income populations	No disproportionately high and adverse environmental impacts expected for minority or low-income populations
Transportation (offsite round-trip truckloads)	0	654	653	19	5
Waste Generation					
Maximum annual waste generation:					
Radioactive liquid waste (gallons)	0	600,000	600,000	600,000	1,200,000
Nonradioactive liquid waste (gallons)	0	20,000	20,000	20,000	0
Transuranic waste (m^3)	0	0	0	0	0
Low-level waste (m^3)	0	60	60	60	900
Hazardous waste (m^3)	0	2	2	2	2
Mixed low-level waste (m^3)	0	12	12	12	20
Industrial waste (m^3)	0	20	20	20	20
Sanitary waste (m^3)	0	0	0	0	0

Table 2-2. (Continued).

Parameter	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	Clean and Remove Tanks Alternative
Total estimated waste generation					
Radioactive liquid waste (gallons)	0	12,840,000	12,840,000	12,840,000	25,680,000
Nonradioactive liquid waste (gallons)	0	428,000	428,000	428,000	0
Transuranic waste (m^3)	0	0	0	0	0
Low-level waste (m^3)	0	1,284	1,284	1,284	19,260
Hazardous waste (m^3)	0	42.8	42.8	42.8	42.8
Mixed low-level waste (m^3)	0	257	257	257	428
Industrial waste (m^3)	0	428	428	428	428
Sanitary waste (m^3)	0	0	0	0	0
Utility and Energy Usage:					
Water (total gallons)	7,120,000	48,930,000	12,840,000	12,840,000	25,680,000
Electricity	NA	NA	NA	NA	NA
Steam (total pounds)	NA	8,560,000	8,560,000	8,560,000	17,120,000
Fossil fuel (total gallons)	NA	214,000	214,000	214,000	428,000
Utility cost (total)	NA	$4,280,000	$4,280,000	$4,280,000	$12,840,000

TC

EC a. No data on TSP emissions for these sources is readily available and is therefore not reflected in the analysis.
b. No exceedances of air quality standards are expected.
c. Collective dose for the No Action Alternative is for the period of closure activities for the other alternatives. This dose would continue indefinitely at a rate of approximately 1.2 person-rem per year.
d. For the No Action Alternative, recordable injuries and lost work day cases are for the period of closure activities for the other alternatives. These values would continue indefinitely.
NA = Not applicable; ND = Below detection limit.

Socioeconomics – An annual average of 284 workers would be required for tank closure activities under the Clean and Remove Tanks Alternative. Fewer workers (85 to 131) would be required by the three tank stabilization options under the Stabilize Tanks Alternative. None of the alternatives or options is expected to measurably affect regional employment or population trends.

Cultural resources – There would be no impacts on cultural resources under any of the alternatives. The tank farms lie in a previously disturbed, highly industrialized area of the SRS.

Worker and public health impacts – All alternatives are expected to result in similar airborne radiological release levels. Public radiation doses and potential adverse health effects could occur from airborne releases only. Latent cancer fatality risk to the maximally exposed offsite individual from air emissions during tank closure would be highest (6.4×10^{-10}) under the Fill with Saltstone Option, due to the operation of the saltstone batch plant. Latent cancer fatality risk to the maximally exposed offsite individual from other alternatives and options would be slightly lower, 6.1×10^{-10}. Estimated latent cancer fatalities to the offsite population of 620,000 people would also be highest under the Fill with Saltstone Option (3.7×10^{-5}), with other alternatives and options expected to result in a nominally lower number of latent cancer fatalities, 3.4×10^{-5}.

Collective involved worker dose for closure of all 49 tanks would be highest under the Clean and Remove Tanks Alternative (12,000 person-rem), with the three stabilization options under the Stabilize Tanks Alternative ranging from 1,600 (Fill with Grout and Fill with Sand options) to 1,800 person-rem (Fill with Saltstone Option). Increased latent cancer fatalities attributable to these collective doses would be 4.9 (Clean and Remove Tanks Alternative), 0.72 (Fill with Saltstone Option), and 0.65 (Fill with Grout and Fill with Sand Options), respectively. The higher dose associated with the Clean and Remove Tanks Alternative relates to larger numbers of personnel required to implement the alternative.

> The primary health effect of radiation is the increased incidence of cancer. Radiation impacts on workers and public health are expressed in terms of latent cancer fatalities. A radiation dose to a population is estimated to result in cancer fatalities at a certain rate, expressed as a dose-to-risk conversion factor. DOE uses dose-to-risk conversion factors of 0.0005 per person-rem for the general population and 0.0004 per person-rem for workers. The difference is due to the presence of children in the general population, who are believed to be more susceptible to radiation.
>
> DOE estimates doses to the population and uses the conversion factor to estimate the number of cancer fatalities that might result from those doses. In most cases the result is a small fraction of one. For these cases, DOE concludes that the action would very likely result in no additional cancer in the exposed population.

Occupational Health and Safety – Recordable injuries and lost workday cases would be the lowest for the No Action Alternative and highest for the Clean and Remove Tanks Alternative. Of the three options under the Stabilize Tanks Alternative, the Fill with Saltstone Option would have about 50 percent more recordable injuries and lost workday cases than the Fill with Grout and Fill with Sand Options.

Environmental Justice – Because short-term impacts from tank closure activities would not significantly affect the surrounding population, and no means were identified for minority or low-income populations to be disproportionately affected, no disproportionately high and adverse impacts would be expected for minority or low-income populations under any of the tank closure alternatives.

Transportation – Offsite transportation by truck of material to close tanks would require from zero round trips per tank for the No Action Alternative to 654 round trips per tank for the Fill with Grout Option. The amount of increased traffic expected under the proposed action and alternatives would be minimal. There would be no transportation of material under the No Action Alternative.

Waste generation – Tank cleaning activities under the Clean and Remove Tanks Alternative would generate as much as 1.2 million gallons of radioactive liquid waste annually, while tank cleaning activities under the Stabilize Tanks Alternative, if needed (regardless of tank stabilization option) would generate as much as 600,000 gallons annually. This radioactive liquid waste would be managed as HLW. Small amounts of mixed LLW, hazardous waste, and industrial waste would be produced under both the Preferred Alternative and the Clean and Remove Tanks Alternative. The amount of LLW generated by the Clean and Remove Tanks Alternative would be much higher than that generated by any of the other alternatives. No radioactive or hazardous wastes would be generated under the No Action Alternative.

Utilities and energy consumption – None of the alternatives would require electricity usage beyond that associated with current tank farm operations. Electrical power for field activities would be supplied by portable diesel generators. The Clean and Remove Tanks Alternative would require twice the fossil fuel use of the three options under the Stabilize Tanks Alternative. Total utility costs under the Clean and Remove Tanks Alternative would be approximately three times the costs of the options under the Stabilize Tanks Alternative. The increased costs are primarily associated with fossil fuel consumption and steam generation. Water consumption is not a substantial contributor to overall utility costs. The highest water usage would be expected for the Fill with Grout Option. The Clean and Remove Tanks Alternative would require the next highest water usage. The water required to clean tanks, mix tank fill material, or to use as tank ballast, would be less than 0.6 percent (or 0.006) of the annual production from F Area wells.

Accidents – DOE evaluated the impacts of potential accidents related to each of the alternatives (Table 2-3). For the tank stabilization options, DOE considered transfers during cleaning, a design basis seismic event during cleaning, and failure of the Salt Solution Hold Tank. For the Clean and Remove Tanks Alternative, DOE considered transfer errors during cleaning and a seismic event.

For each accident, the impacts were evaluated as radiation dose and latent cancer fatalities (or increased risk of a latent cancer fatality) to the noninvolved workers, to the offsite maximally exposed individual, and to the offsite population. For the Stabilize Tanks Alternative and the Clean and Remove Tanks Alternative, a design basis earthquake would result in the highest potential dose and the highest potential increase in latent cancer fatalities or increased risk of latent cancer for each of the receptor groups. The Fill with Saltstone Option was reviewed to identify potential accidents resulting from producing saltstone and using it to fill tanks. The highest consequence accident identified for saltstone production and use was the failure of the Salt Solution Hold Tank. This accident would result in lower doses and cancer impacts than the bounding accidents for other phases of the alternative.

2.4.2 LONG-TERM IMPACTS

Section 4.2 presents a discussion of impacts associated with residual radioactive and nonradioactive material remaining in the closed HLW tanks. DOE estimated long-term impacts by completing a performance evaluation that includes fate and transport modeling over a long time span (10,000 years) to determine when certain measures of impacts (e.g., radiation dose) reach their peak value.

There is always uncertainty associated with the results of analyses, especially if the analyses attempt to predict impacts over a long period of time. The uncertainty could be the result of assumptions used, the complexity and variability of the process being analyzed, the use of incomplete information, or the unavailability of information. The uncertainties involved in estimating impacts over the 10,000-year period analyzed in this EIS are described in Section 4.2 and in Appendix C.

Table 2-3. Estimated accident consequences by alternative.

Alternative	Accident frequency	Consequences: Noninvolved worker (rem)	Latent cancer fatalities	Maximally exposed offsite individual (rem)	Latent cancer fatalities	Offsite population (person-rem)	Latent cancer fatalities
Stabilize Tanks Alternative							
Transfer errors during cleaning	0.1% per year (once in 1,000 years)	7.3	2.9×10^{-3}	0.12	6.0×10^{-5}	5,500	2.8
Seismic event (DBE) during cleaning	0.0019% per year (once in 53,000 years)	15	6.0×10^{-3}	0.24	1.2×10^{-4}	11,000	5.5
Failure of Salt Solution Hold Tank (Saltstone Option only)	0.005% per year (once in 20,000 years)	0.02	8.0×10^{-6}	4.2×10^{-4}	2.1×10^{-7}	17	8.4×10^{-3}
Clean and Remove Tanks Alternative							
Transfer errors during cleaning	0.1% per year (once in 1,000 years)	7.3	2.9×10^{-3}	0.12	6.0×10^{-5}	5,500	2.8
Seismic event (DBE) during cleaning	0.0019% per year (once in 53,000 years)	15	6.0×10^{-3}	0.24	1.2×10^{-4}	11,000	5.5

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Because long-term impacts to certain resources were not anticipated, detailed analyses of impacts to these resources were not conducted. These included air resources, socioeconomics, worker health, environmental justice, traffic and transportation, waste generation, utilities and energy, and accidents. Therefore Section 4.2 (as summarized in Table 2-4) focuses on the following discipline areas: geologic resources, surface water and groundwater resources, ecological resources, land use, and public health. Tables 2-5 through 2-7 present the long-term transport of nonradiological constituents in groundwater.

Geologic resources – Filling the closed-in-place tanks with ballast water (No Action), grout, sand, or saltstone (the three tank stabilization options under the Stabilize Tanks Alternative) could increase the infiltration of rainwater at some point in the future, allowing more percolation of water into the underlying geologic deposits. No detrimental effect on surface soils, topography, or to the structural or load-bearing properties of the geologic deposits would occur from these actions. With tank failure, the underlying soil could become contaminated for either the No Action Alternative or any of the options under the Stabilize Tanks Alternative. No long-term impacts to geologic resources are anticipated from the Clean and Remove Tanks Alternative.

Water resources/surface water – Based on modeling results, any of the three tank stabilization options under the Stabilize Tanks Alternative would be effective in limiting the long-term movement of residual contaminants in closed tanks to nearby streams via groundwater. Concentrations of nonradiological contaminants moving to Upper Three Runs via the Upper Three Runs seepline would be minuscule, in most cases several times below applicable standards. Concentrations of nonradiological contaminants reaching Upper Three Runs and Fourmile Branch would be low under the No Action Alternative as well, but somewhat higher than those expected under the Stabilize Tanks Alternative. In all instances, predicted long-term concentrations of nonradiological contaminants would be well below applicable water quality standards.

The fate and transport modeling indicates that movement of residual radiological contaminants from closed HLW tanks to nearby surface waters via groundwater would also be limited by the three stabilization options under the Stabilize Tanks Alternative. Based on the modeling results, all three stabilization options under the Stabilize Tanks Alternative would be more effective than the No Action Alternative. The Fill with Grout Option would be the most effective of the three options as far as minimizing long-term movement of residual radiological contaminants.

Water resources/groundwater – The highest concentrations of radionuclides in groundwater would occur under the No Action Alternative. For this alternative, the EPA primary drinking water MCL of 4.0 millirem per year for beta-gamma emitting radionuclides would be exceeded at all points of exposure because essentially all of the drinking water dose is due to beta-gamma emitting radionuclides. The Fill with Grout Option shows the lowest groundwater concentrations of radionuclides at all exposure points. Only this option would meet the MCL at the seepline, which is specified in the General Closure Plan for the tanks (see Section 7.1.1) as the regulatory compliance point for groundwater. The beta-gamma MCL would be substantially exceeded at the 1-meter and 100-meter wells under all alternatives.

The results for alpha-emitting radionuclides also show that the highest concentrations would occur for the No Action Alternative. For this alternative, the MCL of 15 picocuries per liter would be exceeded at the 1-meter and 100-meter wells for both tank farms and the seepline north of the groundwater divide for H-Area Tank Farm. The Grout, Sand, and Saltstone Options show similar concentrations at most locations. For these three options, the MCL for alpha-emitting radionuclides would be exceeded only in H Area at the 1-meter well (all three options) and at the 100-meter well (Sand Option).

Table 2-4. Summary comparison of long-term impacts by tank closure alternative.[a]

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Parameter	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option
Geologic Resources	With tank failure, underlying soil could become contaminated	With tank failure, underlying soil could become contaminated	With tank failure, underlying soil could become contaminated	With tank failure, underlying soil could become contaminated
Surface Water	Limited movement of residual contaminants in closed tanks to downgradient surface waters	Almost no movement of residual contaminants in closed tanks to downgradient surface waters	Almost no movement of residual contaminants in closed tanks to downgradient surface waters	Almost no movement of residual contaminants in closed tanks to downgradient surface waters
Nonradiological constituents in Upper Three Runs at point of compliance (mg/L)				
Aluminum	(b)	(b)	(b)	(b)
Chromium IV	(b)	(b)	(b)	(b)
Copper	(b)	(b)	(b)	(b)
Iron	3.7×10^{-5}	(b)	(b)	(b)
Lead	(b)	(b)	(b)	(b)
Mercury	(b)	(b)	(b)	(b)
Nickel	(b)	(b)	(b)	(b)
Silver	1.2×10^{-6}	(b)	(b)	(b)
Nonradiological constituents in Fourmile Branch at point of compliance (mg/L)				
Aluminum	(b)	(b)	(b)	(b)
Chromium IV	(b)	(b)	(b)	(b)
Copper	(b)	(b)	(b)	(b)
Iron	4.9×10^{-5}	3.0×10^{-5}	3.0×10^{-5}	3.0×10^{-5}
Lead	(b)	(b)	(b)	(b)
Mercury	(b)	(b)	(b)	(b)
Nickel	(b)	(b)	(b)	(b)
Silver	1.1×10^{-4}	8.8×10^{-5}	6.5×10^{-6}	8.8×10^{-6}

Table 2-4. (Continued).

Parameter	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	
Maximum dose from beta-gamma emitting radionuclides in surface water (millirem/year)[c]					TC
Upper Three Runs	0.45	(b)	4.3×10^{-3}	9.6×10^{-3}	
Fourmile Branch	2.3	9.8×10^{-3}	0.019	0.130	
Groundwater					
Groundwater concentrations from contaminant transport – F-Area Tank Farm:					
Drinking water dose (mrem/yr.)					
1-meter well	35,000	130	420	790	
100-meter well	14,000	51	190	510	
Seepline, Fourmile Branch	430	1.9	3.5	25	EC
Alpha concentration (pCi/L)					
1-meter well	1,700	13	13	13	
100-meter well	530	4.8	4.7	4.8	
Seepline, Fourmile Branch	9.2	0.04	0.039	0.04	EC
Groundwater concentrations from contaminant transport – H-Area Tank Farm:					
Drinking water dose (mrem/yr.)					
1-meter well	9.3×10^{6}	1×10^{5}	1.3×10^{5}	1×10^{5}	
100-meter well	9.0×10^{4}	300	920	870	
Seepline					EC
North of Groundwater Divide	2,500	2.5	25	46	
South of Groundwater Divide	200	0.95	1.4	16	

Table 2-4. (Continued).

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Parameter	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option
Alpha concentration (pCi/L)				
1-meter well	13,000	24	290	24
100-meter well	3,800	7.0	38	7.0
Seepline, North of Groundwater Divide	34	0.15	0.33	0.15
Seepline, South of Groundwater Divide	4.9	0.02	0.19	0.02
Ecological Resources				
Maximum hazard indices for aquatic environments	2.0	1.42	0.18	0.16
Maximum hazard quotients for terrestrial environments				
Aluminum	(d)	(d)	(d)	(d)
Barium	(d)	(d)	(d)	(d)
Chromium	0.04	0.02	(d)	(d)
Copper	(d)	(d)	(d)	(d)
Fluoride	0.19	0.08	0.01	0.01
Lead	(d)	(d)	(d)	(d)
Manganese	(d)	(d)	(d)	(d)
Mercury	(d)	(d)	(d)	(d)
Nickel	(d)	(d)	(d)	(d)
Silver	1.55	0.81	0.09	0.13
Uranium	(d)	(d)	(d)	(d)
Zinc	(d)	(d)	(d)	(d)
Maximum absorbed dose to aquatic and terrestrial organisms (in millirad per year):				
Sunfish dose	0.89	0.0038	0.0072	0.053
Shrew dose	24,450	24.8	244.5	460.5
Mink dose	2,560	3.3	25.6	265

Table 2-4. (Continued).

Parameter	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	
Land Use	Tank farms zoned heavy industrial; no residential areas allowed on SRS	Tank farms zoned heavy industrial; no residential areas allowed on SRS	Tank farms zoned heavy industrial; no residential areas allowed on SRS	Tank farms zoned heavy industrial; no residential areas allowed on SRS	TC
Public Health					
Radiological contaminant transport from F-Area Tank Farm:					
Adult resident latent cancer fatality risk	2.2×10^{-4}	9.5×10^{-7}	1.8×10^{-6}	1.3×10^{-5}	
Child resident latent cancer fatality risk	2.0×10^{-4}	8.5×10^{-7}	1.7×10^{-6}	1.2×10^{-5}	
Seepline worker latent cancer fatality risk	2.2×10^{-7}	8.0×10^{-10}	1.6×10^{-9}	1.2×10^{-8}	
Intruder latent cancer fatality risk	1.1×10^{-7}	4.0×10^{-10}	8.0×10^{-10}	8.0×10^{-9}	
Adult resident maximum lifetime dose (millirem)[g]	430	1.9	3.6	26	
Child resident maximum lifetime dose (millirem)[g]	400	1.7	3.3	24	
Seepline worker maximum lifetime dose (millirem)[g]	0.54	0.002	0.004	0.03	
Intruder maximum lifetime dose (millirem)[g]	0.27	0.001	0.002	0.02	
1-meter well drinking water dose (millirem per year)	3.6×10^{5}	130	420	790	
1-meter well alpha concentration (picocuries per liter)	1,700	13	13	13	
100-meter well drinking water dose (mrem/yr)	1.4×10^{4}	51	190	510	
100-meter well alpha concentration (picocuries per liter)	530	4.8	4.7	4.8	
Seepline drinking water dose (millirem per year)	430	1.9	3.5	25	
Seepline alpha concentration (picocuries per liter)	9.2	0.04	0.039	0.04	
Radiological contaminant transport from H-Area Tank Farm:					
Adult resident latent cancer fatality risk	8.5×10^{-5}	3.5×10^{-7}	5.5×10^{-7}	6.5×10^{-6}	L-11-5
Child resident latent cancer fatality risk	7.5×10^{-5}	3.3×10^{-7}	5.5×10^{-7}	6.5×10^{-7}	
Seepline worker latent cancer fatality risk	8.4×10^{-8}	(f)	4.0×10^{-10}	6.8×10^{-9}	

Table 2-4. (Continued).

Parameter	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	
					TC
Intruder latent cancer fatality risk	4.4×10^{-8}	(f)	(f)	3.2×10^{-9}	
Adult resident maximum lifetime dose (millirem)[g]	170	0.7	1.1	13	L-11-6
Child resident maximum lifetime dose (millirem)[g]	150	0.65	1.1	1.3	
Seepline worker maximum lifetime dose (millirem)[g]	0.21	(e)	0.001	0.017	
Intruder maximum lifetime dose (millirem)[g]	0.11	(e)	(e)	0.008	
1-meter well drinking water dose (millirem per year)	9.3×10^{6}	1.0×10^{5}	1.3×10^{5}	1.0×10^{5}	EC
1-meter well alpha concentration (picocuries per liter)	13,000	24	290	24	
100-meter well drinking water dose (millirem per year)	9.0×10^{4}	300	920	870	
100-meter well alpha concentration (picocuries per liter)	3,800	7.0	38	7.0	
Seepline drinking water dose (millirem per year)	2.5×10^{3}	2.5	25	46	
Seepline alpha concentration (picocuries per liter)	34	0.15	0.33	0.15	

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the tank farm areas and transported to SRS radioactive waste disposal facilities; impacts of this facility are evaluated in the *SRS Waste Management EIS* (DOE/EIS-0217).
b. Radiation dose less than 1.0×10^{-6} or nonradiological concentration less than 1.0×10^{-6} mg/L.
c. For comparison, the average annual background radiation dose to a member of the public is approximately 360 millirem per year.
d. Hazard quotient is less than ~ 1×10^{-2}.
e. The radiation dose for this alternative is less than 1×10^{-3} millirem.
f. The risk for this alternative is less than 4.0×10^{-10}.
EC g. Calculated based on an assumed 70-year lifetime.

Table 2-5. Maximum nonradiological groundwater concentrations from contaminant transport from F- and H-Area Tank Farms, 1-meter well.[a]

	Maximum concentration (percent of MCL)				
1-Meter well	Ba	F	Cr	Hg	Nitrate
No Action Alternative					
Water Table	0.0	18.5	320	6,500	150
Barnwell McBean	0.0	47.5	380	0.0	270
Congaree	0.0	6.8	0.0	0.0	62
Grout Fill Option					
Water Table	0.0	0.3	21	70	2.3
Barnwell McBean	0.0	5	23	0.0	21
Congaree	0.0	0.1	0.0	0.0	0.5
Saltstone Fill Option					
Water Table	0.0	0.3	21	70	240,000
Barnwell McBean	0.0	5	23	0.0	440,000
Congaree	0.0	0.1	0.0	0.0	160,000
Sand Fill Option					
Water Table	0.0	1.6	8.5	37	6.7
Barnwell McBean	0.0	5.3	19	0.0	22
Congaree	0.0	0.1	0.0	0.0	0.7

EC Note: Only those contaminants with current EPA primary drinking water MCLs are included in table. A value of “100” for a given contaminant is equivalent to the MCL concentration. Values represent the highest concentration from either tank farm.

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the tank farm areas and transported to SRS radioactive waste disposal facilities.

Table 2-6. Maximum nonradiological groundwater concentrations from contaminant transport from F- and H-Area Tank Farms, 100-meter well.[a]

	Maximum concentration (percent of MCL)				
100-Meter well	Ba	F	Cr	Hg	Nitrate
No Action Alternative					
Water Table	0.0	8.3	74	265	69
Barnwell McBean	0.0	12.5	81	0.0	58
Congaree	0.0	1.2	0.0	0.0	11
Grout Fill Option					
Water Table	0.0	0.1	2.7	1.5	0.7
Barnwell McBean	0.0	1.1	4.4	0.0	4.7
Congaree	0.0	0.0	0.0	0.0	0.1
Saltstone Fill Option					
Water Table	0.0	0.1	2.7	1.5	68,000
Barnwell McBean	0.0	1.1	4.4	0.0	180,000
Congaree	0.0	0.0	0.0	0.0	21,000
Sand Fill Option					
Water Table	0.0	0.3	1.5	2.7	1.3
Barnwell McBean	0.0	1.2	3.7	0.0	4.9
Congaree	0.0	0.0	0.0	0.0	0.1

EC Note: Only those contaminants with current EPA primary drinking water MCLs are included in table. A value of “100” for a given contaminant is equivalent to the MCL concentration. Values represent the highest concentration from either tank farm.

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the tank farm areas and transported to SRS radioactive waste disposal facilities.

Table 2-7. Maximum nonradiological groundwater concentrations from contaminant transport from F- and H-Area Tank Farm, seepline.[a]

	Maximum concentration (percent of MCL)				
Fourmile Branch seepline	Ba	F	Cr	Hg	Nitrate
No Action Alternative					
Water Table	0.0	0.4	1.0	0.0	3.4
Barnwell McBean	0.0	0.5	0.8	0.0	2.4
Congaree	0.0	0.0	0.0	0.0	0.1
Grout Fill Option					
Water Table	0.0	0.0	0.0	0.0	0.0
Barnwell McBean	0.0	0.0	0.0	0.0	0.1
Congaree	0.0	0.0	0.0	0.0	0.0
Saltstone Fill Option					
Water Table	0.0	0.0	0.0	0.0	3,000
Barnwell McBean	0.0	0.0	0.0	0.0	3,300
Congaree	0.0	0.0	0.0	0.0	300
Sand Fill Option					
Water Table	0.0	0.0	0.0	0.0	0.1
Barnwell McBean	0.0	0.0	0.0	0.0	0.2
Congaree	0.0	0.0	0.0	0.0	0.0

EC Note: Only those contaminants with current EPA primary drinking water MCLs are included in table. A value of "100" for a given contaminant is equivalent to the MCL concentration. Values represent the highest concentration from either tank farm.

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the tank farm areas and transported to SRS radioactive waste disposal facilities.

If the Clean and Remove Tanks Alternative were chosen, residual waste would be removed from the tanks and the tank systems themselves would be removed and transported to SRS radioactive waste disposal facilities. Long-term impacts at these facilities are evaluated in the *Savannah River Site Waste Management EIS* (DOE/EIS-0217). The long-term impacts of EC LLW disposal in low-activity vaults presented in the *SRS Waste Management EIS* are about one-one thousandth of the long-term tank closure impacts presented in this EIS for water resources and public health.

For nonradiological constituents, the EPA EC primary drinking water MCLs would be exceeded only for the No Action Alternative and TC Fill with Saltstone Option. The impacts would EC be greatest in terms of the variety of contaminants that exceed the MCL for the No EC Action Alternative, but exceedances of the MCLs only occur primarily at the 1-meter well, with mercury exceeding the MCL also at the 100-meter well. Impacts from the Fill with Saltstone Option would occur at all exposure points, including the seepline; however, nitrate is the only contaminant that would exceed its MCL. The MCLs would not be exceeded for EC any contaminant in any aquifer layer, at any point of exposure, for either the Grout or the Sand Options.

Ecological resources – Risks to aquatic organisms in Fourmile Branch and Upper Three Runs for nonradiological contaminants would be negligible under the Fill with Sand and Fill with Saltstone Options. For the Fill with Grout TC Option and the No Action Alternative, there would be relatively low risk to aquatic organisms.

Risks to terrestrial organisms such as the shrew and mink (and other small mammalian carnivores with limited home range sites) from non-radiological contaminants would be negligible for all options under the Stabilize Tanks Alternative. For the No Action Alternative, there would be generally low risk to terrestrial organisms.

All calculated radiological doses to terrestrial and aquatic animal organisms were well below the limit of 365,000 millirad per year (1.0 rad per day) established in DOE Order 5400.5, including the No Action Alternative.

Land use – Long-term land use impacts at the tank farm areas are not expected because of DOE's established land use policy for SRS. In the *Savannah River Site Future Use Plan*, (DOE 1998) and the *Land Use Control Assurance Plan*, DOE established a future use policy for the SRS. Several key elements of that policy would maintain the lands that are now part of the tank farm areas for heavy industrial use and exclude non-conforming land uses. Most notable are:

- Protection and safety of SRS workers and the public shall be a priority.
- The integrity of site security shall be maintained.
- A "restricted use" program shall be developed and followed for special areas (e.g., Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] and Resource Conservation and Recovery Act [RCRA] regulated units).
- SRS boundaries shall remain unchanged, and the land shall remain under the ownership of the Federal government.
- Residential uses of all SRS land shall be prohibited in any area of the site.

As mentioned above, the tank farm areas will remain in an industrialized zone. In principle, industrial zones are ones in which the facilities pose either a potentially significant nuclear or non-nuclear hazard to employees or the general public. In the case of the Industrial-Heavy Nuclear zone, facilities included (1) produce, process, store and/or dispose of radioactive liquid or solid waste, fissionable materials, or tritium; (2) conduct separations operations; (3) conduct irradiated materials inspection, fuel fabrication, decontamination, or recovery operations; or (4) conduct fuel enrichment operations.

Public health – DOE evaluated public health impacts over a 10,000-year period. Structural collapse of the tanks would pose a safety hazard under the No Action Alternative, creating unstable ground conditions and forming holes into which workers or other site users could fall. Neither the Stabilize Tanks Alternative nor the Clean and Remove Tanks Alternative would have this safety hazard, although there could be some moderate ground instability with the Fill with Sand Option. Airborne releases from the tanks are considered to be possible only under the No Action Alternative, and their likelihood is considered to be minimal for that alternative because the presence of moisture and the considerable depth of the tanks below grade would tend to discourage resuspension of tank contents. Therefore, with the exception of the safety hazard of collapsed tanks under the No Action Alternative, the principal source of potential impacts to public health is leaching and groundwater transport of contaminants. DOE calculated risks to public health based on postulated release and transport scenarios.

The maximum calculated dose to the adult resident for either tank farm, as presented in Table 2-4, would be 430 millirem (mrem) for a 70-year lifetime for the No Action Alternative, which is equal to an average annual dose of less than 10 mrem. This dose is less than the 100-mrem-per-year public dose limit and represents only a marginal increase in the annual average exposure of individuals in the United States of approximately 360 mrem due to natural and manmade sources of radiation exposure. Based on this low dose, DOE would not expect any health effects if an individual were to receive this hypothetical dose.

As shown in Table 2-4, at the 1-meter well, the highest calculated peak drinking water dose under the No Action Alternative is 9,300,000 millirem per year (9,300 rem per year), which would lead to acute radiation health effects, including death. Peak doses at this well for the Stabilize Tanks Alternative are calculated to be in the range of 100,000 to 130,000 millirem per year (100 to 130 rem per year), which substantially exceed all criteria for acceptable exposure, could result in acute health effects, and would give a significantly increased probability of a latent cancer fatality. Peak doses calculated at the 100-meter well range from 300 millirem (0.3 rem per year) per year for the Fill with Grout Option to 90,000 millirem per year (90 rem per year) for the No Action Alternative. Individuals exposed to 300 millirem per year would experience a lifetime increased risk of latent cancer fatality of less that 0.02 percent per year of exposure. The estimated doses at the 1- and 100-meter wells are extremely conservative (high) estimates because the analysis treated all tanks in a given group as being at the same physical location. Realistic doses at these close-in locations would be substantially smaller.

DOE considered the potential exposures to people who live in a home built over the tanks at some time in the future and are unaware that the residence was built over closed waste tanks. DOE previously modeled this type of exposure for the saltstone disposal vaults in Z Area. That analysis found that external radiation exposure was the only potentially significant pathway of potential radiological exposure other than groundwater use (WSRC 1992). For the Fill with Grout and Fill with Sand Options of the Stabilize Tanks Alternative, external radiation doses to onsite residents would be negligible because the thick layers of nonradioactive material between the waste (near the bottom of the tanks) and the ground surface would shield residents from any direct radiation emanating from the waste. External radiation exposures could occur under the Fill with Saltstone Option, which would place radioactive saltstone near the ground surface. If it is conservatively assumed that all of the backfill soil is eroded or excavated away and there is no other cap over the saltstone, and a home is built directly on the saltstone, the analysis presented in WSRC (1992) indicated that, 1,000 years after tank closure, a resident would be exposed to an effective dose equivalent of 390 mrem/year, resulting in an estimated 1 percent increase in risk of latent cancer fatality from a 70-year lifetime of exposure. Backfill soils or caps would eliminate or substantially reduce the potential external exposure. For example, with a 30-inch-thick intact concrete cap, the dose would be reduced to 0.1 mrem/year. For the No Action Alternative, external exposures to onsite residents would be expected to be unacceptably high due to the potential for contact with the residual waste.

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CHAPTER 3. AFFECTED ENVIRONMENT

EC Chapter 3 describes the existing Savannah River Site (SRS) environment as it relates to the alternatives described in Chapter 2.

3.1 Geologic Setting and Seismicity

The SRS is in west-central South Carolina, approximately 100 miles from the Atlantic coast (Figure 3.1-1). It is on the Aiken Plateau of the Upper Atlantic Coastal Plain, about 25 miles southeast of the Fall Line that separates the Atlantic Coastal Plain from the Piedmont.

3.1.1 GENERAL GEOLOGY

In South Carolina, the Atlantic Coastal Plain Province consists of a wedge of seaward-dipping and thickening unconsolidated and semi-consolidated sediments that extend from the Fall Line to the Continental Shelf. The Aiken Plateau is the subdivision of the Coastal Plain that includes the location of the SRS. The plateau extends from the Fall Line to the oldest of several scarps incised in the Coastal Plain sediment. The plateau surface is highly dissected and characterized by broad interfluvial areas with narrow steep-sided valleys. Although it is generally well drained, poorly drained depressions (called Carolina bays) do occur (DOE 1995). At the Site, the plateau is underlain by 600 to 1,400 feet of sands, clays, and limestones of Tertiary and Cretaceous age. These sediments are underlain, in turn, by sandstones of Triassic age and older metamorphic and igneous rocks (Arnett and Mamatey 1996). Because of the proximity of the SRS to the Piedmont Province, it has more relief than areas that are nearer the coast, with onsite elevations ranging from 89 to 420 feet above mean sea level.

The sediments of the Atlantic Coastal Plain (Figure 3.1-2) dip gently seaward from the Fall Line and range in age from Late Cretaceous to Recent. The sedimentary sequence thickens from essentially 0 feet at the Fall Line to more than 4,000 feet at the coast. Regional dip is to the southeast. Coastal Plain sediments underlying the SRS consist of sandy clays and clayey sands, although occasional beds of clean sand, gravel, clay, or carbonate occur (DOE 1995). The formations of interest in F and H Areas (General Separations Area) are part of the shallow (Floridan) aquifer system (Figure 3.1-2 and Table 3.1-1). Contaminants released to these formations could be transported by groundwater to local SRS streams.

3.1.2 LOCAL GEOLOGY AND SOILS

The principal surface and near-surface soils in F and H Areas consist of cross-bedded, poorly sorted sands and pebbly sands with lenses and layers of silts and clays. The surface and near-surface soils contain a greater percentage of clay, which has demonstrated a good retention capacity for most radionuclides. A significant portion of the surface soils around the F- and H-Area Tank Farms is composed of backfill material resulting from previous excavation and construction activities.

The vadose zone is comprised of the middle to late Miocene-age "Upland Unit," which extends over much of SRS. The term "Upland Unit" is an informal name used to describe sediments at higher elevations in the Upper Coastal Plain in southwestern South Carolina. This area has also been referred to as the Aiken Plateau, which is bounded by the Savannah and Congaree Rivers and extends from the Fall Line to the Orangeburg escarpment. This unit is highly dissected and is characterized by broad interfluvial areas with narrow, steep-sided valleys (SCDNR 1995). Erosion in these dissected, steep-sided valley areas expose older underlying deposits.

The occurrence of cross-bedded, poorly sorted sands with clay lenses indicate fluvial deposition (high-energy channel deposits to channel-fill deposits) with occasional transitional marine influence. This depositional environment results in wide differences in lithology and presents a very complex system of transmissive and

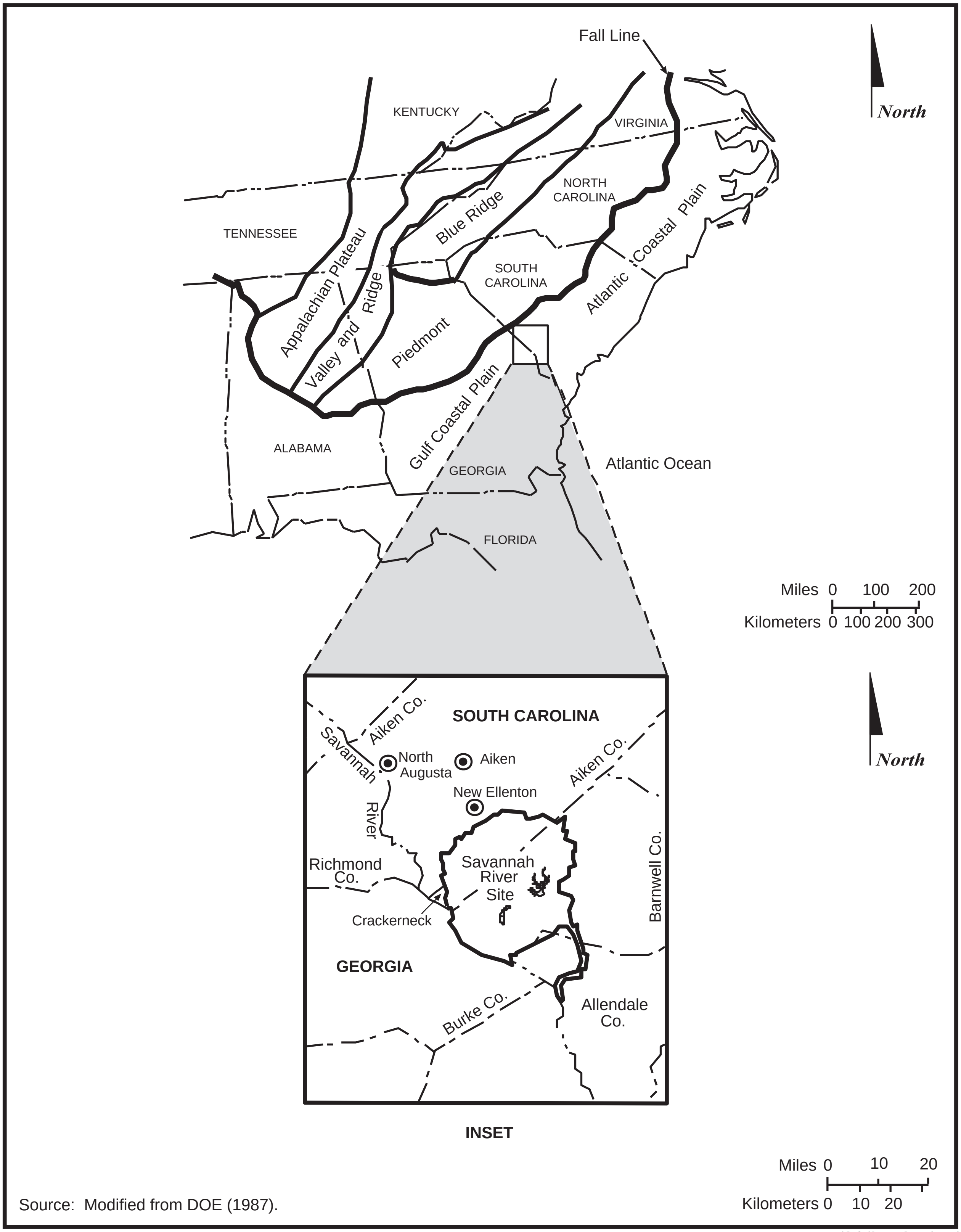

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Figure 3.1-1. Generalized location of Savannah River Site and its relationship to physiographic provinces of the southeastern United States.

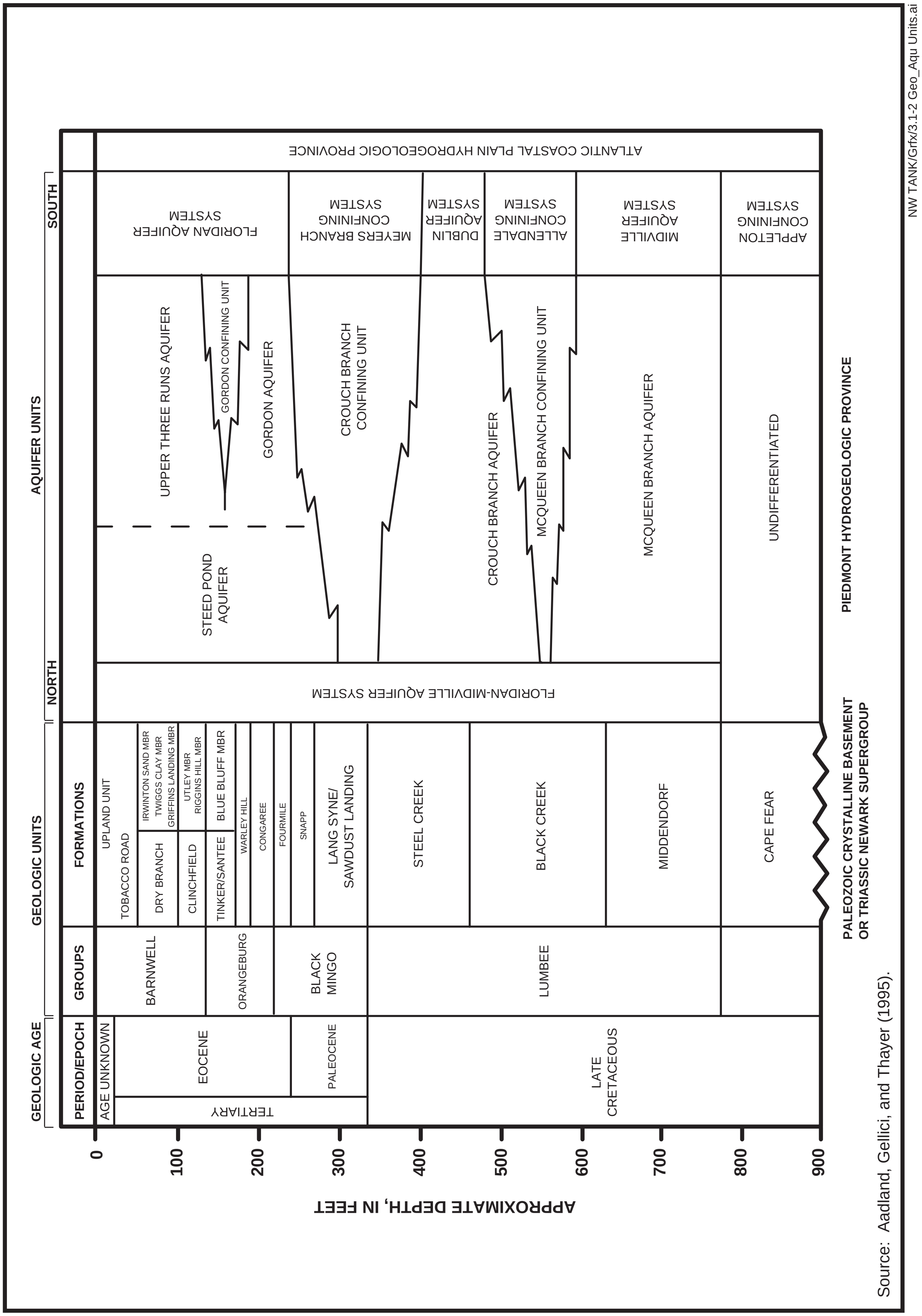


Figure 3.1-2. Generalized geologic and aquifer units in the Savannah River Site region.

Table 3.1-1. Formations of the Floridan aquifer system in F and H Areas.[a]

Aquifer unit	Formation	Description
Upper Three Runs Aquifer -upper zone [Water Table]	"Upland Unit"	Poorly sorted, clayey-to-silty sands, with lenses and layers of conglomerates, pebbly sands, and clays. Clay clasts are abundant, and cross-bedding and flecks of weathered feldspar are locally common.
	Tobacco Road Formation	Moderately to poorly sorted, variably colored, fine-to-coarse-grained sand, pebbly sand, and minor clay beds.
"Tan Clay" Confining Zone Upper Three Runs Aquifer -lower zone [Barnwell-McBean]	Dry Branch Formation -Twiggs Clay Member -Griffins Landing Member -Irwinton Sand Member	Variably colored, poorly sorted to well-sorted sand with the interbedded tan to gray clay ("Tan Clay") of the Twiggs Clay Member. The Tan Clay, where present, divides the Upper Three Runs Aquifer into an upper and lower zone.
	Clinchfield Formation	Light-colored basal quartz sand and glauconitic, biomoldic limestone, calcareous sand and clay. Sand beds of the formation constitute Riggins Mill Member and consist of medium-to-coarse, poorly to well-sorted, loose and slightly indurated, tan, gray, and green quartz. The carbonate sequence of the Clinchfield consists of Utley Member - sandy, glauconitic limestone and calcareous sand with indurated biomoldic facies.
	Tinker/Santee Formation	Unconsolidated, moderately sorted, subangular, lower coarse-to-medium-grained, slightly gravelly, immature yellow and tan quartz sand and clayey sand; calcareous sands and clays and limestone also occur in F and H Areas.
Gordon Confining Unit [Green Clay]	Blue Bluff Member of Santee Limestone	Micritic limestone.
	Warley Hill Formation	Fine-grained, glauconitic, clayey sand, and clay that thicken, thin, and pinch out abruptly.
Gordon Aquifer [Congaree]	Congaree Formation	Yellow, orange, tan, gray, and greenish gray, well-sorted, fine-to-coarse-grained quartz sands. Thin clay laminae occur throughout the section, with pebbly layers, clay clasts, and glauconite in places. In some places on SRS, upper part of Congaree Formation is cemented with silica; in other places, it is slightly calcareous. Glauconitic clay, encountered in some borings on SRS near the base of this formation, indicates that basal contact is unconformable.
	Fourmile Formation	Tan, yellow-orange, brown, and white, moderately to well-sorted sand, with clay beds near middle and top of unit. The sand is very coarse-to-fine-grained, with pebbly zones common. Glauconite and dinoflagellate fossils occur.
	Snapp Formation	Silty, medium-to-coarse-grained quartz sand interbedded with clay. Dark, micaceous, lignitic sand also occurs. In northwestern part of SRS, this formation is less silty and better sorted, with thinner clay interbeds.

a. Source: Aadland, Gellici, and Thayer (1995).

confining beds or zones (SCDNR 1995). The lower surface of the "Upland Unit" is very irregular, due to erosion of the underlying formations (Fallow and Price 1992). The thickness of the "Upland Unit" ranges from 16 feet to 40 feet in the vicinity of the F- and H-Area Seepline Basins (WSRC 1991), but may be as thick as 70 feet in the Central Savannah River Area (Fallow and Price 1992). The F- and H-Area Seepage Basins are located southwest and west of the F- and H-Area Tank Farms, respectively.

A notable feature of the "Upland Unit" is its compositional variability (Figure 3.1.2). This formation predominantly consists of red-brown to yellow-orange, gray, and tan-colored, coarse-to-fine-grained sand, pebbly and with lenses and beds of sandy clay and clay. Generally vertically upward through the unit, sorting of grains becomes poorer, clay beds become more abundant and thicker, and sands become more argilaceous and indurated (Fallow and Price 1992). In some areas, small-scale joints and fractures, both of which are commonly filled with sand or silt, traverse the unit. The mineralogy of the sands and pebbles primarily consists of quartz, with some feldspars. In areas to the east-southeast, sediments may become more phosphatic and dolomitic. The mineralogy of the clays consists of kaolinite, resulting from EC highly weathered feldspars, and muscovite (Nystrom, Widoughby and Price 1991). The soils at F and H Areas may contain as much as 20 to 40 percent clay (WSRC 1991).

3.1.3 SEISMICITY

There are several fault systems off the Site, northwest of the Fall Line (DOE 1990). A EC recent study of geophysical evidence (Wike, Moore-Shedrow and Shedrow 1996) and an earlier study (Stephenson and Stieve 1992) also identified the onsite faults indicated on Figure 3.1-3. The earlier study identified the following faults – Pen Branch, Steel Creek, Advanced Tactical Training Area, Crackerneck, Ellenton, and Upper Three Runs – under SRS. EC The more recent study (Wike Moore-Shedrow and Shedrow 1996) identified a previously unknown fault that passes through the southeastern corner of H Area and passes approximately one-half mile south of F Area, EC between F Area, and Fourmile Branch.

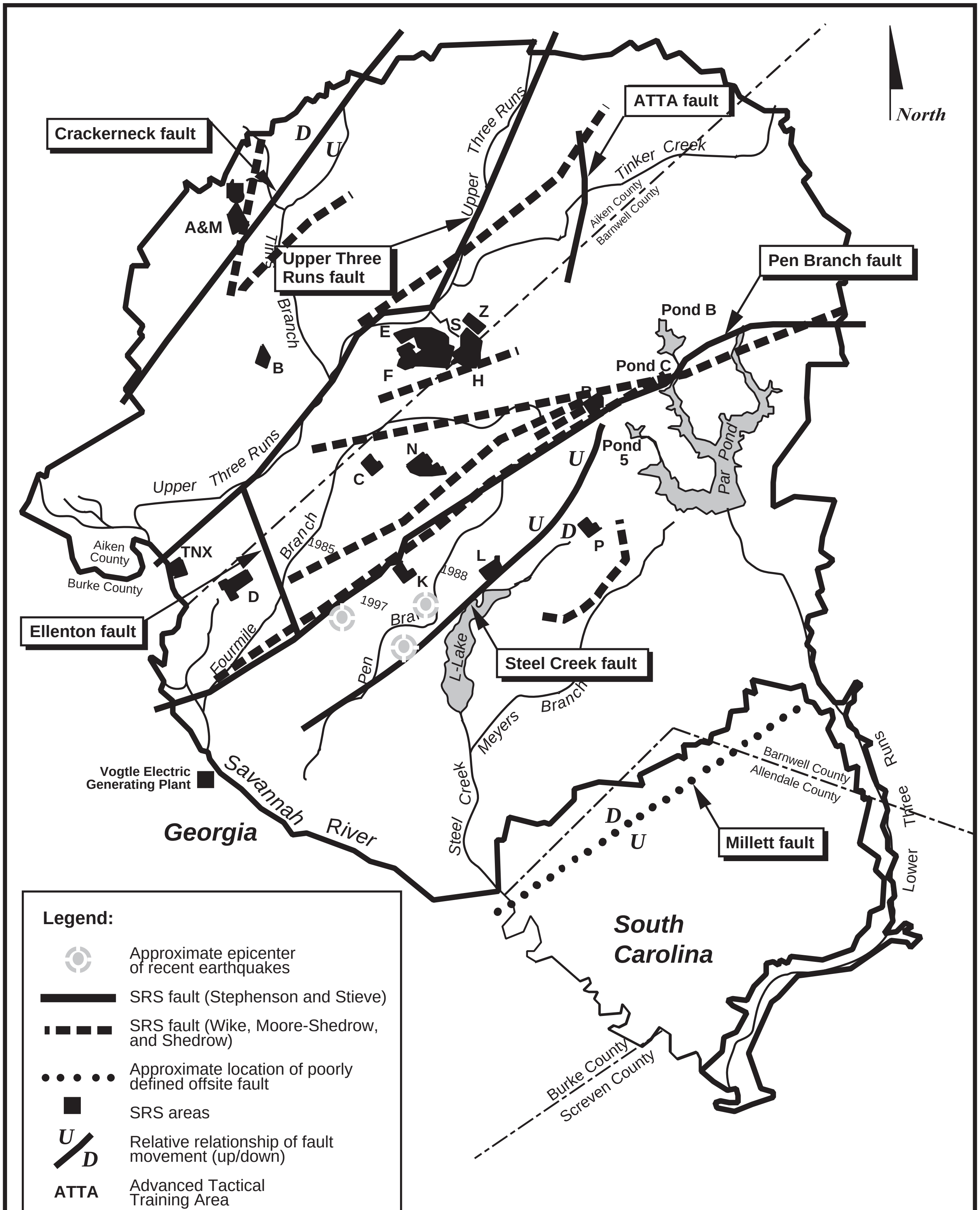
The Upper Three Runs Fault, which is a Paleozoic fault that does not cut Coastal Plain sediments, passes approximately 1 mile north and west of F Area. The lines shown on Figure 3.1-3 represent the projection of faults to the ground surface. The actual faults do not reach the surface, but stop several hundred feet below.

Based on available information, none of the faults discussed in this section is capable, which means that none of the faults has moved at or near the ground surface within the past 35,000 years or is associated with another fault that has moved in the past 35,000 years. Regulation 10 Code of Federal Regulations (CFR) 100 contains a more detailed definition of EC a capable fault. Two major earthquakes have occurred within 186 miles of SRS.

- According to URS/Blume (1982), the Charleston, South Carolina, earthquake of 1886 had an estimated Richter scale magnitude of 6.8; it occurred approximately 90 miles from the SRS area, which experienced an estimated peak horizontal acceleration of 10 percent of gravity (0.10*g*). Lee, Maryak, and McHood (1997) re-evaluated the data and determined the EC magnitude to have been 7.5.
- The Union County, South Carolina, earthquake of 1913 had, according to Bollinger (1973), an estimated Richter scale magnitude of 6.0 and occurred about 99 miles from the Site. The magnitude has since been revised downward to 4.5, based on a re-evaluation of the duration data (Geomatrix 1991).

These earthquakes are not associated conclusively with a specific fault.

In recent years, three earthquakes occurred inside the SRS boundary.



Source: Modified from Stephenson and Stieve (1992) and Wike et al. (1996).

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NW TANK/Grfx/3.1-3 Fault lines.ai

Figure 3.1-3. Savannah River Site, showing seismic fault lines and locations of onsite earthquakes and their years of occurrence.

- On May 17, 1997, with a duration magnitude of 2.3 and a focal depth of 3.38 miles; its epicenter was southeast of K Area.

- On June 8, 1985, with a duration magnitude of 2.6 and a focal depth of 0.59 mile; its epicenter was south of C Area and west of K Area.

- On August 5, 1988, with a duration magnitude of 2.0 and a focal depth of 1.66 miles; its epicenter was northeast of K Area.

Existing information does not relate these earthquakes conclusively to known faults under the Site. In addition, the focal depth of these earthquakes is currently being evaluated. Figure 3.1-3 shows the locations of the epicenters of these earthquakes.

Outside the SRS boundary, an earthquake with a Richter scale magnitude of 3.2 occurred on August 8, 1993, approximately 10 miles east of the City of Aiken near Couchton, South Carolina. People reported feeling this earthquake in Aiken, New Ellenton (immediately north of SRS), North Augusta (approximately 25 miles northwest of the SRS), and on the Site.

3.2 Water Resources

3.2.1 SURFACE WATER

The Savannah River bounds SRS on its southwestern border for about 20 miles, approximately 160 river miles from the Atlantic Ocean. Five upstream reservoirs – Jocassee, Keowee, Hartwell, Richard B. Russell, and Strom Thurmond – reduce the variability of flow downstream in the area of SRS. River flow averages about 10,000 cubic feet per second at SRS (DOE 1995).

Upstream of SRS, the river supplies domestic and industrial water for Augusta, Georgia, and North Augusta, South Carolina. Approximately 130 river miles downstream of SRS, the river supplies domestic and industrial water for Savannah, Georgia, and Beaufort and Jasper Counties in South Carolina through intakes at about River Mile 29 and River Mile 39, respectively (DOE 1995).

Five tributaries discharge directly to the Savannah River from SRS: Upper Three Runs, Beaver Dam Creek, Fourmile Branch, Steel Creek, and Lower Three Runs (Figure 3.2-1). A sixth stream, Pen Branch, which does not flow directly into the river, joins Steel Creek in the Savannah River floodplain swamp. Each of these six streams originates on the Aiken Plateau in the Coastal Plain and descends 50 to 200 feet before discharging into the river (DOE 1995). The streams, which historically have received varying amounts of effluent from SRS operations, are not commercial sources of water.

F and H Areas are situated on the divide that separates the drainage into Upper Three Runs (including McQueen Branch and Crouch Branch) and Fourmile Branch; approximately half of each area drains into each stream (DOE 1996). F and H Areas are relatively elevated areas of SRS and are centrally located inside the SRS boundary. Surface elevations range from approximately 270 to 320 feet above mean sea level for both F and H Areas. The F and H Areas are drained by Upper Three Runs to the north and west and by Fourmile Branch to the south. In addition, the Water Table Aquifer for both F and H Areas outcrops at the seeplines along both Fourmile Branch and Upper Three Runs.

Upper Three Runs, the longest of the SRS streams, is a large blackwater stream in the northern part of SRS that discharges to the Savannah River. It drains an area of over 195 square miles and is approximately 25 miles long, with its lower 17 miles within SRS boundaries. This stream receives more water from underground sources than other SRS streams and is the only stream with headwaters arising outside the Site. It is the only major tributary on SRS that has not received thermal discharges (Halverson et al. 1997).

Fourmile Branch is a blackwater stream that originates near the center of SRS and flows southwest for 15 miles before emptying into the Savannah River (Halverson et al. 1997). It

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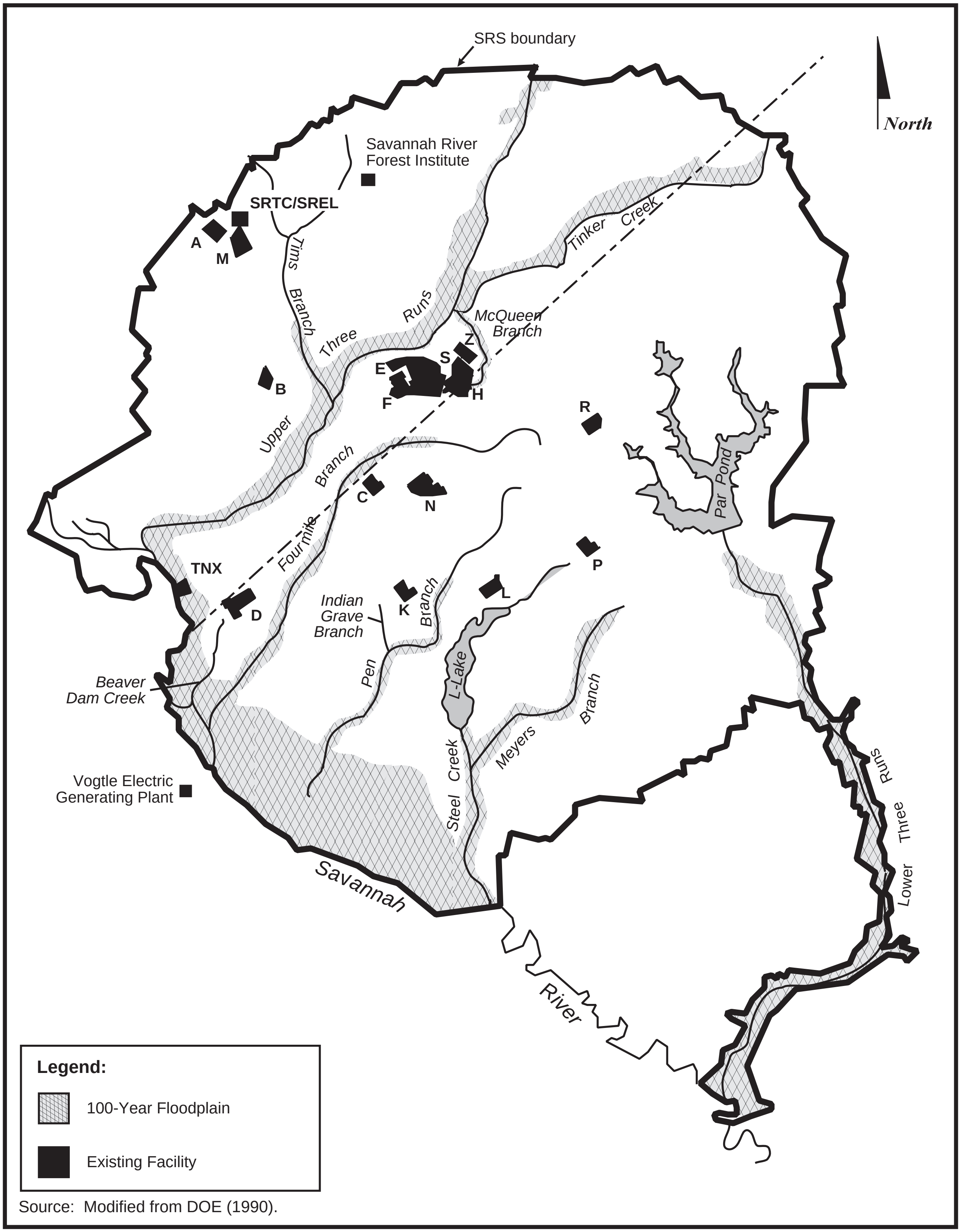

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NW Tank/Grfx/3.2-1 Floodplain.ai

Figure 3.2-1. Savannah River Site, showing 100-year floodplain and major stream systems.

drains an area of about 22 square miles inside SRS, including much of F, H, and C Areas. Fourmile Branch flows parallel to the Savannah River behind natural levees and enters the river through a breach downriver from Beaver Dam Creek. In its lower reaches, Fourmile Branch broadens and flows via braided channels through a delta formed by the deposition of sediments eroded from upstream during high flows.

Downstream from the delta, the channels rejoin into one main channel. Most of the flow discharges into the Savannah River, while a small portion flows west and enters Beaver Dam Creek (DOE 1995).

The natural flow of SRS streams ranges from about 10 cubic feet per second in smaller streams to 245 cubic feet per second in Upper Three Runs. From 1974 to 1995, the mean flow of Upper Three Runs at Road A was 245 cubic feet per second, and the 7Q10 (minimum 7-day average flow rate that occurs with an average frequency of once in 10 years) was 100 cubic feet per second (Halverson et al. 1997). The mean flow of Fourmile Branch southwest of SC Highway 125 from 1976 to 1995 was 113 cubic feet per second, and the 7Q10 was 7.6 cubic feet per second (Halverson et al. 1997). The *SRS Ecology Environmental Information Document* (Halverson et al. 1997) and the *Final Environmental Impact Statement for the Shutdown of the River Water System at the Savannah River Site* (DOE 1997) contain detailed information on flow rates and water quality of the Savannah River and SRS streams. EC

There are various potential sources of contamination to the Upper Three Runs and Fourmile Branch watersheds in and around F and H Areas. These potential sources have been identified in the SRS *Federal Facility Agreement*, Appendix C, RCRA/CERCLA Units (WSRC 1993) and are listed in Table 3.2-1. These potential sources could contribute contaminants to the surface waters of Upper Three Runs and Fourmile Branch in the same manner as the F- and H-Area Tank Farms. EC

The South Carolina Department of Health and Environmental Control (SCDHEC) regulates the physical properties and concentrations of chemicals and metals in SRS effluents under the National Pollutant Discharge Elimination System (NPDES) program. SCDHEC, which also regulates biological water quality standards for SRS waters, has classified the Savannah River and SRS streams as "Freshwaters." In 1998, 99.3 percent of the NPDES water quality analyses on SRS effluents were in compliance with the SRS NPDES permit; only 42 of 5,790 analyses exceeded permit limits (Arnett and Mamatey 1999a). The 1998 exceedances were higher than in previous years. Repeat exceedances at four outfalls accounted for a majority of the exceedances; some of these can be attributed to ongoing heavy rainfall. In particular, heavy rainfall caused groundwater levels to rise significantly at outfall D-1A, which had a total of 18 exceedances. A comparison of 1998 Savannah River water quality analyses showed no significant differences between up- and downstream SRS stations (Arnett and Mamatey 1999a). Table 3.2-2 summarizes the water quality of Fourmile Branch and Upper Three Runs for 1998. EC

3.2.2 GROUNDWATER RESOURCES

3.2.2.1 Groundwater Features

In the SRS region, the subsurface contains two hydrogeologic provinces. The uppermost, consisting of a wedge of unconsolidated Coastal Plain sediments of Late Cretaceous and Tertiary age, is the Atlantic Coastal Plain Hydrogeologic Province. Beneath the sediments of the Atlantic Coastal Plain Hydrogeologic Province are rocks of the Piedmont Hydrogeologic Province. These rocks consist of Paleozoic igneous and metamorphic basement rocks and lithified mudstone, sandstone, and conglomerates of the Dunbarton basin of the Upper Triassic. Sediments of the Atlantic Coastal Plain Hydrogeologic Province are divided into three main aquifer systems, the Floridan Aquifer System, the Dublin Aquifer System, and the Midville Aquifer System, as shown in Figure 3.1-2 (Aadland, Gellici, and Thayer 1995). The Meyers Branch Confining System and/or the Allendale Confining System, as EC

Table 3.2-1. Potential F and H Area contributors of contamination to Upper Three Runs and Fourmile Branch.[a]

Fourmile Branch Watershed	Upper Three Runs Watershed
Burial Ground Complex Groundwater[b]	Burial Ground Complex Groundwater[a]
Burial Ground Complex [the Old Radioactive Waste Burial Ground (643-E) and Solvent Tanks S01-S22 portions]	Burial Ground Complex (the Low-Level Radioactive Waste Disposal Facility [643-7E] portion)
F-Area Coal Pile Runoff Basin, 289-F	Burma Road Rubble Pit, 231-4F
F-Area Hazardous Waste Management Facility, 904-41G, -42G, -43G	F-Area Burning/Rubble Pits, 231-F, -1F, -2F
F-Area Inactive Process Sewer Lines from Building to the Security Fence[a], 081-1F	F-Area Inactive Process Sewer Lines from Building to the Security Fence[a], 081-1F
F-Area Retention Basin, 281-3F	
F-Area Seepage Basin Groundwater Operable Unit	H-Area Coal Pile Runoff Basin, 289-H
H-Area Hazardous Waste Management Facility, 904-44G, -45G, -46G, -56G	H-Area Inactive Process Sewer Lines from Building to the Security Fence[a], 081-H
H-Area Inactive Process Sewer Lines from Building to the Security Fence[a], 081-H	
H-Area Retention Basin, 281-3H	Old F-Area Seepage Basin, 904-49G
H-Area Seepage Basin Groundwater Operable Unit	211-FB Plutonium-239 Release, 081-F
H-Area Tank Farm Groundwater	
Mixed Waste Management Facility, 643-28E	
Warner's Pond, 685-23G	

a. Source: WSRC (1993).
EC b. Units located in more than one watershed.

shown in Figure 3.1-2, separate the aquifer systems of interest.

Groundwater within the Floridan System (the shallow aquifer beneath the Site) flows slowly toward SRS streams and swamps and into the Savannah River at rates ranging from inches to several hundred feet per year. The depth to which onsite streams cut into sediments, the lithology of the sediments, and the orientation of the sediment formations control the horizontal and vertical movement of the groundwater. The valleys of smaller perennial streams allow discharge from the shallow saturated geologic formations. The valleys of major tributaries of the Savannah River (e.g., Upper Three Runs) drain formations of intermediate depth, and the river valley drains deep formations. With the release of water to the streams, the hydraulic head of the aquifer unit releasing the water can become less than that of the underlying unit. If this occurs, groundwater has the potential to migrate upward from the lower unit to the overlying unit.

Groundwater flow in the shallow aquifer (Floridan) system is generally horizontal, but may have a vertically downward component. In the divide areas between surface water drainages, the vertical component of groundwater flow is downward due to the decreasing hydraulic head with increasing depth. In areas along the lower reaches of most of the Site streams, groundwater moves generally in a horizontal direction and has vertically upward potential from deeper aquifers to the shallow aquifers. In these areas, hydraulic heads increase with depth. In the vicinity of these streams, the potential for vertically upward flow occurs across a confining unit where the underlying aquifer has not been incised by an overlying stream (Aadland, Gellici, and Thayer 1995). EC For example, in the area south of H Area where Fourmile Branch cuts into the Upper

Table 3.2-2. SRS stream water quality (onsite downstream locations).[a]

Parameter[b]	Units	Fourmile Branch (FM-6) average	Upper Three Runs (U3R-4) average	Water Quality Criterion[c], MCL[d], or DCG[e]
Aluminum	mg/L	0.285[f]	0.294[f]	0.087
Cadmium	mg/L	NR[g]	NR	0.00066
Calcium	mg/L	NR	NR	NA[h]
Cesium-137	pCi/L	4.74	0.67	120[e]
Chromium	mg/L	ND[i]	ND	0.011
Copper	mg/L	0.006	ND	0.0065
Dissolved oxygen	mg/L	8.31	6.3	≥5
Iron	mg/L	0.717	0.547	1
Lead	mg/L	0.18	0.011	0.0013
Magnesium	mg/L	NR	NR	0.3
Manganese	mg/L	0.045	0.026	1
Mercury	mg/L	0.0002	ND	0.000012
Nickel	mg/L	ND	ND	0.088
Nitrate (as nitrogen)	mg/L	1.29	0.26	10[d1]
pH	pH	6.4	5.8	6-8.5
Plutonium-238	pCi/L	0.003	ND	1.6[e]
Plutonium-239	pCi/L	0.001	0.005	1.2[e]
Strontium-89,90	pCi/L	6.79	0.04	8[d2]
Suspended solids	mg/L	3.9	5.9	NA
Temperature[j]	°C	20.2	18.8	32.2
Tritium	pCi/L	1.9×10^5	4.2×10^3	20,000[d2]
Uranium-234	pCi/L	0.69	0.093	20[e]
Uranium-235	pCi/L	0.053	0.046	24[e]
Uranium-238	pCi/L	0.84	0.11	24[e]
Zinc	mg/L	0.019	0.02	0.059

a. Source: Arnett and Mamatey (1999b).
b. Parameters DOE routinely measures as a regulatory requirement or as part of ongoing monitoring programs.
c. Water Quality Criterion (WQC) is Aquatic Chronic Toxicity unless otherwise indicated.
d. MCL = Maximum Contaminant Level; State Primary Drinking Water Regulations [d1 = Chapter 61-58.5 (b)(2)h; d2= Chapter 61-58.5(h)(2)b]. EC
e. DCG = DOE Derived Concentration Guides for Water (DOE Order 5400.5). DCG values are based on committed effective dose of 100 millirem per year; however, because drinking water MCL is based on 4 millirem per year, value listed is 4 percent of DCG.
f. Concentration exceeded WQC; however, these criteria are for comparison only. WQCs are not legally enforceable.
g. NR = Not reported.
h. NA = Not applicable. EC
i. ND = Not detected.
j. Shall not be increased more than 2.8°C (5°F) above natural temperature conditions or exceed a maximum of 32.2°C (90°F) as a result of the discharge of heated liquids unless appropriate temperature criterion mixing zone has been established.

Three Runs Aquifer, but does not cut into the Gordon Aquifer, the hydraulic head is greater in the Gordon Aquifer than the overlying Upper Three Runs Aquifer that discharges to Fourmile Branch. At these locations, any contaminants in the overlying aquifer system are prevented from migrating into deeper aquifers by the prevailing hydraulic gradient and the low permeability of the confining unit. Groundwater flow in the General Separations Area, which includes F and H Areas, is toward Upper Three Runs and its tributaries to the north and Fourmile Branch to the south.

3.2.2.2 Groundwater Use

Groundwater is a domestic, municipal, and industrial water source throughout the Upper Coastal Plain. Regional domestic water supplies come primarily from the shallow aquifers, including the Gordon Aquifer and the Upper Three Runs Aquifer (water-table aquifer). Most municipal and industrial water supplies in Aiken County are from the Crouch Branch and McQueen Branch Aquifers, formerly the Black Creek and Middendorf, respectively. In Barnwell and Allendale Counties, some municipal water supplies are from the Gordon Aquifer and overlying units that thicken to the southeast. At SRS, most groundwater production for domestic and process water comes from the Crouch Branch and McQueen Branch, with a few lower-capacity domestic waterwells pumping from the shallower Gordon (Congaree) Aquifer and the lower zone of the Upper Three Runs (McBean) Aquifer. These wells are located away from the main operations areas in outlying areas including guard barricades and operations offices/laboratories (DOE 1998).

The domestic water requirements for the General Separations Area are supplied from groundwater wells located in A Area (Arnett and Mamatey 1997). From January to December 1998, the total groundwater withdrawal rate in the General Separations Area for industrial use, including groundwater from process production wells and former domestic wells (now used as process wells in F, H, and S Areas) was approximately 2.1 million gallons per day. These wells are installed in the deeper Crouch Branch and McQueen Branch Aquifers. Groundwater in F Area is pumped from four process production and two former domestic wells currently being used for process production. The total F Area groundwater production rate in 1998 was approximately 1.01 million gallons per day. During the same period, wells in H and S Areas produced approximately 1.02 million gallons per day and 49,000 gallons per day, respectively. H Area has two former domestic wells and three process production wells (Wells 1997; WSRC 1999). S Area's groundwater production is from three process/former domestic wells (WSRC 1995).

3.2.2.3 Hydrogeology

The aquifers of interest for F and H Areas within the General Separations Area are the Upper Three Runs and Gordon Aquifers. The Upper Three Runs Aquifer (formerly Water Table and Barnwell-McBean Aquifers) is defined by the hydrogeologic properties of the Tinker/Santee Formation, the Dry Branch Formation, and the Tobacco Road Formation (DOE 1997). EC
Table 3.1-1 provides descriptions of these formations. The Twiggs Clay Member of the Dry Branch Formation acts as a confining unit (Tan Clay) that separates the Upper Three Runs Aquifer into an upper and lower zone. The horizontal hydraulic conductivity for the upper zone of the Upper Three Runs Aquifer ranges between 5 to 13 feet per day, with localized areas as high as 40 feet per day (Aadland, EC
Gellici, and Thayer 1995). The horizontal hydraulic conductivity for the lower zone of the Upper Three Runs Aquifer is approximately 2.5 to 10 feet per day (Aadland, Gellici, and Thayer EC
1995). The vertical conductivity of the Upper Three Runs Aquifer (upper and lower zones) is generally assumed to be about 1/10th to 1/100th of the horizontal conductivity, based on its lithology and stratified nature. The vertical hydraulic conductivity of the Tan Clay unit is generally taken to be on the order of 5×10^{-3} to 8×10^{-4} feet per day to support groundwater flow modeling calibration (Flach 1994).

Groundwater flow in the Upper Three Runs Aquifer is generally horizontal, but may have a vertically downward component. In the groundwater divide areas generally located between surface water drainages, a component of groundwater flow is downward due to the decreasing hydraulic head with increasing depth. Because the F- and H-Area Tank Farms lie near the groundwater divide, the groundwater flow direction may be toward either Upper Three Runs and its tributaries to the north or Fourmile Branch to the south. In areas along Fourmile Branch, shallow groundwater moves generally in a horizontal direction and deeper groundwater has vertically upward potential to the shallow aquifers. In these areas, hydraulic heads increase with depth. Therefore, along Fourmile Branch, any contaminants in the Upper Three Runs Aquifer are prevented from migrating into deeper aquifers by the prevailing hydraulic gradient and the low permeability of the Tan and Green Clay confining units. To the north of the tank farms, however, the rising elevation of the Upper Three Runs Aquifer and the deep incision of Upper Three Runs Creek result in truncation of the entire aquifer. In these areas, shallow groundwater may seep out along the major tributaries to Upper Three Runs Creek above the valley floor, or may seep downward to the next underlying aquifer zone and discharge along the stream valley.

The Gordon Confining Unit (green clay), which separates the Upper Three Runs and Gordon Aquifers, consists of the Warley Hill Formation and the Blue Bluff Member of the Santee Limestone (Table 3.1-1). It is not a continuous clay unit, but consists of several superimposed lenses of green and gray clay that thicken, thin, and pinch out abruptly. Locally, beds of calcareous mud add to the thickness of the unit, with minor interbeds of clayey sand or sand (Aadland, Gellici, and Thayer 1995). The vertical hydraulic conductivity is generally taken to be on the order of 1×10^{-4} to 1×10^{-5} foot per day to support groundwater flow modeling calibration (Flach 1994).

EC

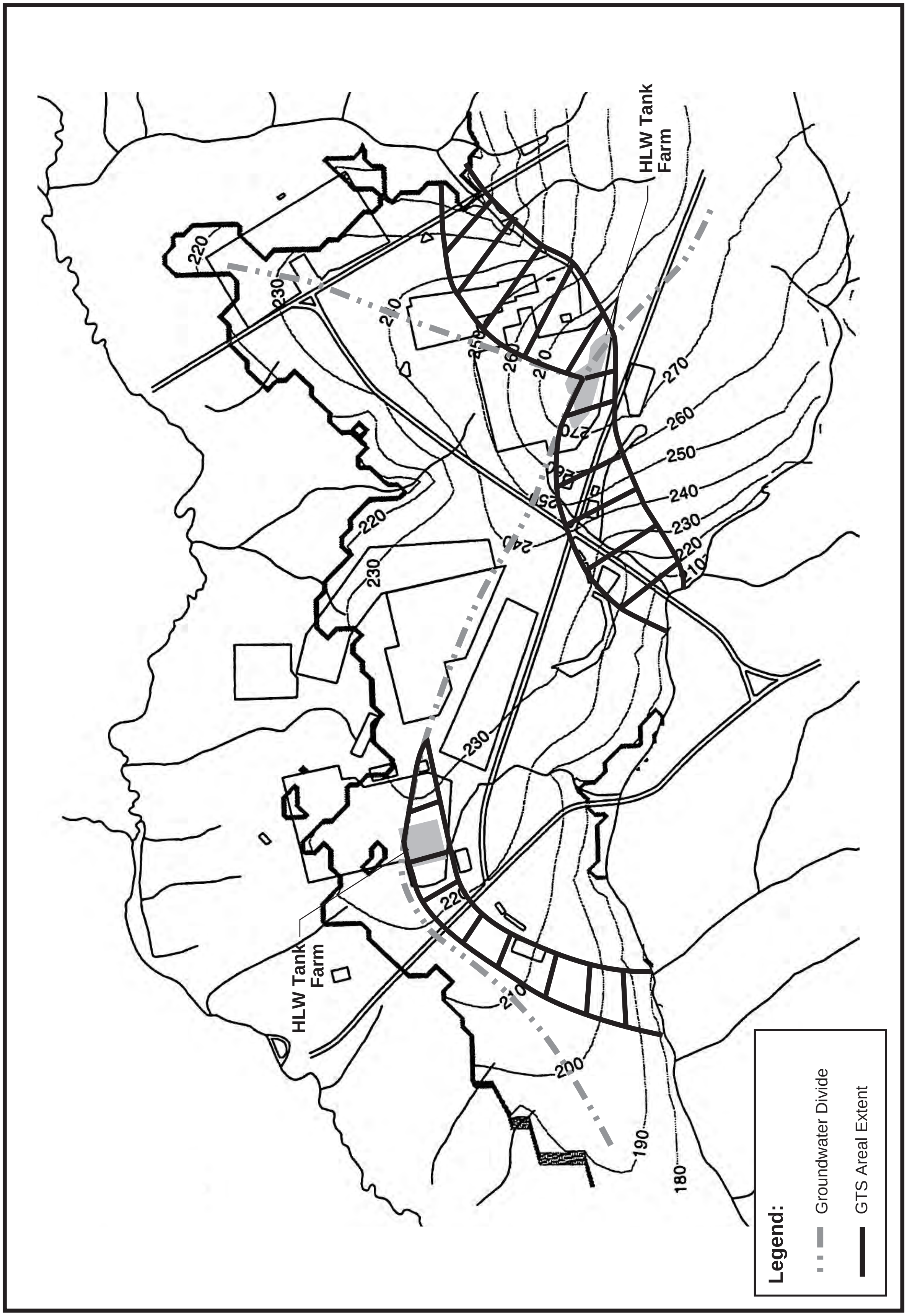
The Gordon Aquifer consists of the Congaree, Fourmile, and Snapp Formations. Table 3.1-1 provides soil descriptions for these formations. The Gordon Aquifer is partially eroded near the Savannah River and along Upper Three Runs. This aquifer is recharged directly by precipitation in the outcrop area, at interstream drainage divides in and near the outcrop area, and by leakage from overlying and underlying aquifers. The southeast-to-northwest hydraulic gradient across SRS is consistent and averages 4.8 feet per mile. The horizontal hydraulic conductivity, ranges between approximately 30 to 40 feet per day (Aadland, Gellici, and Thayer 1995). The vertical hydraulic conductivity is generally assumed to be about 1/10th to 1/100th of the horizontal conductivity, based on its lithology and stratified nature (Flach 1994).

Figures 3.2-2 through 3.2-4 show the approximate groundwater flow paths for F- and H-Area Tank Farms for the Water Table, Barnwell-McBean, and Congaree Aquifers.

3.2.2.4 <u>Groundwater Quality</u>

Industrial solvents, metals, tritium, and other constituents used or generated on SRS have contaminated the shallow aquifers beneath the industrial areas that make up 5 to 10 percent of the Site. In general, DOE does not use these aquifers for SRS process operations or drinking water, although there are a few low-yield wells in the Gordon Aquifer and in the lower zone of the Upper Three Runs Aquifer (formerly known as the McBean and Barnwell-McBean) in remote locations. The shallow aquifer units of the Floridan System discharge to SRS streams and eventually the Savannah River (Arnett and Mamatey 1997).

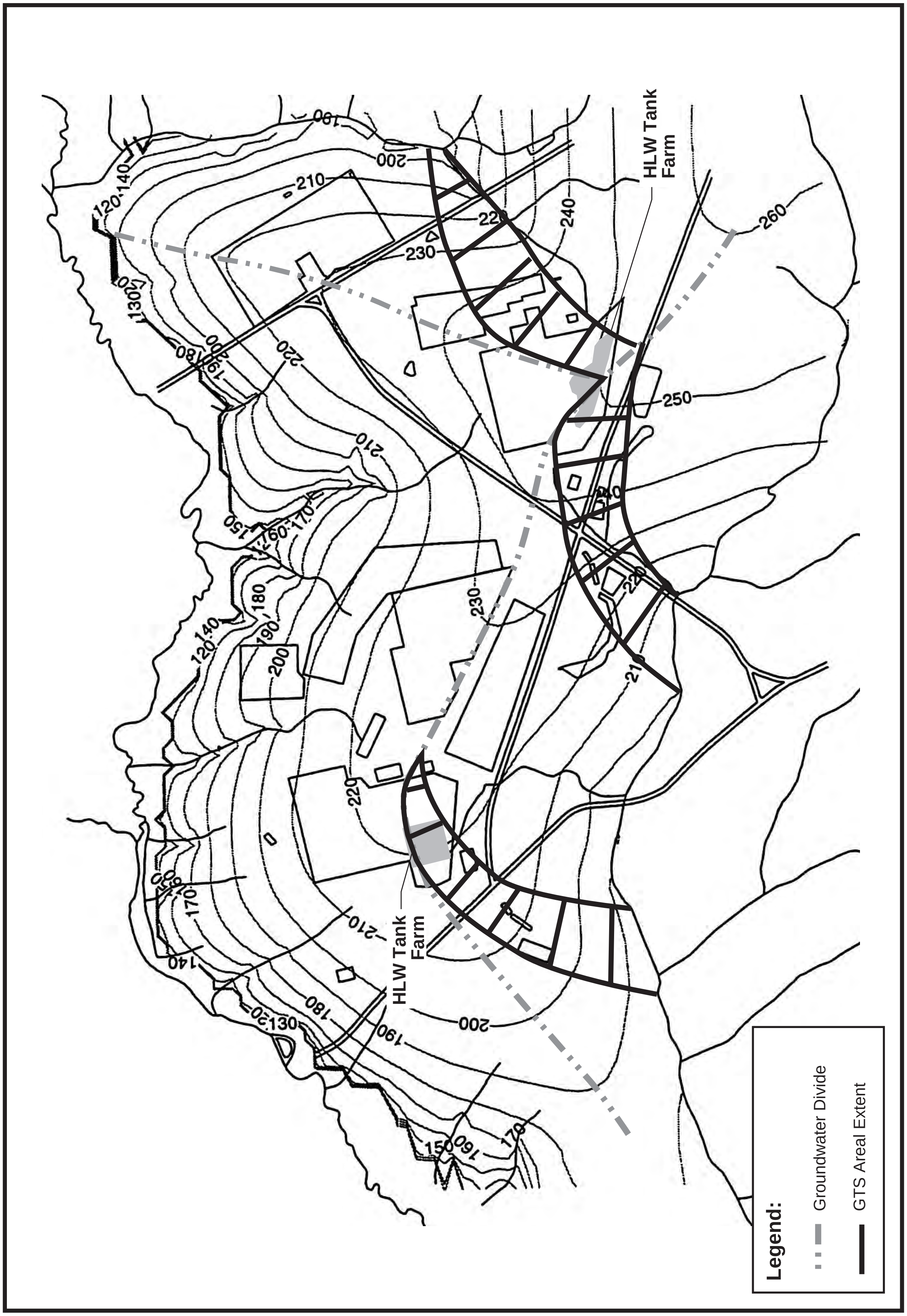
Most contaminated groundwater at SRS occurs beneath the industrial facilities; the contaminants reflect the operations and chemical processes performed at those facilities. In the General Separations Area, contaminants above regulatory and U.S. Department of Energy (DOE) guidelines include tritium and other radionuclides, metals, nitrates, sulfates, and chlorinated and volatile organics. Tables 3.2-3 through 3.2-7 list concentrations of individual analytes above regulatory or SRS guidelines for the period from fourth quarter 1997 through third quarter 1998 for the General Separations Area that includes E, F, H, S, and Z Areas, respectively (WSRC 1997; WSRC 1998a,b,c). EC



NW TANK/Grfx/3.2-2 Water table.ai

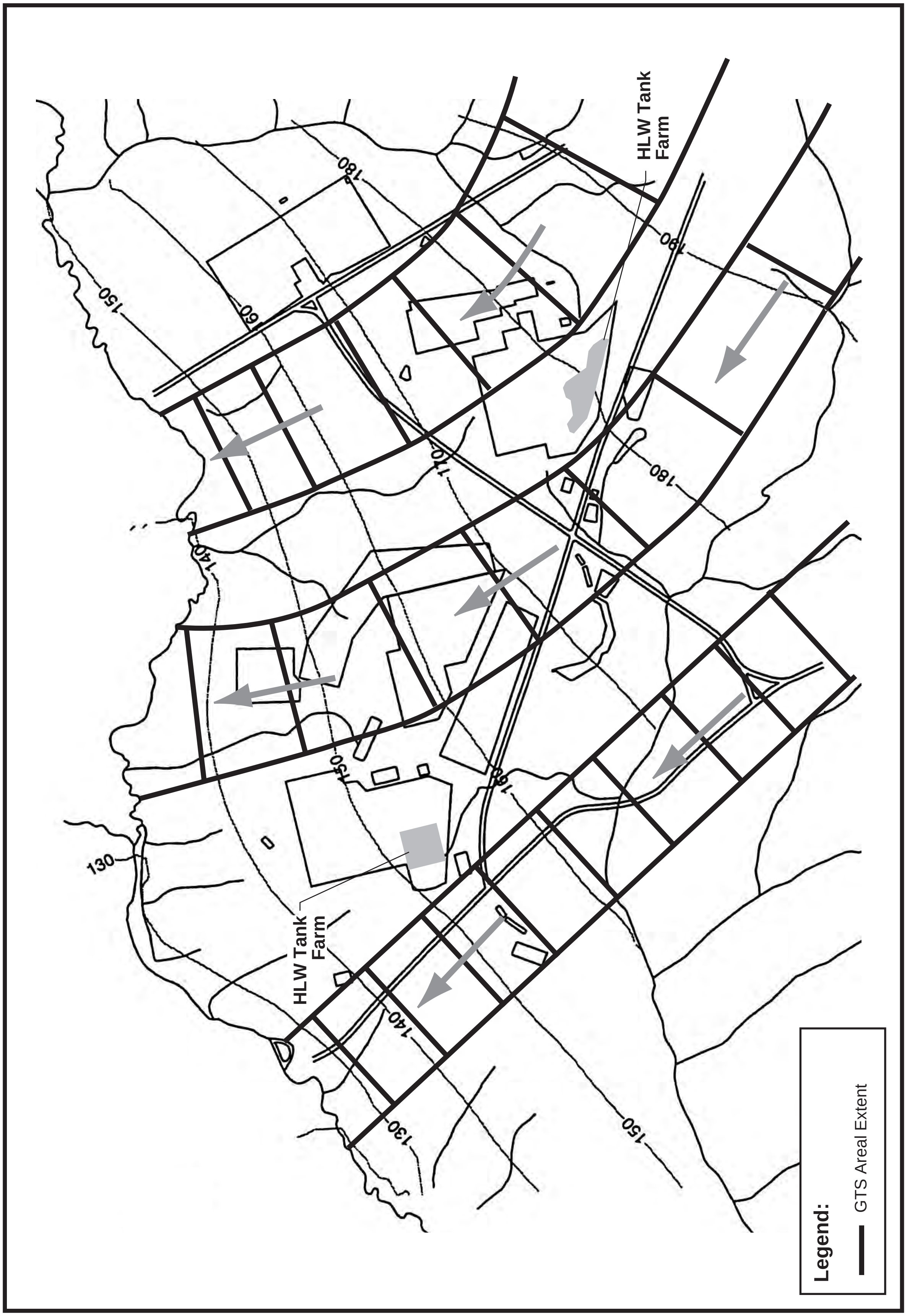
Figure 3.2-2. Calibrated potentiometric surface (ft) for the Water Table aquifer.

EC



NW TANK/Grfx/3.2-3 Barnw-McB.ai

Figure 3.2-3. Calibrated potentiometric surface (ft) for the Barnwell-McBean Aquifer.



NW TANK/Grfx/3.2-4 Congaree.ai

Figure 3.2-4. Calibrated potentiometric surface (ft) for the Congaree Aquifer.

Table 3.2-3. E Area maximum reported groundwater parameters in excess of regulatory and SRS limits.[a]

Analyte	Concentration	Regulatory limit
Aluminum[b]	3,670 µg/L	50 µg/L[c]
Antimony[b]	10.2 µg/L	6.0 µg/L[d]
Bromomethane	20.0 µ/L	20 µg/L[e]
Cadmium[b]	9.48 µg/L	5.0 µg/L[d]
Carbon-14	5.29×10^{-5} µCi/mL	2.0×10^{-6} µCi/mL[f]
Carbon tetrachloride	11.4 µg/L	5.0 µg/L[d]
Chloroethene (vinyl chloride)	24.9 µg/L	2.0 µg/L[d]
Chloroform	163 µg/L	100 µg/L[d]
Chromium[b]	117 µg/L	100 µg/L[d]
1,1-Dichloroethane	60.8 µg/L	5.0 µg/L[e]
1,1-Dichloroethylene	25.6 µg/L	7.0 µg/L[d]
Dichloromethane	150 µg/L	5.0 µg/L[d]
Gross alpha	3.27×10^{-8} µCi/mL	1.5×10^{-8} µCi/mL[d]
Iron[b]	13,500 µg/L	300 µg/L[c]
Lead[b]	116.0 µg/L	50 µg/L[g]
Lithium[b]	1,510 µg/L	250 µg/L[e]
Manganese[b]	309 µg/L	50 µg/L[c]
Mercury[b]	6.67 µg/L	2.0 µg/L[d]
Nickel[b]	134 µg/L	100 µg/L[d]
Nonvolatile beta	1.05×10^{-7} µCi/mL	5.0×10^{-8} µCi/mL[f]
Radium, total alpha-emitting	6.90×10^{-9} µCi/mL	5.0×10^{-9} µCi/mL[f]
Strontium-90	6.44×10^{-8} µCi/mL	8.0×10^{-9} µCi/mL[d]
Tetrachloroethylene	50.2 µg/L	5 µg/L[d]
Thallium[b]	8.30 µg/L	2 µg/L[d]
Total organic halogens	559 µg/L	50 µg/L[e]
Trichloroethylene	1,160 µg/L	5 µg/L[d]
Trichlorofluoromethane	35.1 µg/L	20 µg/L[e]
Tritium	2.96×10^{-1} µCi/mL	2.0×10^{-5} µCi/mL[d]

a. µg/L = micrograms per liter; µCi/mL = microcuries per milliliter.
b. Total recoverable.
c. EPA National Secondary Drinking Water Standards (WSRC 1997; 1998a,b,c). EPA Final Primary Drinking Water Standards (WSRC 1997; 1998a,b,c).
d. Drinking Water Standards do not apply. Criterion 10 times a recently published 90th percentile detection limit was used (WSRC 1997; 1998a,b,c).
e. EPA Interim Final Primary Drinking Water Standard (WSRC 1997, 1998a,b,c).
f. SCDHEC Final Primary Drinking Water Standards (WSRC 1997; 1998a,b,c), Chapter 61-58.6E(7)(d).

Figure 3.2-5 shows generalized groundwater contamination maximum values for analytes at or above regulatory or established SRS guidelines for the areas of concern.

3.3 Air Resources

3.3.1 METEOROLOGY

The southeastern U.S. has a humid, subtropical climate characterized by relatively short, mild winters and long, warm, and humid summers. Summer-like weather typically lasts from May through September, when the area is subject to the persistent presence of the Atlantic subtropical anticyclone (i.e., the "Bermuda" high). The humid conditions often result in scattered afternoon thunderstorms. Average seasonal rainfall is usually lowest during the fall.

Measurable snowfall is rare. Spring is characterized by mild temperatures, relatively

Table 3.2-4. F Area maximum reported groundwater parameters in excess of regulatory and SRS limits.[a]

Analyte	Concentration	Regulatory limit
Aluminum[b]	37,100 µg/L	50 µg/L[c]
Americium-241	5.27×10^{-8} µCi/mL	6.34×10^{-9} µCi/mL[d]
Antimony[b]	27.0 µg/L	6.0 µg/L[e]
Beryllium[b]	16.6 µg/L	4.0 µg/L[e]
Bis (2-ethylhexyl) phthalate	160 µg/L	6 µg/L[e]
Cadmium[b]	36.3 µg/L	5.0 µg/L[e]
Carbon-14	1.97×10^{-5} µCi/mL	2.0×10^{-6} µCi/mL[f]
Cesium-137	2.58×10^{-7} µCi/mL	2.0×10^{-7} µCi/mL[f]
Cobalt[b]	863 µg/L	100 µg/L[g]
Copper[b]	1,530 µg/L	1,000 µg/L[h1]
Curium-243/244	1.08×10^{-7} µCi/mL	8.30×10^{-9} µCi/mL[d]
Dichloromethane	11.3 µg/L	5 µg/L[e]
Gross alpha	2.32×10^{-6} µCi/mL	1.5×10^{-8} µCi/mL[e]
Iodine-129	8.14×10^{-7} µCi/mL	1.0×10^{-9} µCi/mL[f]
Iron[b]	15,200 µg/L	300 µg/L[c]
Lead[b]	548 µg/L	50 µg/L[h2]
Manganese[b]	63.5 µg/L	50 µg/L[c]
Mercury[b]	8.38 µg/L	2.0 µg/L[e]
Nickel[b]	156 µg/L	100 µg/L[e]
Nickel-63	5.58×10^{-8} µCi/mL	5.0×10^{-8} µCi/mL[f]
Nitrate-nitrite as nitrogen	324,000 µg/L	10,000 µg/L[e]
Nonvolatile beta	3.06×10^{-6} µCi/mL	5.0×10^{-8} µCi/mL[f]
Radium-226	1.31×10^{-7} µCi/mL	5.0×10^{-9} µCi/mL[f,i]
Radium-228	6.19×10^{-7} µCi/mL	5.0×10^{-9} µCi/mL[f,i]
Ruthenium-106	5.41×10^{-8} µCi/mL	3.0×10^{-8} µCi/mL[f]
Strontium-89/90	2.46×10^{-5} µCi/mL	8.0×10^{-9} µCi/mL[e]
Strontium-90	9.07×10^{-7} µCi/mL	8.0×10^{-9} µCi/mL[e]
Technicium-99	1.32×10^{-6} µCi/mL	9.0×10^{-7} µCi/mL[f]
Tetrachloroethylene	15.7 µg/L	5 µg/L[e]
Thallium[b]	145 µg/L	2 µg/L[e]
Trichloroethylene	88.3 µg/L	5 µg/L[e]
Trichlorofluoromethane	55.8 µg/L	20µg/L[g]
Tritium	1.55×10^{-2} µCi/mL	2.0×10^{-5} µCi/mL[e]
Uranium-233/234	4.48×10^{-7} µCi/mL	1.38×10^{-8} µCi/mL[d]
Uranium-234	4.71×10^{-7} µCi/mL	1.39×10^{-8} µCi/mL[d]
Uranium-235	3.48×10^{-8} µCi/mL	1.45×10^{-8} µCi/mL[d]
Uranium-238	8.79×10^{-7} µCi/mL	1.46×10^{-8} µCi/mL[d]
Zinc[b]	8,430 µg/L	5,000 µg/L[c]

a. µg/L = micrograms per liter; µCi/mL = microcuries per milliliter.
b. Total recoverable.
c. EPA National Secondary Drinking Water Standards (WSRC 1997, 1998a,b,c).
d. EPA Proposed Primary Drinking Water Standard (WSRC 1997, 1998a,b,c).
e. EPA Final Primary Drinking Water Standards (WSRC 1997, 1998a,b,c).
f. EPA Interim Final Primary Drinking Water Standard (WSRC 1997, 1998a,b,c).
g. Drinking Water Standards do not apply. Criterion 10 times a recently published 90th percentile detection limit was used (WSRC 1997, 1998a,b,c).
h. SCDHEC Final Primary Drinking Water Standards (WSRC 1997, 1998a,b,c) [h1 = Chapter 61-58.5 0(2); h2 = Chapter 61-58.6 F(7)(d)].
i. Radium 226/228 Combined Proposed Maximum Contaminant Level of 5.0×10^{-8} microcuries per milliliter.

Table 3.2-5. H Area maximum reported groundwater parameters in excess of regulatory and SRS limits.[a]

Analyte	Concentration	Regulatory limit
Aluminum[b]	13,000 µg/L	50 µg/L[c]
Bis (2-ethylhexyl) phthalate	142 µg/L	6 µg/L[d]
Dichloromethane	8.45 µg/L	5 µg/L[d]
Gross alpha	9.74×10^{-8} µCi/mL	1.5×10^{-8} µCi/mL[d]
Iodine-129	1.09×10^{-7} µCi/mL	1.0×10^{-9} µCi/mL[e]
Iron[b]	17,100 µg/L	300 µg/L[c]
Lead[b]	417 µg/L	50 µg/L[f]
Manganese[b]	1,650 µg/L	50 µg/L[c]
Mercury[b]	18.5 µg/L	2.0 µg/L[d]
Nickel-63	4.79×10^{-7} µCi/mL	5.0×10^{-8} µCi/mL[e]
Nitrate-nitrite as nitrogen	52,800 µg/L	10,000 µg/L[d]
Nonvolatile beta	3.37×10^{-6} µCi/mL	5.0×10^{-8} µCi/mL[e]
Phorate	2.28 µg/L	1.7 µg/L[g]
Radium-226	6.52×10^{-8} µCi/mL	5.0×10^{-9} µCi/mL[e, h]
Radium-228	6.98×10^{-8} µCi/mL	5.0×10^{-9} µCi/mL[e,h]
Radium, total alpha-emitting	6.70×10^{-9} µCi/mL	5.0×10^{-9} µCi/mL[e]
Ruthenium-106	3.81×10^{-8} µCi/mL	3.0×10^{-8} µCi/mL[e]
Strontium-89/90	1.01×10^{-8} µCi/mL	8.0×10^{-9} µCi/mL[d]
Strontium-90	1.24×10^{-6} µCi/mL	8.0×10^{-9} µCi/mL[d]
Thallium[b]	1,060 µg/L	2 µg/L[d]
Trichloroethylene	14.7 µg/L	5 µg/L[d]
Tetrachloroethylene	12.6 µg/L	5 µg/L[d]
Tritium	1.02×10^{-2} µCi/mL	2.0×10^{-5} µCi/mL[d]
Uranium-233/234	4.28×10^{-8} µCi/mL	1.38×10^{-8} µCi/mL[i]
Uranium-238	4.20×10^{-8} µCi/mL	1.46×10^{-8} µCi/mL[i]
Vanadium[b]	139 µg/L	133 µg/L[g]

a. µg/L = micrograms per liter; µCi/mL = microcuries per milliliter.
b. Total recoverable.
c. EPA National Secondary Drinking Water Standards (WSRC 1997, 1998a,b,c).
d. EPA Final Primary Drinking Water Standards (WSRC 1997, 1998a,b,c).
e. EPA Interim Final Primary Drinking Water Standard (WSRC 1997, 1998a,b,c).
f. SCDHEC Final Primary Drinking Water Standards (WSRC 1997, 1998a,b,c) [Chapter 61-58.6 F(7)(d).
g. Drinking Water Standards do not apply. Criterion 10 times a recently published 90th percentile detection limit was used (WSRC 1997, 1998a,b,c).
h. Radium 226/228 Combined Proposed Maximum Contaminant Level of 5.0×10^{-8} microcuries per milliliter.
i. EPA Proposed Primary Drinking Water Standard (WSRC 1997, 1998a,b,c).

low humidity, and a higher frequency of tornadoes and severe thunderstorms.

3.3.1.1 Local Climatology

Sources of data used to characterize the climatology of SRS consist of a standard instrument shelter in A Area (temperature, humidity, and precipitation for 1961 to 1994), the Central Climatology Meteorological Facility near N Area (temperature, humidity, and precipitation for 1995 to 1996), and seven meteorological towers (winds and atmospheric stability). The average annual temperature at SRS is 64.7 degrees Fahrenheit (°F). July is the warmest month of the year with an average daily maximum of 92°F and an average daily minimum near 72°F; January is the coldest month with an average daily high around 56°F and an average daily low of 36°F. Temperature EC

Table 3.2-6. S Area maximum reported groundwater parameters in excess of regulatory and SRS limits.[a]

Analyte	Concentration	Regulatory limit
Trichloroethylene	49.2 µg/L	5 µg/L[b]

a. µg/L = micrograms per liter; µCi/mL = microcuries per milliliter.
b. EPA Final Primary Drinking Water Standards (WSRC 1997, 1998a,b,c).

Table 3.2-7. Z Area maximum reported groundwater parameters in excess of regulatory and SRS limits.[a]

Analyte	Concentration	Regulatory limit
Gross alpha	9.77×10^{-8} µCi/mL	1.5×10^{-8} µCi/mL[b]
Nonvolatile beta	5.26×10^{-8} µCi/mL	5.0×10^{-8} µCi/mL[c]
Radium-226	7.78×10^{-9} µCi/mL	5.0×10^{-9} µCi/mL[c, d]
Radium-228	8.09×10^{-9} µCi/mL	5.0×10^{-9} µCi/mL[c, d]
Radium, total alpha emitting	5.55×10^{-8} µCi/mL	5.0×10^{-9} µCi/mL[c]
Ruthenium-106	3.08×10^{-8} µCi/mL	3.0×10^{-8} µCi/mL[c]

a. µg/L = micrograms per liter; µCi/mL = microcuries per milliliter.
b. EPA Final Primary Drinking Water Standards (WSRC 1997, 1998a,b,c).
c. EPA Interim Final Primary Drinking Water Standard (WSRC 1997, 1998a,b,c).
d. Radium 226/228 Combined Proposed Maximum Contaminant Level of 5.0×10^{-8} microcuries per milliliter.

extremes recorded at SRS since 1961 range from a maximum of 107°F in July 1986 to -3°F in January 1985.

Annual precipitation averages 49.5 inches. Summer is the wettest season of the year, with an average monthly rainfall of 5.2 inches. Fall is the driest season, with a monthly average rainfall of 3.3 inches. Relative humidity averages 70 percent annually, with an average daily maximum of 91 percent and an average daily minimum of 45 percent.

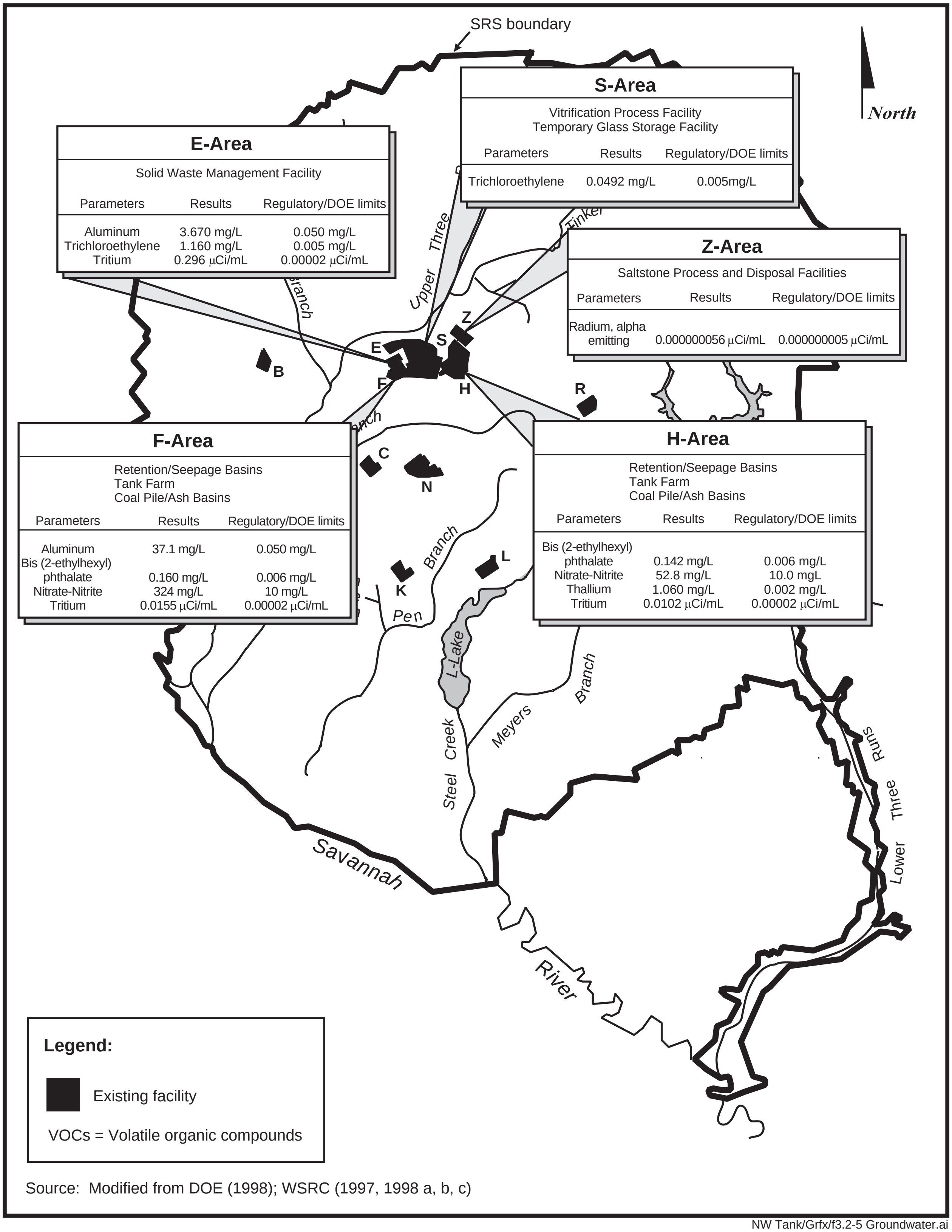
Wind directions frequently observed at SRS show that there is no prevailing wind at SRS, which is typical for the lower Midlands of South Carolina. According to wind data collected from 1992 through 1996, winds are most frequently from the southwest sector (9.7 percent) (Arnett and Mamatey 1998a). Measurements of turbulence are used to determine whether the atmosphere has relatively high, moderate, or low potential to disperse airborne pollutants (commonly identified as unstable, neutral, or stable atmospheric conditions, respectively). Generally, SRS atmospheric conditions were categorized as unstable 56 percent of the time (DOE 1997).

The average wind speed for a measured 5-year period was 8.5 miles per hour. Average hourly wind speeds of less than 4.5 miles per hour occur approximately 10 percent of the time (NOAA 1994).

3.3.1.2 Severe Weather

An average of 54 thunderstorm days per year were observed at the National Weather Service Office in Augusta, Georgia, during the period 1951 to 1995. About half the thunderstorms occurred during the summer. Since operations began at SRS, 10 confirmed tornadoes have occurred on or in close proximity to the Site. Several of these tornadoes, which were estimated to have winds up to 150 miles per hour, did considerable damage to forested areas of SRS. None caused damage to structures. Tornado statistics indicate that the average frequency of a tornado striking any single point on the Site is 2×10^{-4} per year, or about once every 5,000 years (Weber et al. 1998). EC

The highest sustained wind (fastest-mile) recorded at the Augusta National Weather Service Office is 82 miles per hour. Hurricanes



L-13-4

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TC

Figure 3.2-5. Maximum reported groundwater contamination in excess of regulatory/DOE limits at Savannah River Site.

struck South Carolina 36 times during the period from 1700 to 1992, which equates to an average recurrence frequency of once every 8 years. A hurricane-force wind of 75 miles per hour has been observed at SRS only once, during Hurricane Gracie in 1959.

3.3.2 AIR QUALITY

3.3.2.1 <u>Nonradiological Air Quality</u>

The SRS is located in the Augusta-Aiken Interstate Air Quality Control Region (AQCR). All areas within this region are classified as achieving attainment with the National Ambient Air Quality Standards (NAAQS) (40 CFR 50). Ambient air is defined as that portion of the atmosphere, external to buildings, to which the general public has access. The NAAQS define ambient concentration criteria or limits for sulfur dioxide (SO_2), particulate matter equal to or less than 10 microns in aerodynamic diameter (PM_{10}), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and lead (Pb). These pollutants are generally referred to as “criteria pollutants.” The nearest area not in attainment with the NAAQS is Atlanta, Georgia, which is approximately 150 miles west of SRS.

All of the Aiken-Augusta AQCR is designated a Class II area, with respect to the Clean Air Act’s Prevention of Significant Deterioration (PSD) regulations (40 CFR 51.166). The PSD regulations provide a framework for managing the existing clean air resources in areas that meet the NAAQS. Areas designated PSD Class II have sufficient air resources available to support moderate industrial growth. A Class I PSD designation is assigned to areas that are to remain pristine, such as national parks and wildlife refuges. Little additional impact to the existing air quality is allowed with a Class I PSD designation. Industries located within 100 kilometers (62 miles) of Class I Areas are subject to very strict Federal air pollution control standards. There are no Class I areas within 62 miles of SRS. The only Class 1 Area in South Carolina is the Cape Romain National Wildlife Refuge in Charleston County.

The U.S. Environmental Protection Agency (EPA) approved more restrictive ambient standards for ground-level ozone and particulate matter that became effective on September 16, 1997 (62 FR 138). The new primary standard for ground-level ozone is based on an 8-hour averaging interval with a limit of 0.08 parts-per-million (ppm). Monitoring data from 1993 to 1997 indicate that ozone concentrations in the urban areas of Greenville-Spartanburg-Anderson, Columbia-Lexington, Rock Hill, Aiken, and Florence may approach or exceed the new standard. Monitoring data from 1997, 1998, and 1999 will be used to determine compliance with the new ozone standard (SCDHEC 1998).

Based on review of available scientific data on all particulate matter, the EPA determined that fine particulate matter less than 2.5 microns in diameter, or $PM_{2.5}$, present greater health concerns than larger sized particulates. As a result, in addition to keeping the current PM_{10} regulations, EPA issued a daily (24-hour) $PM_{2.5}$ standard of 65 micrograms per cubic meter ($\mu g/m^3$) and an annual limit of 15.0 $\mu g/m^3$. Limited data collected in several rural and urban areas in South Carolina, along with estimates derived from PM_{10} and total suspended particulates (TSP) sampling around the State, indicate that many areas of South Carolina may exceed or have the potential to exceed the new annual standard for $PM_{2.5}$. SCDHEC expects that Aiken County will likely comply with the new standards. States will collect 3 years of monitoring data beginning in 1998 and will make attainment demonstrations beginning in 2002 (SCDHEC 1998).

On May 14, 1999, in response to challenges filed by industry and others, a three-judge panel of the U.S. Court of Appeals for the District of Columbia Circuit issued a split opinion (2 to 1) on the new clean air standards. The Court vacated the new particulate standard and directed EPA to develop a new standard, meanwhile reverting back to the previous PM_{10} standard. The revised ozone standard was not nullified; however, the judges ruled that the standard “cannot be enforced” (EPA 1999). On June 28, 1999, the EPA filed a petition for rehearing key aspects of the case in the U.S. Court of Appeals for the D.C. Circuit. The EPA has asked the U.S. Department of Justice to appeal this decision and take all judicial steps necessary to overturn the decision.

SCDHEC has been delegated authority to implement and enforce requirements of the Clean Air Act for the State of South Carolina. SCDHEC Air Pollution Regulation 62.5, Standard 2, enforces the NAAQS and sets ambient limits for two additional pollutants: TSP and gaseous fluorides (as hydrogen fluoride). The latter is not expected to be emitted as result of tank closure activities and is not included in subsequent discussions. In addition, SCDHEC Standard 8, Section II, Paragraph E) establishes ambient standards for 256 toxic air pollutants.

Significant sources of regulated air pollutants at SRS include coal-fired boilers for steam production, diesel generators, chemical storage tanks, the Defense Waste Processing Facility (DWPF), groundwater air strippers, and various other process facilities. Another source of criteria pollutant emissions at SRS is the prescribed burning of forested areas across the Site by the U.S. Forest Service (Arnett and Mamatey 1998a). Table 3.3-1 shows the actual atmospheric emissions from all SRS sources in 1997.

Prior to 1991, ambient monitoring of SO_2, NO_2, TSP, CO, and O_3 was conducted at five sites across SRS. Because there is no regulatory requirement to conduct air quality monitoring at SRS, all of these stations have been decommissioned. Ambient air quality data collected during 1997 from monitoring stations operated by SCDHEC in Aiken and Barnwell Counties, South Carolina, are summarized in Table 3.3-2. These data indicate that ambient concentrations of the measured criteria pollutants are generally much less than the standards.

SCDHEC also requires dispersion modeling as a means of evaluating local air quality. Periodically, all permitted sources of regulated air emissions at SRS must be modeled to determine estimates of ambient air pollution concentrations at the SRS boundary. (The ambient limits found under Standards 2 and 8 are enforceable at or beyond the Site boundary.) The results are used to demonstrate compliance with ambient standards and to define a baseline from which to assess the impacts of any new or modified sources. Additionally, a Site-wide inventory of air emissions is developed every year as part of an annual emissions inventory required by SCDHEC Regulation 61-62.1, Section III, “Emissions Inventory.” Table 3.3-3 provides a summary of the most recent regulatory compliance modeling for SRS emissions. These calculations were performed with EPA’s Industrial Source Complex (ISC3) air dispersion model (EPA 1995) and Site-wide maximum potential emissions data from the annual air emissions inventory for 1998. Site boundary concentrations for the eight South Carolina ambient air pollutants include background concentrations of these pollutants, as observed at SCDHEC monitoring stations. Background concentrations of toxic/hazardous air pollutants are assumed to be zero. As Table 3.3-3 shows, estimated ambient SRS boundary concentrations are within the ambient standards for all regulated air pollutants emitted at SRS.

3.3.2.2 Radiological Air Quality

In the SRS region, airborne radionuclides originate from natural (i.e., terrestrial and cosmic) sources, worldwide fallout, and SRS operations. DOE maintains a network of 23 air sampling stations on and around SRS to determine concentrations of radioactive particulates and aerosols in the air (Arnett and Mamatey 1999a). Table 3.3-4 lists average and maximum atmospheric concentrations of radioactivity at the SRS boundary and at 25-mile radius monitoring locations during 1998.

DOE provides detailed summaries of radiological releases to the atmosphere from SRS operations, along with resulting concentrations and doses, in a series of annual environmental data reports. Table 3.3-5 lists 1998 radionuclide releases from each major operational group of SRS facilities.

Table 3.3-1. Criteria and toxic/hazardous air pollutant emissions from SRS (1997).[a]

Pollutant	Actual tons/year
Criteria pollutants[b]	
Sulfur dioxide (as SO_x)	490
Total suspended particulates	2,000
Particulate matter (≤10 μm)	1,500
Carbon monoxide	5,200
Ozone (as Volatile Organic Components)	290
Nitrogen dioxide (as NO_x)	430
Lead	0.019
Toxic/Hazardous Air Pollutants [c]	
Benzene	13
Beryllium	0.0013
Mercury	0.039

a. Sources: Mamatey (1999). Based on 1997 annual air emissions inventory from all SRS sources (permitted and unpermitted).
b. Includes an additional pollutant, PM_{10}, regulated under SCDHEC Regulation 61-62.5, Standard 2. Note: gaseous fluoride is also regulated under this standard but is not expected to be emitted as a result of tank closure activities.
c. Pollutants listed only include air toxics of interest to tank closure activities. A complete list of 1997 toxic air pollutant emissions for SRS can be found in Mamatey (1999).

Table 3.3-2. SCDHEC ambient air monitoring data for 1997.[a]

Pollutant	Averaging time	SC Standard (μg/m^3)	Aiken Co. (μg/m^3)	Barnwell Co. (μg/m^3)
Sulfur dioxide (as SO_x)	3-hr[d]	1,300	60	44
	24[d]	365	21	10
	Annual[e]	80	5	3
Total suspended particulates[c]	Annual geometric mean	75	36	--
Particulate matter (≤10 μm)	24-hr[d]	150	45	44
	Annual[e]	50	21	19
Carbon monoxide	1-hr[d]	40,000	5,100 [b]	--
	8-hr[d]	10,000	3,300 [b]	--
Ozone[c]	1-hr	235	200	210
Nitrogen dioxide (as NO_x)	Annual[c]	100	9	8
Lead	Calendar quarterly mean	1.5	0.01	--

a. Source: SCDHEC (1998).
b. Richland County in Columbia, South Carolina (nearest monitoring station to SRS).
c. New standards may be applicable in the future; see discussion in text.
d. Second highest maximum concentration observed.
e. Arithmetic mean of observed concentrations.

Table 3.3-3. SRS baseline air quality for maximum potential emissions and observed ambient concentrations.

Pollutant	Averaging time	SCDHEC ambient standard (μg/m^3)[a]	Estimated SRS baseline concentration (μg/m^3)[b]
Criteria pollutants			
Sulfur dioxide (as SO_x)[c]	3-hr	1,300	1,200
	24-hr	365	350
	Annual	80	34
Total suspended particulates	Annual geometric mean	75	67
Particulate matter (≤10 μm)[d]	24-hr	150	130
	Annual	50	25
Carbon monoxide	1-hr	40,000	10,000
	8-hr	10,000	6,900
Nitrogen Dioxides (as NO_x)[e]	Annual	100	26
Lead	Calendar quarterly mean	1.5	0.03
Ozone	1-hr	235	200[f]
Toxic/hazardous air pollutants			
Benzene	24-hr	150	4.6
Beryllium	24-hr	0.01	0.009
Mercury	24-hr	0.25	0.03

Source: SCDHEC Regulation 61-62.5, Standard 2, "Ambient Air Quality Standards," and Regulation 61-62.5, Standard 8, Section II, Paragraph E, "Toxic Air Pollutants" (SCDHEC 1976).

a. Source: Hunter (1999). Concentration is the sum of Industrial Source Complex (ISC3) modeled air concentrations using the maximum potential emissions from the 1998 air emissions inventory for all SRS sources not exempted by Clean Air Act Title V requirements and observed concentrations from nearby ambient air monitoring stations.

b. Based on emissions for all oxides of sulfur (SO_x).

c. New NAAQS for particulate matter ≤2.5 microns (24-hour limit of 65 μg/m^3 and an annual average limit of 15 μg/m^3) may become enforceable during the life of this project.

d. Based on emissions for all oxides of nitrogen (NO_x).

e. Source: SCDHEC (1998). Observed concentration of ozone at SCDHEC ambient monitoring station for Aiken County. Ambient concentration of ozone from SRS emissions is not available.

f. New NAAQS for ozone (8-hour limit of 0.08 parts per million) may become enforceable during the life of this project.

Atmospheric emissions of radionuclides from DOE facilities are limited under the EPA regulation "National Emission Standards for Hazardous Air Pollutants (NESHAP)," 40 CFR Part 61, Subpart H. The EPA annual effective dose equivalent limit of 10 millirem per year to members of the public for the atmospheric pathway is also incorporated in DOE Order 5400.5, "Radiation Protection of the Public and the Environment." To demonstrate compliance with the NESHAP regulations, DOE annually calculates maximally exposed offsite individual (MEI) and collective doses and a percentage of dose contribution from each radionuclide using
EC the CAP88 computer code. The dose to the MEI from 1998 SRS emissions (Table 3.3-5) was estimated at 0.08 millirem, which is 0.8 percent of the 10-millirem-per-year EPA standard. The population dose was calculated, by pathway and radionuclide, using the POPGASP computer code which is discussed later in this section. The POPGASP collective (population) dose was estimated at 3.5 person-rem. Tritium oxide accounts for 94 and 77 percent of the MEI and the population dose, respectively. Plutonium-239 is the second highest contributor to dose, with 3 percent of both the collective and MEI doses (Arnett and Mamatey 1999b). The contributions to dose from other radionuclides

Table 3.3-4. Radioactivity in air at the SRS boundary and at a 25-mile radius during 1998 (picocuries per cubic meter).[a]

Location	Tritium	Gross alpha	Gross beta	Cobalt-60	Cesium-137	Strontium-89,90	Plutonium-238	Plutonium-239
Site boundary								
Average[b]	11.3	1.4×10^{-3}	0.017	1.3×10^{-3}	2.6×10^{-4}	1.1×10^{-5}	7×10^{-7}	(c)
Maximum[d]	79.6	5.91×10^{-3}	0.061	0.021	0.011	1.1×10^{-4}	4.1×10^{-6}	7.4×10^{-7}
Background (25-mile radius)								
Average	6.7	0.0015	0.019	1.48	2.8×10^{-4}	(c)	(c)	(c)
Maximum	54	0.0036	0.003	0.011	0.0079	5.1×10^{-4}	8.6×10^{-6}	2.9×10^{-6}

a. Source: Arnett and Mamatey (1999b).
b. The average value is the average of the arithmetic means reported for the site perimeter sampling locations.
c. Below background levels.
d. The maximum value is the highest value of the maximum reported for the site perimeter sampling locations.

can be found in *SRS Environmental Data for 1998* (Arnett and Mamatey 1999a).

SRS-specific computer dispersion models such as MAXIGASP and POPGASP (see discussion of these models in Section 4.1.3.2) are also used to calculate radiological doses to members of the public from SRS annual releases. Whereas the CAP88 code assumes that all releases occur from one point (for SRS, at the center of the site), MAXIGASP can model multiple release locations which is truer to actual conditions.

3.4 Ecological Resources

3.4.1 NATURAL COMMUNITIES OF THE SAVANNAH RIVER SITE

The SRS comprises a variety of diverse habitat types that support terrestrial and semi-aquatic wildlife species. These habitat types include upland pine forests, mixed hardwood forests, bottomland hardwood forests, swamp forests, and Carolina bays. Since the early 1950s, the Site has changed from 60 percent forest and 40 percent agriculture to 90 percent forest, with the remainder in aquatic habitats and developed (facility) areas (Halverson et al. 1997). The wildlife correspondingly shifted from forest-farm edge species to a predominance of forest-dwelling species. The SRS now supports 44 species of amphibians, 59 species of reptiles, 255 species of birds, and 54 species of mammals (Halverson et al. 1997). Comprehensive descriptions of the SRS's ecological resources and wildlife can be found in documents such as *SRS Ecology Environmental Information Document* (Halverson et al. 1997) and the *Final Environmental Impact Statement for the Shutdown of the River Water System at the Savannah River Site* (DOE 1997a).

SRS has extensive, widely distributed wetlands, most of which are associated with floodplains, creeks, or impoundments. In addition, approximately 200 Carolina bays occur on SRS (DOE 1995). Carolina bays are unique wetland features of the southeastern United States. They are isolated wetland habitats dispersed throughout the uplands of SRS. The approximately 200 Carolina bays on SRS exhibit extremely variable hydrology and a range of plant communities from herbaceous marsh to forested wetland (DOE 1995).

The Savannah River bounds SRS to the southwest for approximately 20 miles. The river floodplain supports an extensive swamp, covering about 15 square miles of SRS; a natural levee separates the swamp from the river (Halverson et al. 1997).

Timber was cut in the swamp from the turn of the century until 1951, when the Atomic Energy Commission assumed control of the area. At present, the swamp forest is comprised of two

Table 3.3-5. 1998 Radioactive atmospheric releases by source.[a]

Radionuclide	Reactors	Separations[c]	Reactor materials	Heavy water	SRTC[d]	Diffuse and fugitive[e]	Total
	Curies[b]						
Gases and vapors							
H-3(oxide)	2.28×10^{4}	3.45×10^{4}		4.04×10^{2}		9.31×10^{2}	5.86×10^{4}
H-3(elem.)		2.41×10^{4}					2.41×10^{4}
H-3 Total	2.28×10^{4}	5.86×10^{4}		4.04×10^{2}		9.31×10^{2}	8.27×10^{4}
C-14		7.01×10^{-2}				9.68×10^{-5}	7.02×10^{-2}
Kr-85		1.70×10^{4}					1.70×10^{4}
Xe-135		4.95×10^{-2}					4.95×10^{-2}
I-129		1.25×10^{-2}				1.29×10^{-5}	1.25×10^{-2}
I-131		5.92×10^{-5}			8.29×10^{-6}		6.75×10^{-5}
I-133					1.59×10^{-4}		1.59×10^{-4}
Particulates							
Na-22						7.76×10^{-11}	7.76×10^{-11}
Cr-51						1.21×10^{-4}	1.21×10^{-4}
Fe-55						3.90×10^{-4}	3.90×10^{-4}
Co-57						9.40×10^{-11}	9.40×10^{-11}
Co-58						1.27×10^{-4}	1.27×10^{-4}
Co-60					2.65×10^{-7}	1.38×10^{-4}	1.38×10^{-4}
Ni-59						8.33×10^{-13}	8.33×10^{-13}
Ni-63						8.21×10^{-6}	8.21×10^{-6}
Zn-65						2.23×10^{-5}	2.23×10^{-5}
Se-79						1.85×10^{-11}	1.85×10^{-11}
Sr-89,90[F,6]	1.62×10^{-3}	3.22×10^{-4}	5.50×10^{-4}	2.61×10^{-4}	2.66×10^{-5}	2.58×10^{-2}	2.85×10^{-2}
Zr-95						1.71×10^{-5}	1.71×10^{-5}
Nb-95						1.13×10^{-4}	1.13×10^{-4}
Tc-99						2.82×10^{-5}	2.82×10^{-5}
Ru-103						2.26×10^{-5}	2.26×10^{-5}
Ru-106		1.80×10^{-5}				2.26×10^{-5}	3.34×10^{-5}
Sn-126						1.29×10^{-13}	1.29×10^{-13}
Sb-125		1.79×10^{-7}				5.27×10^{-5}	5.29×10^{-5}
Cs-134		2.32×10^{-7}				1.31×10^{-4}	1.31×10^{-4}
Cs-137	3.50×10^{-5}	3.77×10^{-4}			2.30×10^{-6}	4.89×10^{-3}	5.30×10^{-3}
Ce-141						4.16×10^{-5}	4.16×10^{-5}
Ce-144						1.45×10^{-4}	1.45×10^{-4}
Pm-147						9.79×10^{-10}	9.79×10^{-10}
Eu-152						4.19×10^{-8}	4.19×10^{-8}
Eu-154						5.74×10^{-6}	5.74×10^{-6}

Table 3.3-5. (Continued).

Radionuclide	Reactors	Separations[c]	Reactor materials	Heavy water	SRTC[d]	Diffuse and fugitive[e]	Total
Eu-155						1.10×10^{-6}	1.10×10^{-6}
Ra-226						8.64×10^{-6}	8.64×10^{-6}
Ra-228						2.13×10^{-5}	2.13×10^{-5}
Th-228						9.44×10^{-6}	9.44×10^{-6}
Th-230						1.02×10^{-5}	1.02×10^{-5}
Th-232						7.51×10^{-7}	7.51×10^{-7}
Pa-231						1.00×10^{-9}	1.00×10^{-9}
U-232			1.20×10^{-6}				1.20×10^{-6}
U-233						2.35×10^{-6}	2.35×10^{-6}
U-234		2.62×10^{-5}	3.39×10^{-5}			1.83×10^{-5}	7.84×10^{-5}
U-235		1.57×10^{-6}	6.21×10^{-6}			2.10×10^{-6}	9.88×10^{-6}
U-236						2.39×10^{-9}	2.39×10^{-9}
U-238		6.92×10^{-5}	6.32×10^{-5}			5.12×10^{-5}	1.84×10^{-4}
Np-237						1.01×10^{-9}	1.01×10^{-9}
Pu-238		1.15×10^{-4}	4.76×10^{-8}			3.28×10^{-4}	4.43×10^{-4}
Pu-239[h]	2.19×10^{-4}	1.12×10^{-4}	5.09×10^{-5}	2.98×10^{-5}	6.71×10^{-6}	1.41×10^{-3}	1.83×10^{-3}
Pu-240						1.12×10^{-6}	1.12×10^{-6}
Pu-241						6.02×10^{-5}	6.02×10^{-5}
Pu-242						1.59×10^{-7}	1.59×10^{-7}
Am-241		3.31×10^{-5}	2.17×10^{-8}			5.75×10^{-6}	3.89×10^{-5}
Am-243						1.89×10^{-5}	1.89×10^{-5}
Cm-242						1.58×10^{-7}	1.58×10^{-7}
Cm-244		3.67×10^{-6}	4.90×10^{-9}			1.30×10^{-4}	1.34×10^{-4}
Cm-245						2.08×10^{-13}	2.08×10^{-13}
Cm-246						9.37×10^{-7}	9.37×10^{-7}
Cf-249						5.27×10^{-16}	5.27×10^{-16}
Cf-251						2.17×10^{-14}	2.17×10^{-14}

Note: Blank spaces indicate no quantifiable activity.
a. Source: Arnett and Mamatey (1999b).
b. One curie equals 3.7×10^{10} Becquerels.
c. Includes separations, waste management, and tritium facilities.
d. Savannah River Technology Center.
e. Estimated releases from minor unmonitored diffuse and fugitive sources.
f. Includes unidentified beta emissions.
g. Includes SR-89.
h. Includes unidentified alpha emissions.

kinds of forested wetland communities (Halverson et al. 1997). Areas that are slightly elevated and well-drained are characterized by a mixture of oak species (*Quercus nigra*, *Q. laurifolia*, *Q. michauxii*, and *Q. lyrata*), as well as red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), and other hardwood species. Low-lying areas that are continuously flooded are dominated by second-growth bald cypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*).

The aquatic resources of SRS have been the subject of intensive study for more than 30 years. Research has focused on the flora and fauna of the Savannah River, the tributaries of the river that drain SRS, and the artificial impoundments (Par Pond and L-Lake) on two of the tributary systems. Several monographs (Britton and Fuller 1979; Bennett and McFarlane 1983), the eight-volume comprehensive cooling water study (du Pont 1987), and a number of environmental impact statements (EISs) (DOE 1987, 1990, 1997a) describe the aquatic biota (fish and macroinvertebrates) and aquatic systems of SRS. The *SRS Ecology Environmental Information Document* (Halverson et al. 1997) and the *Final Environmental Impact Statement for the Shutdown of the River Water System at the Savannah River Site* (DOE 1997a) review ecological research and monitoring studies conducted in SRS streams and impoundments over several decades.

The SRS was designated as the first National Environmental Research Park by the Atomic Energy Commission in 1972. Especially significant components of the National Environmental Research Park are DOE Research Set-Aside Areas, representative habitats that DOE has preserved for ecological research and that are protected from public intrusion and most Site-related activities. Set-Aside Areas protect major plant communities and habitats indigenous to the SRS, preserve habitats for endangered species, and also serve as controls against which to measure potential environmental impacts of SRS operations. These ecological Set-Aside Areas total 14,005 acres, approximately 7 percent of the Site's total area. Descriptions of the 30 tracts that have been set aside to date can be found in Davis and Janacek (1997).

Under the Endangered Species Act of 1973, the Federal government provides protection to six species that occur on the SRS: American alligator (*Alligator mississippiensis*, threatened due to similarity of appearance to the endangered American crocodile); shortnose sturgeon (*Acipenser brevirostrum*, endangered); bald eagle (*Haliaeetus leucocephalus*, threatened); wood stork (*Mycteria americana*, endangered); red-cockaded woodpecker (*Picoides borealis*, endangered); and smooth purple coneflower (*Echinacea laevigata*, endangered) (SRFS 1994; Halverson et al. 1997). None of these species is known to occur on or near the F- and H-Area Tank Farms, which are intensively developed industrial areas surrounded by roads, parking lots, construction shops, and construction laydown areas and are continually exposed to high levels of human disturbance.

3.4.2 ECOLOGICAL COMMUNITIES POTENTIALLY AFFECTED BY TANK FARM CLOSURE ACTIVITIES

F- and H-Area Biota

The F- and H-Area Tank Farms are located within a densely developed, industrialized area of SRS. The immediate area provides habitat for only those animal species typically classified as urban wildlife (Mayer and Wike 1997). Species commonly encountered in this type of urban landscape include the Southern toad, green anole, rat snake, rock dove, European starling, house mouse, opossum, and feral cats and dogs (Mayer and Wike 1997). Lawns and landscaped areas within F and H Areas also provide some marginal terrestrial wildlife habitat. A number of ground-foraging bird species (e.g., American robin, killdeer, and mourning dove) and small mammals (e.g., cotton mouse, cotton rat, and Eastern cottontail) that use lawns and landscaped areas around buildings may be present at certain times of the year, depending on the level of human activity (e.g., frequency of mowing) (Mayer and Wike 1997). Pine plantations managed for timber production by the U.S. Forest Service (under an interagency agreement with DOE) occupy surrounding areas (DOE 1994).

Wildlife characteristically found in SRS pine plantations include toads (i.e., the southern toad), lizards (e.g., the eastern fence lizard), snakes (e.g., the black racer), songbirds (e.g., the brown-headed nuthatch, and the pine warbler), birds of prey (e.g., the sharp-shinned hawk), and a number of mammal species (e.g., the cotton mouse), the gray squirrel, the opossum, and the white-tailed deer) (Sprunt and Chamberlain 1970; Cothran et al. 1991; Gibbons and Semlitsch 1991; Halverson et al. 1997).

Several populations of rare plants have been found in undeveloped areas adjacent to F and H Areas. One population of Nestronia *(Nestronia umbellula)* and three populations of Oconee azalea (*Rhododendron flammeum*) were located on the steep slopes adjacent to the Upper Three Runs floodplain approximately one mile north of the F-Area Tank Farm (DOE 1995: SRFS 1999). Populations of two additional rare plants, Elliott's croton (*Croton elliotti*) and spathulate seedbox (*Ludwigia spathulata*) were found in the pine forest southeast of H Area, approximately one-half mile from the H-Area Tank Farm (SRFS 1999).

Seeplines and Associated Riparian Communities

As mentioned in Section 3.2, F and H Areas are on a near-surface groundwater divide, and groundwater from these areas discharges at seeplines adjacent to Upper Three Runs and Fourmile Branch. The biota associated with the seepage areas are discussed in the following paragraphs.

The Fourmile Branch seepline area is located in a bottomland hardwood forest community (DOE 1997b). The canopy layer of this bottomland forest is dominated by sweetgum (*Liquidambar styraciflua)*, red maple (*Acer rubrum*), and red bay (*Persea borbonia*). Sweet bay (*Magnolia virginiana)* is also common. The understory consists largely of saplings of these same species, as well as a herbaceous layer of greenbrier (*Smilax* sp), dog hobble (*Leucothoe axillaris*), giant cane (*Arundinaria gigantea*), poison ivy (*Rhus radicans*), chain fern (*Woodwardia virginica*), and hepatica (*Hepatica americana*). At the seepline's upland edge, scattered American holly and white oak occur. Upslope of the seepline area is an upland pine/hardwood forest. Tag alder (*Alnus serrulata*), willow (*Salix nigra)*, sweetgum, and wax myrtle (*Myrica cerifera)* are found along the margins of the Fourmile Branch in this area. The Upper Three Runs seepline is located in a similar bottomland hardwood forest community (DOE 1997b).

The floodplains of both streams in the general vicinity of the seeplines provide habitat for a variety of aquatic, semi-aquatic, and terrestrial animals including amphibians (e.g., leopard frogs), reptiles (e.g., box turtles), songbirds (e.g., wood warblers), birds of prey (e.g., barred owls), semi-aquatic mammals (e.g., beaver), and terrestrial mammals (white-tailed deer). For detailed lists of species known or expected to occur in the riparian forests and wetlands of SRS, see Gibbons et al. (1986), duPont (1987), Cothran et al. (1991), DOE (1997a), and Halverson et al. (1997).

No endangered or threatened fish or wildlife species have been recorded near the Upper Three Runs and Fourmile Branch seeplines. The seeplines and associated bottomland community do not provide habitat favored by endangered or threatened fish and wildlife species known to occur at SRS. The American alligator is the only Federally protected species that could potentially occur in the area of the seeplines. Fourmile Branch does support a small population of American alligator in its lower reaches, where the stream enters the Savannah River swamp (Halverson et al. 1997). Alligators have been infrequently observed in man-made waterbodies (e.g., stormwater retention basins) in the vicinity of H Area (Mayer and Wike 1997).

Aquatic Communities Downstream of F and H Areas

Upper Three Runs

According to summaries of studies on Upper Three Runs documented in the *SRS Ecology Environmental Information Document* (Halverson et al. 1997), the macroinvertebrate communities of Upper Three Runs are characterized by unusually high measures of taxa richness and diversity. Upper Three Runs is a spring-fed stream and is colder and generally clearer than most streams in the upper Coastal Plain. As a result, species normally found in the Northern U.S. and southern Appalachians are found here along with endemic lowland (Atlantic Coastal Plain) species (Halverson et al. 1997).

A study conducted from 1976 to 1977 identified 551 species of aquatic insects within this stream system, including a number of species and genera new to science (Halverson et al. 1997). A 1993 study found more than 650 species in Upper Three Runs, including more than 100 caddisfly species. Although no threatened or endangered species have been found in Upper Three Runs, there are several environmentally sensitive species. Davis and Mulvey (Halverson et al. 1997) identified a rare clam species (*Elliptio hepatica*) in this drainage. Also, in 1997 the U.S. Fish and Wildlife Service listed the American sand-burrowing mayfly (*Dolania americana*), a mayfly relatively common in Upper Three Runs, as a species of special concern. Between 1987 and 1991, the density and variety of insects collected from Upper Three Runs decreased for unknown reasons. More recent data, however, indicate that insect communities are recovering (Halverson et al. 1997).

The fish community of Upper Three Runs is typical of third- and higher-order streams on SRS that have not been greatly affected by industrial operations, with shiners and sunfish dominating collections. The smaller tributaries to Upper Three Runs are dominated by shiners and other small-bodied species (i.e., pirate perch, madtoms, and darters) indicative of unimpacted streams in the Atlantic Coastal Plain (Halverson et al. 1997). In the 1970s, the U.S. Geological Service designated Upper Three Runs as a National Hydrological Benchmark Stream, due to its high water quality and rich fauna. However, this designation was rescinded in 1992, due to increased development of the Upper Three Runs watershed north of the SRS (Halverson et al. 1997).

Fourmile Branch

Until C-Reactor was shut down in 1985, the distribution and abundance of aquatic biota in Fourmile Branch were strongly influenced by reactor operations (high water temperatures and flows downstream of the reactor discharge). Following the shutdown of C-Reactor, macroinvertebrate communities began to recover and, in some reaches of the stream, began to resemble those in nonthermal and unimpacted streams of the SRS (Halverson et al. 1997). Surveys of macroinvertebrates in more recent years showed that some reaches of Fourmile Branch had healthy macroinvertebrate communities (high measures of taxa richness) while others had depauperate macroinvertebrate communities (low measures of diversity or communities dominated by pollution-tolerant forms). Differences appeared to be related to variations in dissolved oxygen levels in different portions of the stream. In general, macroinvertebrate communities of Fourmile Branch show more diversity (taxa richness) in downstream reaches than upstream reaches (Halverson et al. 1997).

Studies of fish populations in Fourmile Branch conducted in the 1980s, when C-Reactor was operating, revealed that very few fish were present downstream of the reactor outfall (Halverson et al. 1997). Water temperatures exceeded 140°F at the point where the discharge entered Fourmile Branch and were as high as 100°F where the stream flowed into the Savannah River Swamp, approximately 10 miles downstream. Following the shutdown of C-Reactor in 1985, Fourmile Branch was rapidly recolonized by fish from the Savannah River swamp system. Centrarchids (sunfish) and cyprinids (minnows) were the most common taxa.

To assess potential impacts of groundwater outcropping to Fourmile Branch, Westinghouse Savannah River Company in 1990 surveyed fish populations in Fourmile Branch up- and downstream of F- and H-Area seepage basins (Halverson et al. 1997). Upstream stations were dominated by pirate perch, creek chubsucker, yellow bullhead, and several sunfish species (redbreast sunfish, dollar sunfish, spotted sunfish). Downstream stations were dominated by shiners (yellowfin shiner, dusky shiner, and taillight shiner) and sunfish (redbreast sunfish and spotted sunfish), with pirate perch and creek chubsucker present, but in lower numbers. Differences in species composition were believed to be due to habitat differences rather than the effect of contaminants in groundwater.

Savannah River

An extensive information base is available regarding the aquatic ecology of the Savannah River in the vicinity of SRS. The most recent water quality data available from environmental monitoring conducted on the river in the vicinity of SRS and its downstream reaches can be found in *Savannah River Site Environmental Data for 1998* (Arnett and Mamatey 1999b). These data demonstrate that the Savannah River is not adversely impacted by SRS wastewater discharges to its tributary streams. A full description of the ecology of the Savannah River in the vicinity of SRS can be found in the *SRS Ecology Environmental Information Document* (Halverson et al. 1997), the *Final Environmental Impact Statement for the Shutdown of the River Water System at the Savannah River Site* (DOE 1997a), and the EIS for *Accelerator Production of Tritium at the Savannah River Site* (DOE 1997c).

3.5 Land Use

The SRS is in west-central South Carolina (Figure 3.1-1), approximately 100 miles from the Atlantic Coast. The major physical feature at SRS is the Savannah River, about 20 miles of which serve as the southwestern boundary of the Site and the South Carolina-Georgia border. The SRS includes portions of Aiken, Barnwell, and Allendale Counties in South Carolina.

The SRS occupies an almost circular area of approximately 300 square miles or 192,000 acres and contains production, service, and research and development areas (Figure 3.2-1). The production facilities occupy less than 10 percent of the SRS; the remainder of the site is undeveloped forest or wetlands (DOE 1997).

The site is a significant large-scale facility available for wildlife management and research activities. SRS is a desirable location for landscape scale studies and externally funded studies conducted as a part of DOE’s National Environmental Research Park. Public use of the Site's natural resources is presently limited to controlled hunts and to various science literacy programs encompassing elementary through graduate school levels.

The F and H Areas, of which the tank farms are a part, are in the north-central portion of the SRS, bounded by Upper Three Runs to the north and Fourmile Branch to the South. The F Area occupies about 364 acres, while the H Area occupies 395 acres (DOE 1997). Land within a 5-mile radius of these areas lies entirely within the SRS boundaries and is used for either industrial purposes or as forested land (DOE 1997).

In March 1998, the *Savannah River Future Use Plan* (DOE 1998a) was formally issued. It was developed in partnership with all major Site contractors, support agencies, and DOE Headquarters counterparts, with the input of stakeholders, and defines the future use for the Site. The Plan states as policy the following important points: (1) SRS boundaries shall remain unchanged, and the land shall remain under the ownership of the Federal government, consistent with the Site’s designation as a National Environmental Research Park; (2) residential uses of all SRS land shall be prohibited; and (3) an Integral Site Model that incorporates three planning zones (industrial, industrial support, and restricted public uses) will be utilized. The land around the F and

H Areas (i.e., between Upper Three Runs and Fourmile Branch) will be considered in the industrial use category (DOE 1998b). Consequently, DOE's plan is to continue active institutional control for those areas as long as necessary to protect the public and the environment (DOE 1998b). For purposes of analysis, however, DOE assumes institutional control for the next 100 years. After that, the area would be zoned as industrial for an indefinite period, with deed restrictions on the use of groundwater. This was the basis for the analysis in the *Industrial Wastewater Closure Plan for F- and H- Area High-Level Waste Tank Systems* (DOE 1997).

3.6 Socioeconomics and Environmental Justice

This section describes the economic and demographic baseline for the area around SRS. The purpose of this information is to assist in understanding the potential impacts that high-level waste tank closure could have on population and employment income and to identify any potential disproportionately high and adverse impacts the actions could have on minority and low-income populations.

3.6.1 SOCIOECONOMICS

The socioeconomic region of influence for the proposed action is a six-County area around the SRS where the majority of Site workers reside and where socioeconomic impacts are most likely to occur. The six Counties are Aiken, Allendale, Barnwell, and Bamberg in South Carolina, and Columbia and Richmond in Georgia. *Socioeconomic Characteristics of Selected Counties and Communities Adjacent to the Savannah River Site* (HNUS 1997) contains details on the region of influence, as well as most of the information discussed in this section. The study includes full discussions of regional fiscal conditions, housing, community services and infrastructure, social services and institutions, and educational services. This section will, however, focus on population and employment estimates that have been updated to reflect the most recently available data.

Population

Based on State and Federal agency surveys and trends, the estimated 1998 population that lives in the region of influence was 466,222. About 90 percent lived in the following counties: Aiken (29 percent), Columbia (20 percent), and Richmond (41 percent). The population in the region grew at an annual growth rate of about 6.5 percent between 1990 and 1998 (U.S. Bureau of the Census 1999). Columbia County, and to a lesser extent Aiken County, contributed to most of the growth, due to inmigration from other region of influence counties and states. Over the same period, Bamberg and Barnwell Counties experienced net outmigration.

Population projections indicate that the overall population in the region should continue to grow less than 1 percent until about 2040, except Columbia County, which could experience 2 to 3 percent annual growth. Table 3.6-1 presents projections by county through 2040.

Based on the most recent information available (1992), the estimated median age of the population in the region was 31.8 years, somewhat higher than 1980, when the estimated median age was 28. Median ages in the region are generally lower than those of the nation and the two States. The region had slightly higher percentages of persons in younger age groups (under 5 and 5 to 19) than the U.S., while for all other age groups, the region was comparable to U.S. percentages. The only exception to this was Columbia County, with only 6 percent of its population 65 years or older, while the other counties and the U.S. were 10 percent or greater in this age group. The proportion of persons younger than 20 is expected to decrease, while the proportion of persons older than 64 is expected to increase (DOE 1997).

Employment

In 1994, the latest year consistently developed information is available for all counties in the region of influence, the total civilian labor force for the region of influence was 206,518, with 6.9 percent unemployment. The unemployment rate for the U.S. for the same period was 6.1 percent.

Table 3.6-1. Population projections and percent of region of influence.[a]

Jurisdiction	2000 Population	2000 % ROI	2010 Population	2010 % ROI	2020 Population	2020 % ROI
South Carolina						
Aiken County	135,126	28.7	143,774	27.9	152,975	26.9
Allendale County	11,255	2.4	11,514	2.2	11,778	2.1
Bamberg County	16,366	3.5	17,528	3.4	18,773	3.3
Barnwell County	21,897	4.6	23,517	4.6	25,257	4.5
Georgia						
Columbia County	97,608	20.7	120,448	23.3	148,633	26.9
Richmond County	189,040	40.1	199,059	38.6	209,609	37.0
Six-county total	471,292	100	515,840	100	567,025	100

Jurisdiction	2030 Population	2030 % ROI	2040 Population	2040 % ROI
South Carolina				
Aiken County	162,766	26.0	173,182	24.9
Allendale County	12,049	1.9	12,326	1.8
Bamberg County	20,106	3.2	21,533	3.1
Barnwell County	27,126	4.5	29,134	4.2
Georgia				
Columbia County	184,413	29.4	226,332	32.6
Richmond County	220,718	35.2	232,417	33.4
Six-county total	627,178	100	694,924	100

EC a. Source: Scaled from HNUS (1997) and U.S. Bureau of the Census (1999).
ROI = region of influence.

For the Augusta-Aiken Metropolitan Statistical Area, which does not exactly coincide with the counties in the region of influence, the 1996 labor force totaled 202,400, with an unemployment rate of 6.7 percent. The most recent unemployment rate for the Augusta-Aiken Metropolitan Statistical Area issued for February 1999 was 5.0 percent.

In 1994, total employment according to Standard Industrial Code sectors ranged from 479 workers in the mining sector (e.g., clay and gravel pits) to 58,415 workers in the services sector (e.g., health care and education). Average per capita personal income in 1993 (adjusted to 1995 dollars) was $18,867, in comparison to the U.S. figure of $21,937.

Based on a detailed workforce survey completed in the fall of 1995, the SRS had 16,625 workers (including contractors, permanent and temporary workers, and persons affiliated with Federal agencies and universities who work on the Site) with a total payroll of slightly over $634 million. In September 1997, DOE had reduced the total workforce to 15,112 (DOE 1998).

3.6.2 ENVIRONMENTAL JUSTICE

DOE completed an analysis of the economic and racial characteristics of the population in areas affected by SRS operations for the *Interim Management of Nuclear Materials Environmental Impact Statement* (DOE 1995). That EIS evaluated whether minority or low-income communities could receive disproportionately high and adverse human health and environmental impacts from the alternatives included in that EIS. EC Geographically, it examined the population within a 50-mile radius of the SRS, plus areas downstream of the Site that withdraw drinking water from the Savannah River. The area encompasses a total of 147 census tracts, resulting in a total potentially affected population of 993,667. Of that population, 618,000 (62 percent) are white. In the minority population, approximately 94 percent are African American; the remainder consists of small percentages of Asian, Hispanic, and Native American persons (see Table 3.6-2).

It should be noted that the *Interim Management of Nuclear Materials EIS* used data on minority and low-income populations from the 1990 census. Although the U.S. Bureau of the Census publishes county- and state-level population estimates and projections in odd (inter-census) years, census-tract-level statistics on minority and low-income populations are only collected for decennnial censuses. EC EC

The analysis determined that, of the 147 census tracts in the combined region, 80 contain populations of 50 percent or more minorities. An additional 50 tracts contain between 35 and 50 percent minorities. These tracts are well distributed throughout the region, although there are more toward the south and in the immediate vicinities of Augusta and Savannah (see Figure 3.6-1).

Low-income communities (25 percent or more of the population living in poverty [i.e., income of $8,076 for a family of two]) occur in 72 census tracts distributed throughout the region of influence, but primarily to the south and west of SRS (see Figure 3.6-2.). This represents more than 169,000 persons, or about 17 percent of the total population (see Table 3.6-3).

3.7 Cultural Resources

Through a cooperative agreement, DOE and the South Carolina Institute of Archaeology and Anthropology of the University of South Carolina conduct the Savannah River Archaeological Research Program to provide the services required by Federal law for the protection and management of archaeological resources. Ongoing research programs work in conjunction with the South Carolina State Historic Preservation Office. They provide theoretical, methodological, and empirical bases for assessing site significance, using the compliance process specified by law. Archaeological investigations usually begin through the Site Use Program, which requires a permit for clearing land on SRS.

The archaeological research has provided considerable information about the distribution and content of archaeological and historic sites on SRS. Savannah River archaeologists have examined SRS land since 1974. To date they have examined 60 percent of the 300-square-mile area and recorded more than 1,200 archaeological sites (HNUS 1997). Most (approximately 75 percent) of these sites are prehistoric. To facilitate the management of these resources, SRS is divided into three archaeological zones based upon an area's potential for containing sites of historical or archaeological significance (DOE 1995). Zone 1 represents areas with the greatest potential for having significant resources, Zone 2 areas possess sites with moderate potential, and Zone 3 has areas of low archaeological significance. EC

Table 3.6-2. General racial characteristics of population in the Savannah River Site region of influence.[a]

State	Total population	Total White	Total Minority	African-American	Hispanic	Asian	Native American	Other	Percent minorities
South Carolina ROI	418,685	267,639	151,046	144,147	3,899	1,734	911	355	36.1%
Georgia ROI	574,982	350,233	224,749	208,017	7,245	7,463	1,546	478	39.1%
Total	993,667	617,872	375,795	352,164	11,144	9,197	2,457	833	37.8%

a. Source: DOE (1995).
OI = region of influence.

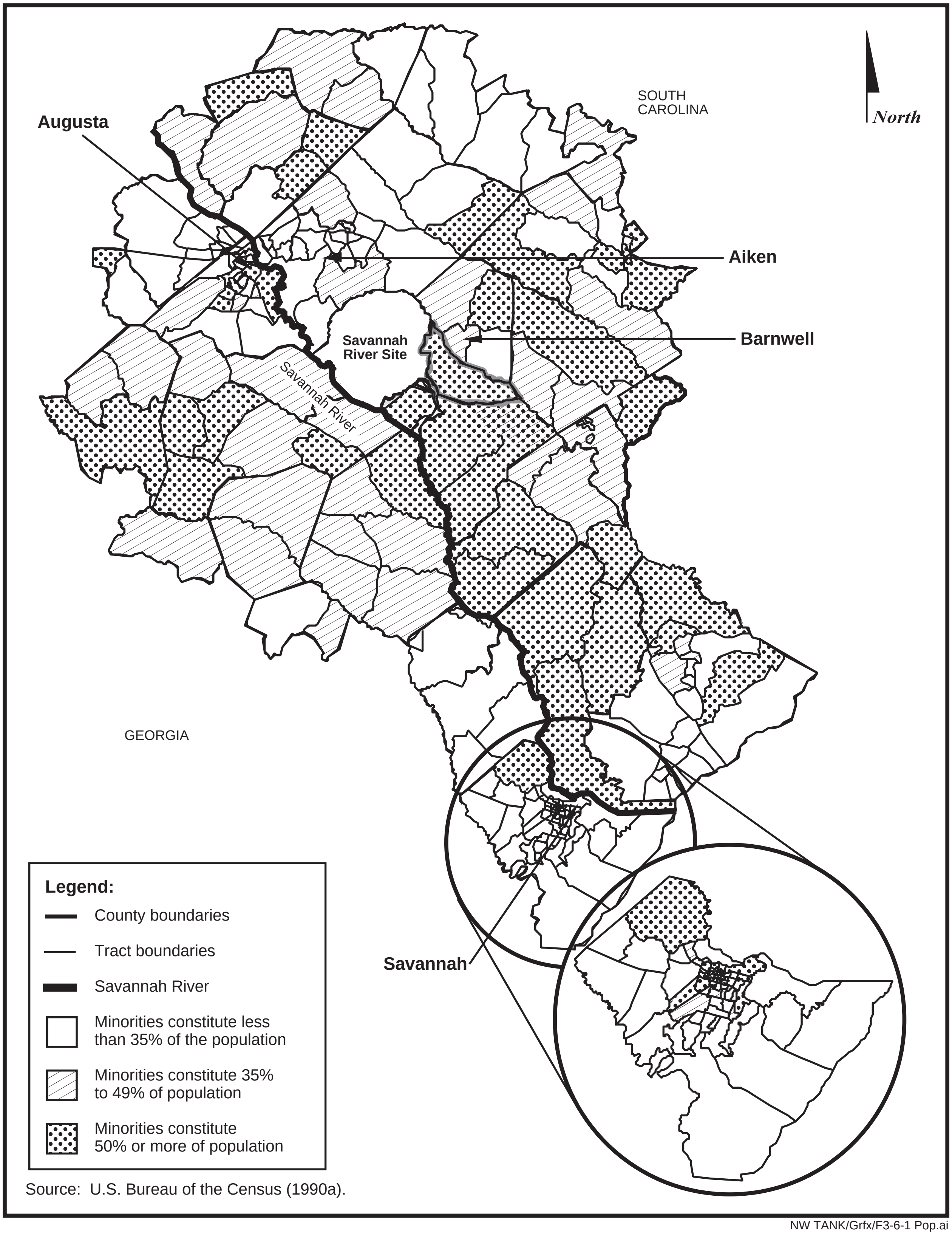

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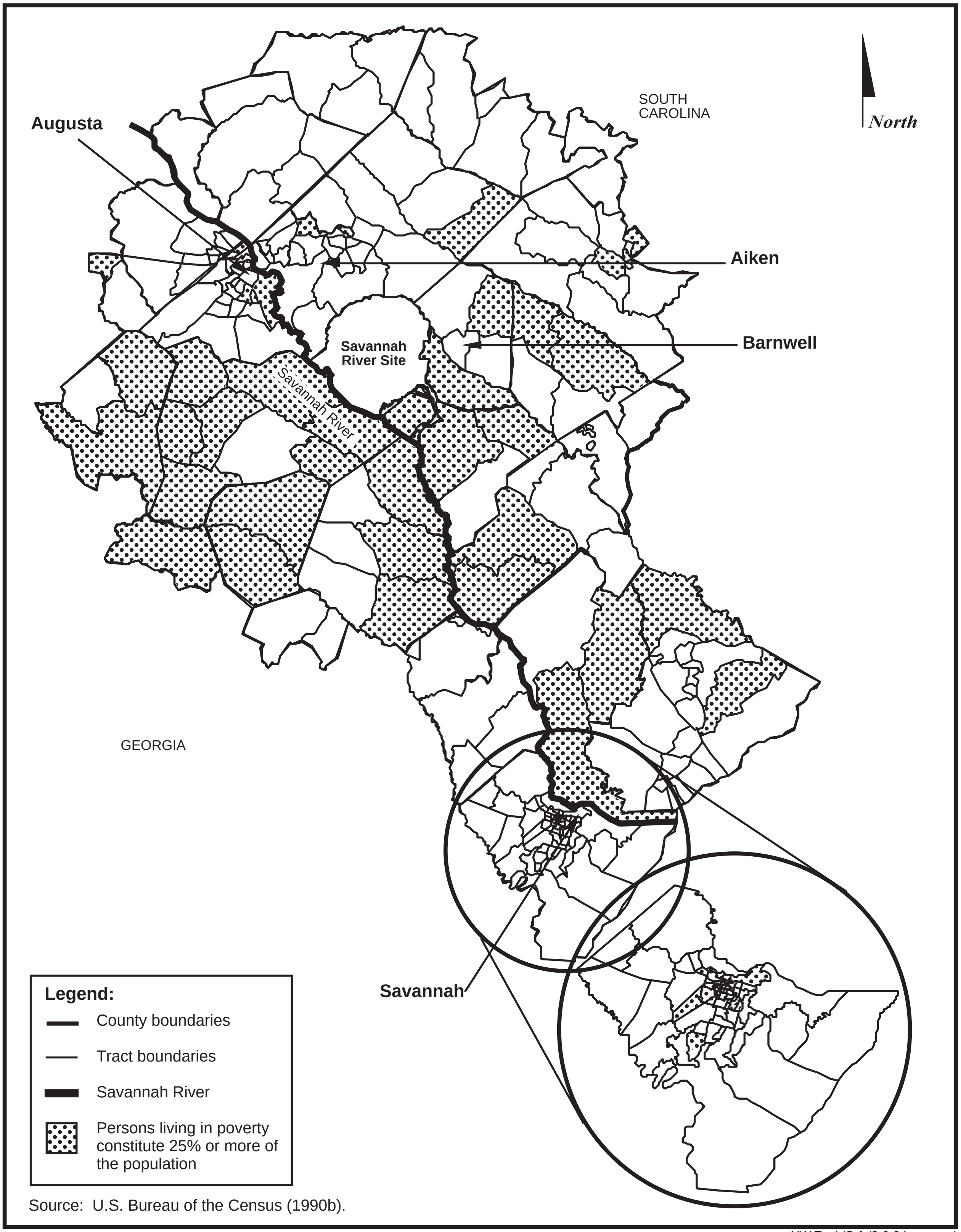
Figure 3.6-1. Distribution of minority population by census tracts in the SRS region of analysis.



NW Tank/Grfx/3-6-2 Income.ai

Figure 3.6-2. Low income census tracts in the SRS region of analysis.

TC

Table 3.6-3. General poverty characteristics of population in the Savannah River Site region of interest.

Area	Total population	Persons living in poverty[a]	Percent living in poverty
South Carolina	418,685	72,345	17.3%
Georgia	574,982	96,672	16.8%
Total	993,667	169,017	17.0%

a. Families with income less than the statistical poverty threshold, which in 1990 was 1989 income of $8,076 for a family of two [U.S Bureau of the Census (1990b)].

Studies of F and H Areas in a previous EIS (DOE 1994) noted that activities associated with the construction of F and H Areas during the 1950s could have destroyed historic and archaeological resources present in this area. As mentioned in Chapter 2, F and H Areas are heavily industrialized sites. They are surrounded by Zone 2 and Zone 3 lands outside of the facilities' secure parameters.

3.8 Public and Worker Health

3.8.1 PUBLIC RADIOLOGICAL HEALTH

Because there are many sources of radiation in the human environment, evaluations of radioactive releases from nuclear facilities must consider all ionizing radiation to which people are routinely exposed.

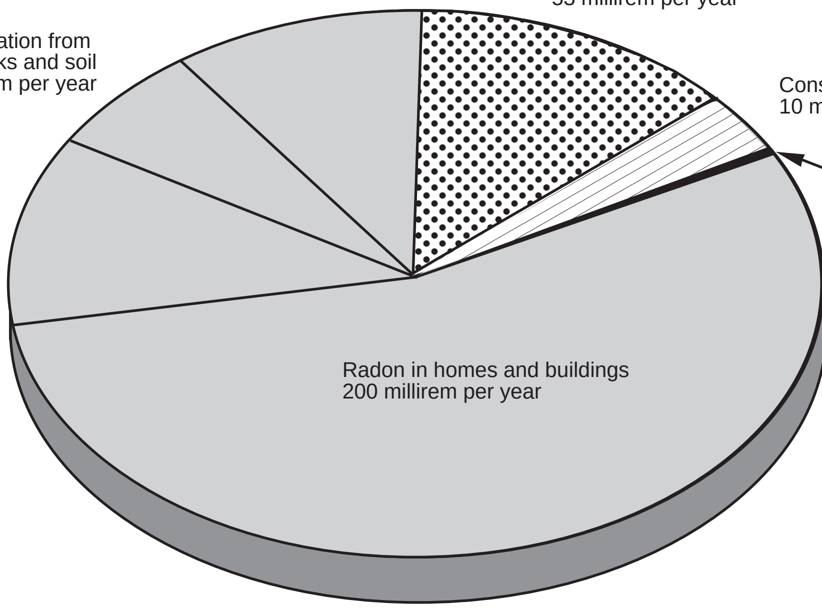
Doses of radiation are expressed as millirem, rem (1,000 millirem), and person-rem (sum of dose to all individual in population).

An individual's radiation exposure in the vicinity of SRS amounts to approximately 357 millirem per year, which is comprised of: natural background radiation from cosmic, terrestrial, and internal body sources; radiation from medical diagnostic and therapeutic practices; weapons test fallout; consumer and industrial products, and nuclear facilities. Figure 3.8-1 shows the relative contribution of each of these sources to the dose an individual living near SRS would receive. All radiation doses mentioned in this EIS are effective dose equivalents. Effective dose equivalents include the dose from internal deposition of radionuclides and the dose attributable to sources external to the body.

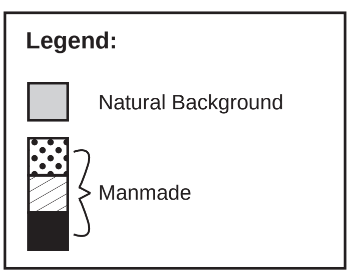
Releases of radioactivity to the environment from SRS account for less than 0.1 percent of the total annual average environmental radiation dose to individuals within 50 miles of the Site. Natural background radiation contributes about 293 millirem per year, or 82 percent of the annual dose of 357 millirem received by an average member of the population within 50 miles of the Site. Based on national averages, medical exposure accounts for an additional 15 percent of the annual dose, and combined doses from weapons test fallout, consumer and industrial products, and air travel account for about 3 percent (NCRP 1987a).

Other nuclear facilities within 50 miles of SRS include a low-level waste disposal site operated by Chem-Nuclear Systems, Inc., near the eastern Site boundary and Georgia Power Company's Vogtle Electric Generating Plant, directly across the Savannah River from SRS. In addition, Starmet CMI (formerly Carolina Metals), Inc., which is northwest of Boiling Springs in Barnwell County, processes depleted uranium.

The *South Carolina Department of Health and Environmental Control Annual Report* (SCDHEC 1995) indicated that the Chem-Nuclear and Starmet CMI facilities do not influence radioactivity levels in the air, precipitation, groundwater, soil, or vegetation. Plant Vogtle began commercial operation in 1987: 1992 re leases produced an annual dose of 0.054 millirem to the maximally exposed individual at the plant boundary and a total population dose within a 50-mile radius of 0.045 person-rem (NRC 1996). EC



Notes:
1. Values are effective dose equivalents from NCRP (1987a) unless noted otherwise.
2. Cosmic: NCRP (1987a) reports 26 millirem per year for sea level. Multiplying value by a factor of 1.1 to correct for the altitude of 300 meters above sea level gives 29 millirem per year.
3. External terrestrial: NCRP (1987b) reports an absorbed dose rate for Augusta, Georgia of 4 microrad per hour, which is 35 millirad per year. NCRP (1987b) uses a factor of 0.7 to convert absorbed dose in air to effective dose equivalent, so 35 x 0.7 = 24 millirem per year.
4. Other sources include SRS operations (0.19 millirem per year; Arnett and Mamatey (1999a)), commercial nuclear facilities (nationwide), occupational exposure, air travel, and fallout.



NW TANK/Grfx/3.8-1 Radiation.ai

Figure 3.8-1. Major sources of radiation exposure in the vicinity of the Savannah River Site.

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In 1997, releases of radioactive material to the environment from SRS operations resulted in a maximum individual dose of 0.07 millirem in the west-southwest sector of the Site boundary from atmospheric releases, and a maximum dose from liquid releases of 0.12 millirem for a maximum total annual dose at the boundary of 0.19 millirem. The maximum dose to downstream consumers of Savannah River water – 0.05 millirem – occurred to users of the Port Wentworth and the Beaufort-Jasper public water supplies (Arnett and Mamatey 1999a).

In 1990, the population within 50 miles of the Site was approximately 620,100. The collective effective dose equivalent to that population in 1998 was 3.5 person-rem from atmospheric releases. The 1998 population of 10,000 people using water from the Cherokee Hill Water Treatment Plant near Port Wentworth, Georgia, and 60,000 people using water from the Beaufort-Jasper Water Treatment Plant near Beaufort, South Carolina, received a collective dose equivalent of 1.8 person-rem in 1998 (Arnett and Mamatey 1999a). Population statistics indicate that cancer caused 23.2 percent of the deaths in the United States in 1997 (CDC 1998). If this percentage of deaths from cancer continues, 23.2 percent of the U.S. population would contract a fatal cancer from all causes. Thus, in the population of 620,100 within 50 miles of SRS, 143,863 persons would be likely to contract fatal cancers from all causes. The total population dose from SRS of 5.3 person-rem (3.5 person-rem from atmospheric pathways plus 1.8 person-rem from water pathways) could result in 0.0027 additional latent cancer death in the same population (based on 0.0005 cancer death per person-rem [NCRP 1993]).

3.8.2 PUBLIC NONRADIOLOGICAL HEALTH

The hazards associated with the alternatives described in this EIS include exposure to nonradiological chemicals in the form of water and air pollution (see Sections 3.2 and 3.3). Table 3.3-2 lists ambient air quality standards and concentrations for selected pollutants. The purpose of these standards is to protect the public health and welfare. The concentrations of pollutants from SRS sources, listed in Table 3.3-3, are lower than the standards. Section 3.2 discusses water quality in the SRS vicinity.

3.8.3 WORKER RADIOLOGICAL HEALTH

One of the major goals of the SRS Health Protection Program is to keep worker exposures to radiation and radioactive material as low as reasonably achievable. Such a program must evaluate both external and internal exposures, with the goal being to minimize the total effective dose equivalent. An effective as low as reasonably achievable program to keep doses as low as reasonably achievable must also balance minimizing individual worker doses with minimizing the collective dose of workers in a group. For example, using many workers to perform small portions of a task would reduce the individual worker dose to low levels. However, frequent worker changes would make the work inefficient, resulting in a significantly higher collective dose to all the workers than if fewer had received slightly higher individual doses. EC

SRS worker doses have typically been well below DOE worker exposure limits. DOE set administrative exposure guidelines at a fraction of the exposure limits to help enforce doses that are as low as reasonably achievable. For example, the current DOE worker exposure limit is 5,000 millirem per year, and the 1998 SRS as low as reasonably achievable administrative control level for the whole body is 500 millirem per year. Every year DOE evaluates the SRS as low as reasonably achievable administrative control levels and adjusts them as needed.

Table 3.8-1 lists average individual doses and SRS collective doses from 1988 to 1998.

3.8.4 WORKER NONRADIOLOGICAL HEALTH

Industrial hygiene and occupational health programs at the SRS deal with all aspects of worker health and relationship of the worker to

Table 3.8-1. SRS annual individual and collective radiation doses.[a]

Year	Average individual worker dose (rem)[b]	Site worker collective dose (person-rem)
1988	0.070	864
1989	0.056	754
1990	0.056	661
1991	0.038	392
1992	0.049	316
1993	0.051	263
1994	0.022	311
1995	0.018	247
1996	0.019	237
1997	0.013	164
1998	0.015	163

a. Sources: DuPont (1989), Petty (1993), WSRC (1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999).
b. The average dose includes only workers who received a measurable dose during the year.

the work environment. The objective of an effective occupational health program is to protect employees from hazards in their work environment. To evaluate these hazards, DOE uses routine monitoring to determine employee exposure levels to hazardous chemicals.

Exposure limit values are the basis of most occupational health codes and standards. If an overexposure to a harmful agent does not exist, that agent generally does not create a health problem.

EC The Occupational Safety and Health Administration (OSHA) has established Permissible Exposure Limits to regulate worker exposure to hazardous chemicals. These limits refer to airborne concentrations of substances and represent conditions under which nearly all workers could receive repeated exposures day after day without adverse health effects.

Table 3.8-2 lists OSHA-regulated workplace pollutants likely to be generated by high-level waste (HLW) tank closure activities and the applicable OSHA limits. EC

A well-defined worker protection program is in place at the SRS to protect the occupational health of DOE and contractor employees. To prevent occupational illnesses and injuries and to preserve the health of the SRS workforce, contractors involved in the construction and operations programs have implemented DOE-approved health and safety programs. Tables 3.8-3 and 3.8-4 indicate that these health and safety programs have resulted in lower incidences of injury and illness than those that occur in the general industry, construction, and manufacturing workforces. EC

3.9 Waste and Materials

3.9.1 WASTE MANAGEMENT

This section describes the waste generation baseline that DOE uses in Chapter 4 to gauge the relative impact of each tank closure alternative on the overall waste generation at SRS and on DOE's capability to manage such waste. In 1995, DOE prepared an EIS on the management of wastes projected to be generated by SRS for the next 40 years (DOE 1995).

DOE generates six basic types of waste – HLW, low-level radioactive (LLW), hazardous, mixed (low-level radioactive and hazardous), transuranic (including alpha-contaminated), and sanitary (nonhazardous, nonradioactive) – which this EIS considers because they are possible byproducts of the SRS tank closure activities. The following sections describe the waste types. Table 3.9-1 lists projected total waste generation EC

Table 3.8-2. Potential occupational safety and health hazards and associated exposure limits.

Pollutant	OSHA PEL[a] (mg/m^3)	Time period
Carbon monoxide	55	8 hours
Oxides of nitrogen	9	Ceiling limit
Total particulates	15	8 hours
Particulate matter (<10 microns)	150	24 hours
	50	Annual
Oxides of sulfur	13	8 hours

a. PEL = Permissible Exposure Limits. The OSHA PEL listed in Table Z-1-A or Z-2 of the OSHA General Industry Air Contaminants Standard (29 CFR 1910.1000) provided if appropriate. These limits, unless otherwise noted (e.g., ceiling), must not be exceeded during any 8-hour work shift of a 40-hour work week.

Table 3.8-3. Comparison of 1997 rates for SRS construction to general industry construction.

Incident rate	SRS construction department[a]	Construction industry[b]
Total recordable cases	4.6	8.70
Total lost workday cases	2.3	4.09

a. Source: Hill (1999).
b. Source: Bureau of Labor Statistics (1998).

Table 3.8-4. Comparison of 1997 rates for SRS operations to private industry and manufacturing.

Incident rate	SRS operations[a]	Private industry[b]	Manufacturing[b]
Total recordable cases	1.08	6.05	10.30
Total lost workday cases	0.44	2.82	4.83

a. Source: Hill (1999).
b. Source: Bureau of Labor Statistics (1998).

Table 3.9-1. Total waste generation forecast for SRS (cubic meters).[a]

	Waste class				
Inclusive dates	LLW	HLW	Hazardous	Mixed LLW	Transuranic and alpha
1999 to 2029	180,299	14,129	6,315	3,720	6,012

EC

a. Source: Halverson (1999).

volumes for fiscal years 1999 through 2029 (a time period that encompasses the expected duration of the tank closure activities addressed in this EIS). The assumptions and uncertainties applicable to SRS waste management plans and waste generation estimates are described in Halverson (1999). These estimates do not include wastes that would be generated as a result of closure of the SRS HLW tank systems.

Tables 3.9-2 through 3.9-4 provide an overview of the existing and planned facilities that DOE expects to use in the storage, treatment, and disposal of the various waste classes.

3.9.1.1 <u>Low-Level Radioactive Waste</u>

DOE (1999) defines LLW as radioactive waste that cannot be classified as HLW, spent nuclear fuel, transuranic waste, byproduct material, or naturally occurring radioactive material.

At present, DOE uses a number of methods for treating and disposing of LLW at SRS, depending on the waste form and activity. Approximately 41 percent of this waste is low in low-activity waste and place it in either shallow land disposal or vault disposal in E Area.

DOE places LLW of intermediate activity and some tritiated LLW in E Area intermediate activity vaults and will store long-lived LLW (e.g., spent deionizer resins) in the long-lived waste storage buildings in E Area, where they will remain until DOE determines their final disposition.

3.9.1.2 <u>Mixed Low-Level Waste</u>

Mixed LLW is radioactive waste that contains material that is listed as hazardous waste under the Resource Conservation and Recovery Act (RCRA) or that exhibits one or more of the following hazardous waste characteristics: ignitability, corrosivity, reactivity, or toxicity. It includes such materials as tritiated mercury, tritiated oil contaminated with mercury, other mercury-contaminated compounds, radioactively contaminated lead shielding, equipment from the tritium facilities in H Area, and filter paper takeup rolls from the M Area Liquid Effluent Treatment Facility.

As described in the *Approved Site Treatment Plan* (WSRC 1999a), storage facilities for mixed LLW are in several different SRS areas. These facilities are dedicated to solid, containerized, or bulk liquid waste and all are approved for this storage under RCRA as interim status or permitted facilities or as Clean Water Act-permitted tank systems. Several treatment processes described in WSRC (1999a) exist or are planned for mixed LLW. These facilities, which are listed in Table 3.9-3, include the Consolidated Incineration Facility, the M-Area Vendor Treatment Facility, and the Hazardous Waste/Mixed Waste Containment Building.

Depending on the nature of the waste residues remaining after treatment, DOE plans to use either shallow land disposal or RCRA-permitted hazardous waste/mixed waste vaults for disposal.

3.9.1.3 <u>High-Level Waste</u>

HLW is highly radioactive material, resulting from the reprocessing of spent nuclear fuel, that contains a combination of transuranic waste and fission products in concentrations that require permanent isolation. It includes both liquid waste produced by reprocessing and any solid waste derived from that liquid (DOE 1999).

At present, DOE stores HLW in carbon steel and reinforced concrete underground tanks in the F- and H-Area Tank Farms. The HLW in the tanks consists of three physical forms: sludge, saltcake, and liquid. The sludge is solid material that precipitates or settles to the bottom of a tank. The saltcake is comprised of salt compounds that have crystallized as a result of concentrating the liquid by evaporation. The liquid is highly concentrated salt solution. Although some tanks contain all three forms, many tanks are considered primarily sludge tanks, while others are considered salt tanks (containing both saltcake and liquid salt solution).

Table 3.9-2. Planned and existing waste storage facilities.[a]

			Original waste stream[b]						
Storage facility	Location	Capacity	Low-level	HLW	Transuranic	Alpha[c]	Hazardous	Mixed Low-level	Status
Long-lived waste storage buildings	E-Area	140 m^3/bldg	X						One exists; DOE plans to construct additional buildings, as necessary.
Containerized mixed waste storage	Buildings 645-2N, 643-29E, 643-43E, 316-M, and Pad 315-4M	4,237 m^3						X	DOE plans to construct additional storage buildings, similar to 643-43E, as necessary.
Liquid mixed waste storage	DWPF Organic Waste Storage Tank (S Area) SRTC Mixed Waste Tanks Liquid Waste Solvent Tanks (H Area) Process Waste Interim Treatment/Storage Facility Tanks (M Area)	9,586 m^3						X	The Process Waste Interim Treatment/Storage Facility ceased operation under RCRA in March 1996 and now operates under the Clean Water Act.
HLW tank farms	F and H Areas	(d)		X					51 underground tanks; one (16H) has been removed from service and two (17F, 20F) have been closed.[e]
Failed equipment storage vaults	Defense Waste Processing Facility (S Area)	300 m^3		X					Two exist; DOE plans approximately 12 additional vaults.
Glass waste storage buildings	Defense Waste Processing Facility (S Area)	2,286 canisters[f]		X					One exists and is expected to reach capacity in 2005; a second is planned to accommodate canister production from 2005 to 2015.
Hazardous waste storage facility	Building 710-B Building 645-N Building 645-4N Waste Pad 1 (between 645-2N and 645-4N) Waste Pad 2 (between 645-4N and 645-N) Waste Pad 3 (east of 645-N)	4,557 m^3					X		Currently in use. No additional facilities are planned, as existing space is expected to adequately support the short-term storage of hazardous wastes awaiting treatment and disposal.
Transuranic waste storage pads	E Area	(g)			X	X		X	19 pads exists; additional pads will be constructed as necessary.

m^3 = cubic meters, SRTC = Savannah River Technology Center.
a. Sources: DOE (1994, 1995), WSRC (1998, 1999a).
b. Sanitary waste is not stored at SRS, thus it is not addressed in this table.
c. Currently, alpha waste is handled and stored as transuranic waste.
d. As of April 1998, there were approximately 660,00 gallons of space available in each of the HLW tank farms.
e. Twenty-four of these tanks do not meet secondary containment requirements and have been scheduled for closure.
f. Usable storage capacity of 2,159 canisters due to floor plug problems.
g. Transuranic waste storage capacities depend on the packaging of the waste and the configuration of packages on the pads.

EC

Table 3.9-3. Planned and existing waste treatment processes and facilities.[a]

Waste Treatment Facility	Waste Treatment Process	Waste type: Low-level	High-level	Transuranic	Alpha[b]	Hazardous	Mixed Low-level	Sanitary	Status
Consolidated Incineration Facility	Incineration	X				X	X		Began treating waste in 1997.
Offsite facility[c]	Incineration	X				X	X		Currently operational.
Offsite facility	Compaction	X							Currently operational.
Offsite facility	Supercompaction	X							Currently operational.
Offsite facility	Smelting	X							Currently operational.
Offsite facility	Repackaging	X							Currently operational.
Defense Waste Processing Facility	Vitrification		X						Currently operational.
Saltstone Manufacturing and Disposal Facility	Stabilization						X		Currently operational.
Replacement High-Level Waste Evaporator[d]	Volume Reduction		X						Planned to replace existing evaporators in December 1999.
M-Area Vendor Treatment Facility	Vitrification						X		Treatment of design basis wastes completed in February 1999.
Hazardous Waste/Mixed Waste Containment Building	Macroencapsulation					X	X		Plan to begin operations in 2006.
Treatment at point of waste stream origin	Decontamination Macroencapsulation						X		As feasible, based on waste and location.
Non-Alpha Vitrification Facility	Vitrification	X				X	X		Under evaluation as a potential process.
DOE Broad Spectrum Contractor	Amalgamation/ Stabilization/ Macroencapsulation						X		DOE is considering use of the Broad Spectrum Contract.
Offsite facility	Offsite Treatment and Disposal					X			Currently operational.
Offsite facility	Decontamination						X		Begin treating waste onsite in December 1998. Plan to pursue treatment offsite in 2000, if necessary.
Various onsite and offsite facilities[e]	Recycle/Reuse	X				X	X	X	Currently operational.
High-activity mixed transuranic waste facility	Repackaging/size reduction			X	X				Planned to begin operations in 2012.
Low-activity mixed transuranic waste facility	Repackaging/size reduction/ supercompaction			X	X				Planned to begin operations in 2002.
Existing DOE facilities	Repackaging/ Treatment			X					Transuranic waste strategies are still being finalized.
F- and H-Area Effluent Treatment Facility	Wastewater Treatment	X					X		Currently operational.

a. Sources: DOE (1994, 1995); Sessions (1999); WSRC (1998, 1999a).
b. Currently, alpha waste is handled as transuranic waste. After it is surveyed and separated, most will be treated and disposed of as LLW or mixed LLW.
c. An offsite incinerator may be used as a back-up to the Consolidated Incineration Facility.
d. Evaporation precedes treatment at the DWPF and is used to maximize HLW storage capacity.
e. Various waste streams have components (e.g., silver, lead, freon, paper) that might be recycled or reused. Some recycling activities might occur onsite, while other waste streams are directed offsite for recycling. Some of the recycled products are released for public sale, while others are reused onsite.

EC

Table 3.9-4. Planned and existing waste disposal facilities.[a]

Disposal facility	Location	Capacity (m^3)	Original waste stream[b]: Low-level	High-level	Transuranic	Hazardous	Mixed Low-level	Sanitary	Status
Shallow land disposal trenches	E Area	(c)	X						Four have been filled; up to 58 more may be constructed.
Low-activity vaults	E Area	30,500/vault	X						One vault exists and one additional is planned.
Intermediate-activity vaults	E Area	5,300/vault	X						Two vaults exist and five more may be constructed.
Hazardous waste/mixed waste vaults	NE of F Area	2,300/vault				X	X		RCRA permit application submitted for 10 vaults. At least 11 additional vaults may be needed.
Saltstone Manufacturing and Disposal Facility	Z Area	80,000/vault[d]	X						Two vaults exist and approximately 13 more are planned.
Three Rivers Landfill	SRS Intersection of SC 125 and Rd. 2	NA						X	Current destination for SRS sanitary waste.
Burma Road Cellulosic and Construction Waste Landfill	SRS Intersection of C Rd. and Burma Rd	NA						X	Current destination for demolition/construction debris. DOE expects to reach permit capacity in 2008.
Waste Isolation Pilot Plant	New Mexico	175,600			X				EPA certification of WIPP completed in April 1998. RCRA permit expected to be finalized in fall of 1999.[e]
Federal repository	See Status	NA		X					Proposed Yucca Mountain, Nevada site is currently under investigation.

NA = Not Available, WIPP = Waste Isolation Pilot Plant.
a. Sources: DOE (1994, 1995, 1997); WSRC (1998, 1999a,b).
b. After alpha waste is assayed and separated from the transuranic waste, DOE plans to dispose of it as LLW or mixed LLW so it is not addressed separately here. EC
c. Various types of trenches exist including engineered low-level trenches, greater confinement disposal boreholes and engineered trenches, and slit trenches. The different trenches are designed for different waste types, are constructed differently, and have different capacities.
d. This is the approximate capacity of a double vault. One single vault and one double vault have been constructed. Future vaults are currently planned as double vaults.
e. SRS is scheduled for WIPP certification audit in summer 1999, after which WIPP could begin receiving SRS waste.

The sludge portion of the HLW is currently being transferred to the DWPF for immobilization in borosilicate glass. The saltcake and liquid portions of the HLW must be separated into high-radioactivity and low-radioactivity fractions before ultimate treatment. EC The process for separating HLW is the subject of a Supplemental EIS, *High-Level Waste Salt Disposition Alternatives at the Savannah River Site*. The high-radioactivity fraction would be transferred to the DWPF for vitrification. The low-radioactivity fraction would be treated and disposed at the Saltstone Manufacturing and Disposal Facility. Both treatment processes are described in the *Final Supplemental Environmental Impact Statement for the Defense Waste Processing Facility* (DOE 1994).

DOE has committed to complete closure by EC 2022 of the 24 HLW tank systems that do not meet the secondary containment requirements in the Federal Facility Agreement (WSRC 1998). L-4-16 Figure 3.9-1 presents the approved schedule for waste removal and closure of these 24 tanks. During waste removal, DOE will retrieve as much of the stored HLW as can be removed using the existing waste transfer equipment. The retrieved waste will be processed through the remaining tank systems and treated at either the DWPF Vitrification Facility or the Saltstone Manufacturing and Disposal Facility. The tank closure activities described in this EIS would occur after waste removal is completed.

3.9.1.4 <u>Sanitary Waste</u>

Sanitary waste is solid waste that is neither EC hazardous, as defined by RCRA, nor radioactive. It consists of salvageable material and material that is suitable for disposition in a municipal sanitary landfill. Sanitary waste streams include such items as paper, glass, discarded office material, and construction debris (DOE 1994).

Sanitary waste volumes have declined due to recycling and the decreasing SRS workforce. DOE sends sanitary waste that is not recycled or reused to the Three Rivers Landfill on SRS. The SRS also continues to operate the Burma Road Cellulosic and Construction Waste Landfill to dispose of demolition and construction debris.

3.9.1.5 <u>Hazardous Waste</u>

Hazardous waste is nonradioactive waste that SCDHEC regulates under RCRA and corresponding State regulations. Waste is hazardous if the EPA lists it is as such or if it exhibits the characteristic(s) of ignitability, corrosivity, reactivity, or toxicity. SRS hazardous waste streams consist of a variety of materials, including mercury, chromate, lead, paint solvents, and various laboratory chemicals.

At present, DOE stores hazardous wastes in three buildings and on three solid waste storage pads that have RCRA permits. Hazardous waste is sent to offsite treatment and disposal facilities and is also treated at the Consolidated Incineration Facility. DOE also plans to continue to recycle, reuse, or recover certain hazardous wastes, including metals, excess chemicals, solvents, and chlorofluorocarbons. Wastes remaining after treatment might be suitable for either shallow land disposal or disposal in the Hazardous/Mixed Waste Disposal Vaults (DOE 1995).

3.9.1.6 <u>Transuranic and Alpha Waste</u>

Transuranic waste contains alpha-emitting transuranic radionuclides (those with atomic weights greater than 92) that have half-lives greater than 20 years at activities exceeding 100 nanocuries per gram (DOE 1999). At present, DOE manages low-level alpha-emitting waste with activities between 10 and 100 nanocuries per gram, referred to as alpha waste, as transuranic waste at SRS.

WSRC (1999a) defines the future handling, treatment, and disposal of the SRS transuranic and alpha waste stream. Current SRS efforts consist primarily of providing continued safe storage until treatment and disposal facilities are available. Eventually, DOE plans to ship the SRS retrievably - stored transuranic and mixed transuranic waste to the Waste Isolation Pilot Plant in New Mexico for disposal.

Before disposition, DOE plans to measure the radioactivity levels of the wastes stored on the

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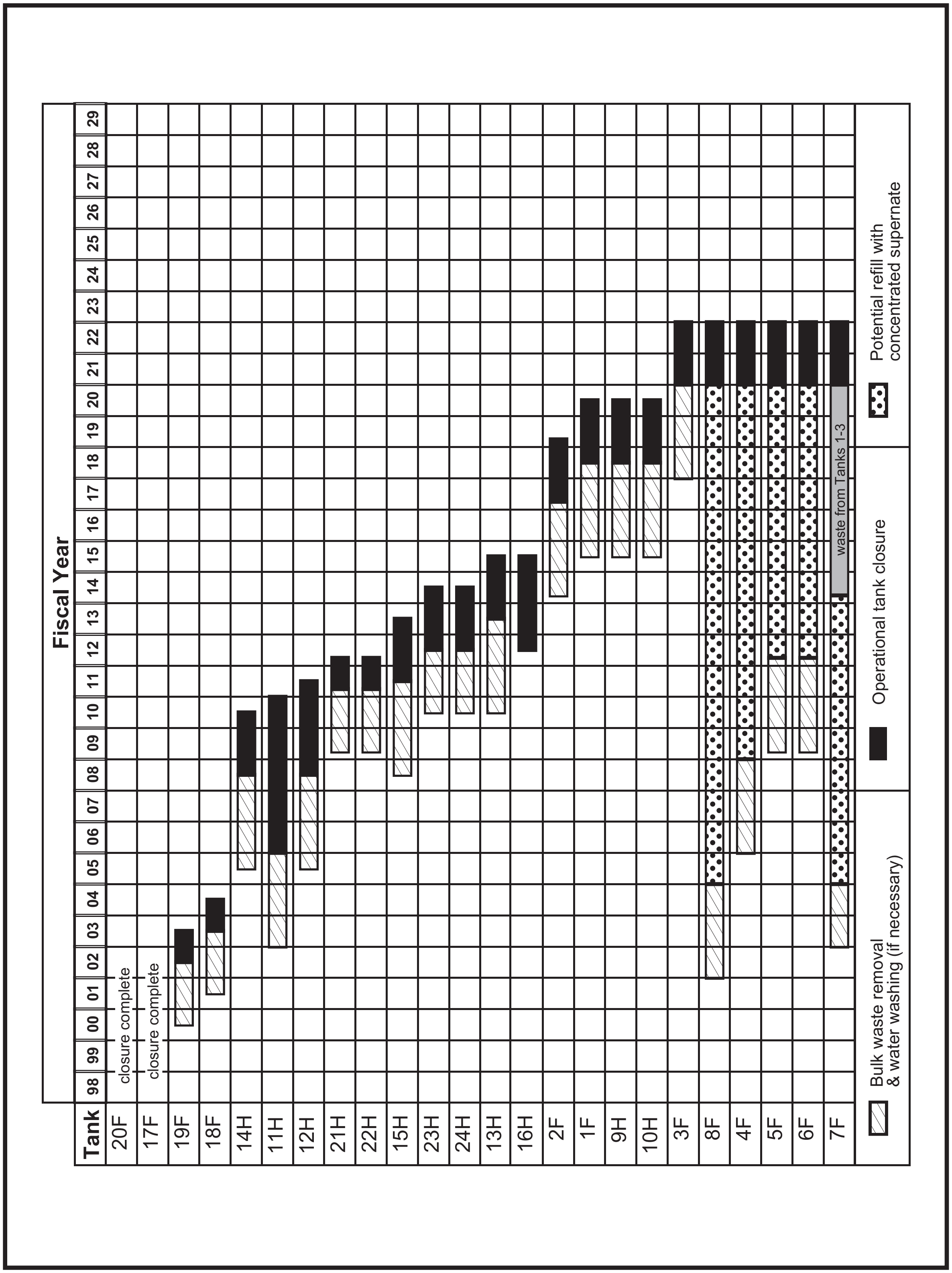

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Figure 3.9-1. Approved Federal Facility Agreement Waste Removal Plan and Schedule.

transuranic waste storage pads and segregate the alpha waste. A high-activity mixed transuranic waste facility could be constructed to process the higher activity SRS waste in preparation for shipment to the Waste Isolation Pilot Plant. This facility would use repackaging, sorting, and size reduction technologies. A low-activity mixed transuranic waste facility could also be constructed to process the lower activity SRS waste. The technology to process low-activity SRS waste is currently under development. A compactor could also be used to process lower activity mixed transuranic waste in preparation for shipment to the Waste Isolation Pilot Plant. After segregation and repackaging, DOE could dispose of much of the alpha waste as either mixed LLW or LLW.

EC

3.9.2 HAZARDOUS MATERIALS

The *Savannah River Site Tier II Emergency and Hazardous Chemical Inventory Report* for 1998 (WSRC 1999c) lists more than 79 hazardous chemicals that were present at SRS at some time during the year in amounts that exceeded the minimum reporting thresholds (generally 10,000 pounds for hazardous chemicals and 500 pounds for extremely hazardous substances). Four of the 79 hazardous chemicals are considered extremely hazardous substances under the Emergency Planning and Community Right-to-Know Act of 1986. The actual number and quantity of hazardous chemicals present on the Site and at individual facilities changes daily as a function of use and demand.

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Table 3.9-2. Planned and existing waste storage facilities.[a]

Storage facility	Location	Capacity	Original waste stream[b]: Low-level	HLW	Transuranic	Alpha[c]	Hazardous	Mixed Low-level	Status
Long-lived waste storage buildings	E-Area	140 m^3/ bldg	X						One exists; DOE plans to construct additional buildings, as necessary.
Containerized mixed waste storage	Buildings 645-2N, 643-29E, 643-43E, 316-M, and Pad 315-4M	4,237 m^3						X	DOE plans to construct additional storage buildings, similar to 643-43E, as necessary.
Liquid mixed waste storage	DWPF Organic Waste Storage Tank (S Area) SRTC Mixed Waste Tanks Liquid Waste Solvent Tanks (H Area) Process Waste Interim Treatment/Storage Facility Tanks (M Area)	9,586 m^3						X	The Process Waste Interim Treatment/Storage Facility ceased operation under RCRA in March 1996 and now operates under the Clean Water Act.
HLW tank farms	F and H Areas	(d)		X					51 underground tanks; one (16H) has been removed from service and two (17F, 20F) have been closed.[e]
Failed equipment storage vaults	Defense Waste Processing Facility (S Area)	300 m^3		X					Two exist; DOE plans approximately 12 additional vaults.
Glass waste storage buildings	Defense Waste Processing Facility (S Area)	2,286 canisters[f]		X					One exists and is expected to reach capacity in 2005; a second is planned to accommodate canister production from 2005 to 2015.
Hazardous waste storage facility	Building 710-B Building 645-N Building 645-4N Waste Pad 1 (between 645-2N and 645-4N) Waste Pad 2 (between 645-4N and 645-N) Waste Pad 3 (east of 645-N)	4,557 m^3					X		Currently in use. No additional facilities are planned, as existing space is expected to adequately support the short-term storage of hazardous wastes awaiting treatment and disposal.
Transuranic waste storage pads	E Area	(g)			X	X		X	19 pads exists; additional pads will be constructed as necessary.

m^3 = cubic meters, SRTC = Savannah River Technology Center.
a. Sources: DOE (1994, 1995), WSRC (1998, 1999a).
b. Sanitary waste is not stored at SRS, thus it is not addressed in this table.
c. Currently, alpha waste is handled and stored as transuranic waste.
d. As of April 1998, there were approximately 660,00 gallons of space available in each of the HLW tank farms.
e. Twenty-four of these tanks do not meet secondary containment requirements and have been scheduled for closure.
f. Usable storage capacity of 2,159 canisters due to floor plug problems.
g. Transuranic waste storage capacities depend on the packaging of the waste and the configuration of packages on the pads.

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Table 3.9-3. Planned and existing waste treatment processes and facilities.[a]

Waste Treatment Facility	Waste Treatment Process	Waste type: Low-level	High-level	Transuranic	Alpha[b]	Hazardous	Mixed Low-level	Sanitary	Status
Consolidated Incineration Facility	Incineration	X				X	X		Began treating waste in 1997.
Offsite facility[c]	Incineration	X				X	X		Currently operational.
Offsite facility	Compaction	X							Currently operational.
Offsite facility	Supercompaction	X							Currently operational.
Offsite facility	Smelting	X							Currently operational.
Offsite facility	Repackaging	X							Currently operational.
Defense Waste Processing Facility	Vitrification		X						Currently operational.
Saltstone Manufacturing and Disposal Facility	Stabilization						X		Currently operational.
Replacement High-Level Waste Evaporator[d]	Volume Reduction		X						Planned to replace existing evaporators in December 1999.
M-Area Vendor Treatment Facility	Vitrification						X		Treatment of design basis wastes completed in February 1999.
Hazardous Waste/Mixed Waste Containment Building	Macroencapsulation					X	X		Plan to begin operations in 2006.
Treatment at point of waste stream origin	Decontamination Macroencapsulation						X		As feasible, based on waste and location.
Non-Alpha Vitrification Facility	Vitrification	X				X	X		Under evaluation as a potential process.
DOE Broad Spectrum Contractor	Amalgamation/ Stabilization/ Macroencapsulation						X		DOE is considering use of the Broad Spectrum Contract.
Offsite facility	Offsite Treatment and Disposal					X			Currently operational.
Offsite facility	Decontamination						X		Begin treating waste onsite in December 1998. Plan to pursue treatment offsite in 2000, if necessary.
Various onsite and offsite facilities[e]	Recycle/Reuse	X				X	X	X	Currently operational.
High-activity mixed transuranic waste facility	Repackaging/size reduction			X	X				Planned to begin operations in 2012.
Low-activity mixed transuranic waste facility	Repackaging/size reduction/ supercompaction			X	X				Planned to begin operations in 2002.
Existing DOE facilities	Repackaging/ Treatment			X					Transuranic waste strategies are still being finalized.
F- and H-Area Effluent Treatment Facility	Wastewater Treatment	X					X		Currently operational.

a. Sources: DOE (1994, 1995); Sessions (1999); WSRC (1998, 1999a).
b. Currently, alpha waste is handled as transuranic waste. After it is surveyed and separated, most will be treated and disposed of as LLW or mixed LLW. EC
c. An offsite incinerator may be used as a back-up to the Consolidated Incineration Facility.
d. Evaporation precedes treatment at the DWPF and is used to maximize HLW storage capacity.
e. Various waste streams have components (e.g., silver, lead, freon, paper) that might be recycled or reused. Some recycling activities might occur onsite, while other waste streams are directed offsite for recycling. Some of the recycled products are released for public sale, while others are reused onsite.

Table 3.9-4. Planned and existing waste disposal facilities.[a]

Disposal facility	Location	Capacity (m^3)	Original waste stream[b]: Low-level	High-level	Transuranic	Hazardous	Mixed Low-level	Sanitary	Status
Shallow land disposal trenches	E Area	(c)	X						Four have been filled; up to 58 more may be constructed.
Low-activity vaults	E Area	30,500/vault	X						One vault exists and one additional is planned.
Intermediate-activity vaults	E Area	5,300/vault	X						Two vaults exist and five more may be constructed.
Hazardous waste/mixed waste vaults	NE of F Area	2,300/vault				X	X		RCRA permit application submitted for 10 vaults. At least 11 additional vaults may be needed.
Saltstone Manufacturing and Disposal Facility	Z Area	80,000/vault[d]	X						Two vaults exist and approximately 13 more are planned.
Three Rivers Landfill	SRS Intersection of SC 125 and Rd. 2	NA						X	Current destination for SRS sanitary waste.
Burma Road Cellulosic and Construction Waste Landfill	SRS Intersection of C Rd. and Burma Rd	NA						X	Current destination for demolition/construction debris. DOE expects to reach permit capacity in 2008.
Waste Isolation Pilot Plant	New Mexico	175,600			X				EPA certification of WIPP completed in April 1998. RCRA permit expected to be finalized in fall of 1999.[e]
Federal repository	See Status	NA		X					Proposed Yucca Mountain, Nevada site is currently under investigation.

NA = Not Available, WIPP = Waste Isolation Pilot Plant.

a. Sources: DOE (1994, 1995, 1997); WSRC (1998, 1999a,b).

b. After alpha waste is assayed and separated from the transuranic waste, DOE plans to dispose of it as LLW or mixed LLW so it is not addressed separately here. EC

c. Various types of trenches exist including engineered low-level trenches, greater confinement disposal boreholes and engineered trenches, and slit trenches. The different trenches are designed for different waste types, are constructed differently, and have different capacities.

d. This is the approximate capacity of a double vault. One single vault and one double vault have been constructed. Future vaults are currently planned as double vaults.

e. SRS is scheduled for WIPP certification audit in summer 1999, after which WIPP could begin receiving SRS waste.

The sludge portion of the HLW is currently being transferred to the DWPF for immobilization in borosilicate glass. The saltcake and liquid portions of the HLW must be separated into high-radioactivity and low-radioactivity fractions before ultimate treatment. The process for separating HLW is the subject of a Supplemental EIS, *High-Level Waste Salt Disposition Alternatives at the Savannah River Site*. The high-radioactivity fraction would be transferred to the DWPF for vitrification. The low-radioactivity fraction would be treated and disposed at the Saltstone Manufacturing and Disposal Facility. Both treatment processes are described in the *Final Supplemental Environmental Impact Statement for the Defense Waste Processing Facility* (DOE 1994).

DOE has committed to complete closure by 2022 of the 24 HLW tank systems that do not meet the secondary containment requirements in the Federal Facility Agreement (WSRC 1998). Figure 3.9-1 presents the approved schedule for waste removal and closure of these 24 tanks. During waste removal, DOE will retrieve as much of the stored HLW as can be removed using the existing waste transfer equipment. The retrieved waste will be processed through the remaining tank systems and treated at either the DWPF Vitrification Facility or the Saltstone Manufacturing and Disposal Facility. The tank closure activities described in this EIS would occur after waste removal is completed.

3.9.1.4 Sanitary Waste

Sanitary waste is solid waste that is neither hazardous, as defined by RCRA, nor radioactive. It consists of salvageable material and material that is suitable for disposition in a municipal sanitary landfill. Sanitary waste streams include such items as paper, glass, discarded office material, and construction debris (DOE 1994).

Sanitary waste volumes have declined due to recycling and the decreasing SRS workforce. DOE sends sanitary waste that is not recycled or reused to the Three Rivers Landfill on SRS. The SRS also continues to operate the Burma Road Cellulosic and Construction Waste Landfill to dispose of demolition and construction debris.

3.9.1.5 Hazardous Waste

Hazardous waste is nonradioactive waste that SCDHEC regulates under RCRA and corresponding State regulations. Waste is hazardous if the EPA lists it is as such or if it exhibits the characteristic(s) of ignitability, corrosivity, reactivity, or toxicity. SRS hazardous waste streams consist of a variety of materials, including mercury, chromate, lead, paint solvents, and various laboratory chemicals.

At present, DOE stores hazardous wastes in three buildings and on three solid waste storage pads that have RCRA permits. Hazardous waste is sent to offsite treatment and disposal facilities and is also treated at the Consolidated Incineration Facility. DOE also plans to continue to recycle, reuse, or recover certain hazardous wastes, including metals, excess chemicals, solvents, and chlorofluorocarbons. Wastes remaining after treatment might be suitable for either shallow land disposal or disposal in the Hazardous/Mixed Waste Disposal Vaults (DOE 1995).

3.9.1.6 Transuranic and Alpha Waste

Transuranic waste contains alpha-emitting transuranic radionuclides (those with atomic weights greater than 92) that have half-lives greater than 20 years at activities exceeding 100 nanocuries per gram (DOE 1999). At present, DOE manages low-level alpha-emitting waste with activities between 10 and 100 nanocuries per gram, referred to as alpha waste, as transuranic waste at SRS.

WSRC (1999a) defines the future handling, treatment, and disposal of the SRS transuranic and alpha waste stream. Current SRS efforts consist primarily of providing continued safe storage until treatment and disposal facilities are available. Eventually, DOE plans to ship the SRS retrievably - stored transuranic and mixed transuranic waste to the Waste Isolation Pilot Plant in New Mexico for disposal.

Before disposition, DOE plans to measure the radioactivity levels of the wastes stored on the

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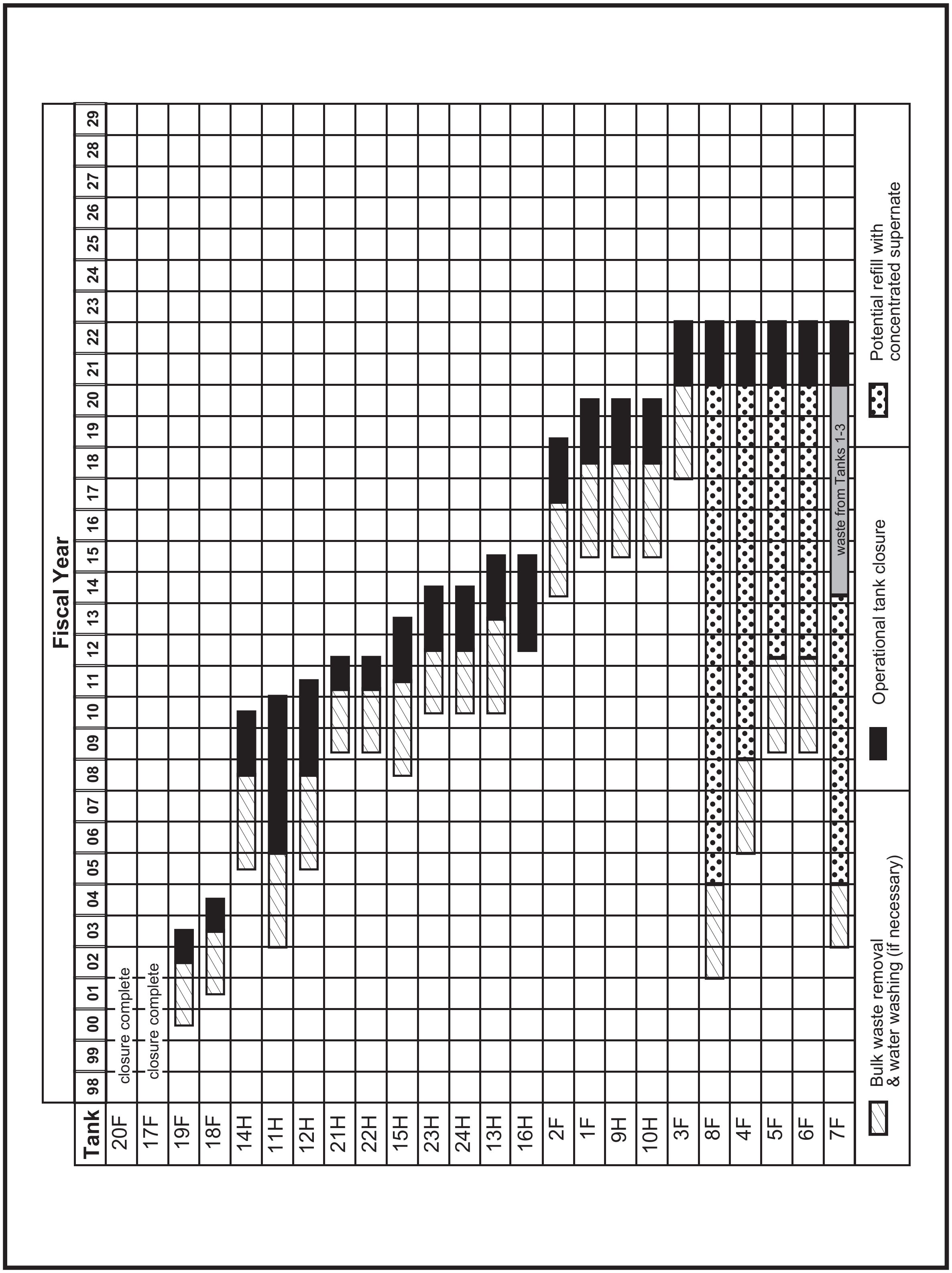

NW TANK/Final EIS/Graphic files/chp 3/3.9-1 App FFA Waste Rem Plan&Sch.ai

Figure 3.9-1. Approved Federal Facility Agreement Waste Removal Plan and Schedule.

transuranic waste storage pads and segregate the alpha waste. A high-activity mixed transuranic waste facility could be constructed to process the higher activity SRS waste in preparation for shipment to the Waste Isolation Pilot Plant. This facility would use repackaging, sorting, and size reduction technologies. A low-activity mixed transuranic waste facility could also be constructed to process the lower activity SRS waste. The technology to process low-activity SRS waste is currently under development. A compactor could also be used to process lower activity mixed transuranic waste in preparation for shipment to the Waste Isolation Pilot Plant. After segregation and repackaging, DOE could dispose of much of the alpha waste as either EC | mixed LLW or LLW.

3.9.2 HAZARDOUS MATERIALS

The *Savannah River Site Tier II Emergency and Hazardous Chemical Inventory Report* for 1998 (WSRC 1999c) lists more than 79 hazardous chemicals that were present at SRS at some time during the year in amounts that exceeded the minimum reporting thresholds (generally 10,000 pounds for hazardous chemicals and 500 pounds for extremely hazardous substances). Four of the 79 hazardous chemicals are considered extremely hazardous substances under the Emergency Planning and Community Right-to-Know Act of 1986. The actual number and quantity of hazardous chemicals present on the Site and at individual facilities changes daily as a function of use and demand.

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CHAPTER 4. ENVIRONMENTAL IMPACTS

Chapter 4 describes the potential environmental consequences to the Savannah River Site (SRS) and the surrounding region of implementing each of the alternatives described in Chapter 2. As discussed in Chapter 2, the U.S. Department of Energy (DOE) has identified three alternatives and three tank stabilization options:

- No Action Alternative
- Stabilize Tanks Alternative
  - Fill with Grout Option (Preferred Alternative)
  - Fill with Sand Option
  - Fill with Saltstone Option
- Clean and Remove Tanks Alternative

Environmental consequences of actions could include direct physical disturbance of resources, consumption of affected resources, and degradation of resources caused by effluents and emissions. Resources include air, water, soils, plants, animals, cultural artifacts, and people, including SRS workers and people in nearby communities. Consequences may be detrimental (e.g., increased airborne emissions of hazardous chemicals) or beneficial (e.g., jobs created by new construction).

Section 4.1 describes the short-term impacts associated with each alternative within the scope of this Environmental Impact Statement (EIS). For purposes of the analyses in the EIS, the short-term impacts span from the year 2000 through final closure of the existing high-level waste (HLW) tanks associated with operation of the Defense Waste Processing Facility (DWPF) (approximately 2030). Section 4.2 describes the long-term impacts of the residual radioactive and non-radioactive material in the closed HLW tanks. Long-term assessment involves a 10,000-year performance evaluation, beginning with a 100-year period of institutional control and continuing through an extended period during which it is assumed that residents and intruders could be present.

The impact assessments in this EIS have generally been performed in such a way that the magnitude and intensity of estimated impacts are unlikely to be exceeded during either normal operations or in the event of an accident. For routine operations, the results of monitoring the impacts from actual operations provide realistic predictions of impacts. For accidents, there is more uncertainty because the impacts are based on events that have not occurred. In this EIS, the DOE selected hypothetical accidents that would produce impacts as severe or more severe than any reasonably foreseeable accidents, which bounds the impacts of all reasonably foreseeable accidents for each alternative. The use of this methodology ensures that all of the alternatives have been evaluated using the same methods and data, allowing a non-biased comparison of impacts.

To ensure that small potential impacts are not over-analyzed and large potential impacts are not under-analyzed, analysts have assessed potential impacts based on their significance. This methodology follows the recommendation for the use of a "sliding scale" approach to analysis described in *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements* (DOE 1993). The sliding scale approach uses a determination of significance by the analyst (and, in some cases, peer reviewers) for each potential impact. Potential impacts determined to be insignificant are not analyzed further, while potential impacts that may be significant are analyzed at a level of detail commensurate with the magnitude of the impacts.

4.1 Short-Term Impacts

Section 4.1 describes the short-term impacts associated with each alternative. For purposes of the analyses in the EIS, the short-term impacts span from year 2000 through final closure of the existing HLW tanks associated with operation of the DWPF (approximately 2030). The structure of Section 4.1 closely parallels that of Chapter 3, Affected Environment, with the addition of sections on utilities and energy consumption and accidents. The sections discuss methodology and present the potential impacts of each alternative evaluated. More details on the methodology for accident analysis are provided in Appendix B.

4.1.1 GEOLOGIC RESOURCES

No geologic deposits within F and H Areas have potential for development. There are, however, four tanks in F Area and four tanks in H Area that would require backfill soil to be placed over the tops of the tanks for the Stabilize Tanks Alternative been economically or industrially developed, and none are known to have significant. The backfill soil would bring the ground surface at these tanks up to the surrounding surface elevations to prevent surface water from collecting in the surface depressions. This action would prevent ponded conditions over these tanks that could facilitate the degradation of the tank structure. DOE currently estimates that 170,000 cubic meters of soil would be required to fill the depressions to grade.

Under the Clean and Remove Tanks Alternative, the tanks would be cleaned as appropriate and removed from the subsurface. This would require the backfilling of the excavations left by removal of the tanks. The backfill material would consist of a soil type similar to the soils currently surrounding the tanks. DOE currently estimates that 356,000 cubic meters of soil would be required to backfill the voids left by the removal of the tanks.

The backfill soils would be excavated from an onsite borrow area(s), as determined by DOE. The excavation of borrow soils would be performed under Best Management Practices to limit impact to geologic resources that may be present. As a result, there would be no short-term impacts at the individual tank locations to geologic resources from any of the proposed alternatives discussed in Chapter 2.

4.1.2 WATER RESOURCES

4.1.2.1 <u>Surface Water</u>

Surface runoff in the F- and H-Area Tank Farms flows to established storm sewer systems that may be used to block, divert, re-route, or hold up flow as necessary. During periods of earth moving or soil excavating, surface water runoff can be routed to area stormwater basins to prevent sediment from moving into down-gradient streams. During phases of the operation when the potential for a contaminant spill exists, specific storm sewer zones (or "flowpaths") can be secured, ensuring that contaminated water or inadvertently spilled cleaning chemicals would be routed to a lined retention basin via paved ditches and underground drainage lines.

The retention basins are flat-bottomed, slope-walled, earthen basins lined with rubber (H-Area Retention Basin) or polyethylene (F-Area Retention Basin). Both basins have a capacity of 6,000,000 gallons. Stormwater in the retention basins may be sent to Fourmile Branch (if uncontaminated rainwater), to the Effluent Treatment Facility for removal of contaminants, or re-routed to the tank farms for temporary storage prior to treatment. Because any construction site runoff or spills would be controlled by the tank farm storm sewer system, DOE does not anticipate impacts to down-gradient surface waters. Activities would be confined to developed areas and discharges would be in compliance with existing storm-water permits.

Small (approximately one acre) lay-down areas would be established just outside of the F- and H-Area Tank Farms to serve as equipment storage and staging areas. Development of these lay-down areas would require little or no construction or land disturbance; therefore, the potential for erosion and sedimentation under any of the alternatives would be negligible.

Prior to construction, DOE would review and augment (if necessary) its existing erosion and sedimentation plans, ensuring that they were in compliance with State regulations on stormwater discharges and approved by the South Carolina Department of Health and Environmental Control (SCDHEC).

4.1.2.2 Groundwater

The only direct impact to groundwater resources during the short-term activities associated with tank closure would be the use of groundwater for cleaning, for tank ballast, and for mixing grout, saltstone, or sand fill. Of the alternatives described in Chapter 2, only the No Action Alternative involves using water as ballast; however, this alternative does not use water for tank cleaning. The Fill with Grout and Fill with Saltstone Options under the Stabilize Tanks Alternative include water use for tank cleaning and for mixing with the grout and saltstone backfill. The Fill with Sand Option uses water for tank cleaning and a relatively small amount of water to prepare the sand slurry for tank filling. The Clean and Remove Tanks Alternative only uses water for cleaning, although the higher degree of cleaning required for tank removal would use more water than cleaning for in-place tank closure alternatives.

An accounting of the volumes of water required for each of the closure alternatives (as described in Section 4.1.11) shows that the largest volume of water would be used during the Stabilize Tanks Alternative (Fill with Grout Option). The largest volume on a per tank basis would be consumed during closure of Type III tanks. Based on the anticipated closure schedule, closure of two Type III tanks in any given year would consume approximately 2.3 million gallons of water. This water would come from the groundwater production wells located at various operating areas at SRS. As a comparison, the total groundwater production from the F Area industrial wells from January through December 1998 was approximately 1.01 million gallons per day (370 millions gallons per year) (Johnson 1999). This water was pumped from the intermediate and deep aquifers that have been widely used as an industrial and municipal groundwater source for many years across Aiken County. The tank closure water requirements represent less than 0.6 percent of the F Area annual production alone. Based on these projections, there would be no significant impact to groundwater resources for any of the tank closure alternatives.

The tank farms are situated in highly developed industrial areas. Some of the tank groups were constructed in pits substantially lower in elevation than the surrounding terrain. The existing tank farm sites include facilities and structures designed to prevent surface ponding and to manage precipitation runoff in a controlled manner. Reclamation of the tank farms after closure would require backfilling and grading to provide a suitable site for future industrial/commercial development, to prevent future ponding of water at the surface, and to promote non-erosional surface water runoff. Backfilling and grading would be performed by using borrow material derived from local areas at the SRS; borrow material is assumed to be physically similar to the in-place materials. Therefore, there should be little or no impact to short-term groundwater recharge as a result of the surface reclamation activities.

The in-place tank closure alternatives would result in residual waste being left in the tanks. The residual waste has the potential to contaminate groundwater at some point in the future, due to leaching and water-borne transport of contaminants. This is not expected to occur, however, until several hundred years after tank closure when the tank, tank contents, and underlying basemat are anticipated to fail, due to deterioration. Under all closure alternatives, construction and/or demolition activities have the potential to result in soil, wastewater, or direct groundwater contamination through spills of fuels or chemicals or construction byproducts and wastes. By following safe work practices and implementing good engineering methodologies, concentrations in soil, wastewater, and groundwater should be kept well within applicable standards and guidelines to protect groundwater resources.

4.1.3 AIR RESOURCES

This section discusses nonradiological and radiological air quality impacts that would result from actions related to tank closure activities. To determine the impacts on air quality, DOE estimated the emission rates associated with processes used in each alternative. This included an identification of potential emission sources and any methods by which air would be filtered before being released to the environment. These emissions were entered into air dispersion models to determine potential maximum concentrations at onsite and offsite locations. The estimated emissions and air concentrations of nonradiological and radiological pollutants are discussed and compared to the pertinent SCDHEC and Federal regulatory limits in the following two sections. Any human health effects resulting from increased air concentrations are discussed in the Worker and Public Health Section (4.1.8).

4.1.3.1 <u>Nonradiological Air Quality</u>

Tank closure activities would result in the release of regulated nonradiological pollutants to the surrounding air. The estimated emission rates (tons per year) for each emitted regulated pollutant and each alternative/option are presented in Table 4.1.3-1. These emission rates can be compared against emission rates defined in SCDHEC Standard 7, "Prevention of Significant Deterioration (PSD)." The PSD limits are included in Table 4.1.3-1 and are discussed in this section.

TC The primary sources of nonradiological air pollutants for the Fill with Grout Option under the Stabilize Tanks Alternative would be a concrete batch plant located next to each of the F- and H-Area Tank Farms and three diesel generators that would provide electrical power for each of these batch plants. The batch plants and generators were assumed to be identical to those used during the two previous tank closures, and were conservatively assumed to run continuously. The diesel generators account for a majority of the pollutants emitted; however, the batch plants' emissions would account for 77 percent of the total PM_{10} (particulate matter with an aerodynamic diameter ≤ 10 μm) emitted. Additional nonradiological pollutants would be expected from the exhaust from trucks delivering raw materials to the batch plant every few days. Because these emissions would only occur occasionally, they were considered very small, relative to batch plant emission, and were not included in the emissions calculations for this option or any other option under the Stabilize Tanks Alternative. EC TC

For the Fill with Sand Option of the Stabilize Tanks Alternative, nonradiological pollutants would be emitted from operation of the sand conveyance (feed) plants, one at H Area and a second at F Area, and three diesel generators providing electric power for each of the sand conveyance plants. The sand feed plants would emit 67 percent of the total PM_{10} that would be emitted under this option. The diesel generators and sand conveyance plants were assumed to operate continuously. TC

The option of filling the tanks with saltstone would require saltstone batching facilities to be located at F and H Areas. The total amount of saltstone that would be made from the stabilization of all the low-activity fraction of HLW would probably be greater than the capacity of the waste tanks (DOE 1996). Therefore, each of the two new facilities for producing the saltstone necessary to fill the tanks was assumed to be one-half the size of the existing facility and was assumed to have identical sources of air pollution (Hunter 1999). The diesel generator emissions were based on the permitted emissions for the three generators at the Saltstone Manufacturing and Disposal Facility. TC

Regulated nonradiological air pollutants released as a result of activities associated with the No Action Alternative would consist primarily of emissions from vehicular traffic operating during waste removal. Relatively few vehicles would be required and would not run continuously; therefore, the emissions would be very small.

Table 4.1.3-1. Nonradiological air emissions (tons per year) for tank closure alternatives.[a]

			Diesel Generators			Batch/Feed Plant			
Air pollutant	PSD significant emissions rate[b]	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	Clean and Remove Tank Alternative
Sulfur dioxide (as SO_x)	40	-[c]	2.2	2.2	6.6				-[c]
Total suspended particulates	25	-[c]	-[d]	-[d]	5.2				-[c]
Particulate matter (≤10 μm)	15	-[c]	1.0	1.0	3.3	3.5	2.1	0.3	-[c]
Carbon monoxide	100	-[c]	5.6	5.6	16.0				-[c]
VOCs	40	-[c]	2.3	2.3	4.9			0.8	-[c]
Nitrogen dioxide (as NO_x)	40	-[c]	33	33	77				-[c]
Lead	0.6	-[c]	9.0×10^{-4}	9.0×10^{-4}	2.9×10^{-3}				-[c]
Beryllium	4.0×10^{-4}	-[c]	1.7×10^{-4}	1.7×10^{-4}	5.6×10^{-4}				-[c]
Mercury	0.1	-[c]	2.2×10^{-4}	2.2×10^{-4}	7.0×10^{-4}			8.4×10^{-5}	-[c]
Benzene	NA	-[c]	0.02	0.02	0.04			0.84	-[c]

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NA = Not applicable; no regulatory limit for this pollutant.
a. Source: Hunter (1999). EC
b. SCDHEC, Regulation 61-62.5, Standard 7, "Prevention of Significant Deterioration (PSD), Part V(1)."
c. Emissions from these alternatives have not been quantified, but would be small in relation to the Stabilize Tanks Alternative. TC
d. No data on TSP emissions for these sources are readily available and therefore are not reflected in this analysis.
e. VOCs = volatile organic compounds, includes benzene.

Regulated nonradiological air pollutants released as a result of activities associated with the Clean and Remove Tanks Alternative would consist of emissions from cutting the carbon-steel tanks and emissions from vehicular traffic operating during cleaning and removal. The tank cutting would produce particulates, but not air toxics, and these particulates would be heavier and deposited to the ground much quicker than for welding. The cutting operations would be intermittent and short-term (a day or two every few weeks). Also, a hut would be erected around the cutting operation to control the particulates; therefore, the emissions would be very small. Relatively few vehicles would be required and would not run continuously.

Additionally, all but one alternative includes the possibility of cleaning the interior tank walls with oxalic acid, a toxic air pollutant regulated under SCDHEC Standard 8. Oxalic acid would likely be stored in aboveground storage tanks. Tank ventilation would result in the release of small amounts of vapor to the atmosphere. A review of emissions data from two oxalic acid tanks currently used at SRS shows that the emissions from these sources are less than 3.5×10^{-9} tons per year. This resulting concentration in the vented air would be much less than any ambient air limit and would, therefore, be considered to be very small for purposes of assessing impacts to air quality (Hunter 1999).

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The oxalic acid would be stored as a 4-8 percent (by weight) solution in tank trucks and driven to each tank to be cleaned. The acid would be transferred to the HLW tanks through a sealed pipeline. No releases are expected during this procedure. The cleaning process would consist of spraying hot (80-90 degrees Celsius [°C]) acid using remotely operated water sprayers. The tanks would be ventilated with 300-400 cubic foot per minute of air (cfm), which would pass through a high-efficiency particulate air (HEPA) filter. The acid has a very low vapor

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pressure (as demonstrated by the very low tank emissions); therefore, releases from the ventilated air will be minimal. After its use in the tank, the acid is pumped and neutralized. Although no specific monitoring for oxalic acid fumes was performed during the cleaning of Tank 16 (see Section 2.1.1), no deleterious effects of using the acid were noted at the time.

The expected emission rates from the identified sources for each alternative/option were compared to the emission rates listed in SCDHEC Standard 7, "Prevention of Significant Deterioration (PSD)," to determine if the emission would result in an exceedance of this standard or a significant emission increase. Facilities such as SRS that are located in attainment areas and are classified as major facilities may trigger a PSD permit review under the new source review requirements of the Clean Air Act when they construct a major stationary source or make a major modification to a major source. A major source is defined as a source with the potential to emit any air pollutant regulated under the Clean Air Act in amounts equal to or exceeding specified thresholds. A PSD permit review is required if that modification or addition to the major facility results in a significant net emissions increase of any regulated pollutant. However, as can be seen in Table 4.1.3-1, the expected nonradiological emissions would be below the PSD significant emission rates listed in Standard 7 for most pollutants. The estimated emission rate for oxides of nitrogen under each alternative (33, 33, and 77 tons per year) are close to or exceed the PSD limit of 40 tons per year. However, the estimated emission rates were based on the assumption that batch operations at both F Area and H Area are running at the same time and continuously throughout the year. In all likelihood, tanks would be closed one at a time and there would be time between each closure when equipment is not in operation. Therefore, the estimated emission rates in Table 4.1.3-1 are conservative and none would be expected to exceed the PSD limits in Standard 7. In addition, the estimated emission rate for beryllium from diesel generators for the Fill with Saltstone Option would slightly exceed the PSD significant emissions rate.

Using the emission rates from Table 4.1.3-1, maximum concentrations of released regulated pollutants were determined using the U.S. Environmental Protection Agency's (EPA's) Industrial Source Complex – Short Term (ISC3) air dispersion model (EPA 1995). The one-year meteorological data set collected onsite at SRS for 1996 was used as input into the model. Maximum concentrations were estimated at: (1) the SRS boundary where members of the public potentially could receive the highest exposure, and (2) at the location of a hypothetical noninvolved site worker. For the location of the noninvolved worker, the analysis used a generic location 2,100 feet from the release point in the direction of the greatest concentration. This location is the standard distance for assessing consequences from facility accidents and is used here for normal operations for consistency. Concentrations at the receptor locations were calculated at an elevation of 2 meters above ground to approximate the breathing height of a typical adult. The maximum air concentrations (micrograms per cubic meter) at the SRS boundary associated with the release of regulated nonradiological pollutants are listed in Tables 4.1.3 2 and 4.1.3-3. As can be expected, the Fill with Saltstone Option, which has slightly higher emissions, results in higher concentrations at the Site boundary. However, ambient concentrations for all the pollutants and alternatives/options would increase by less than 1 percent of the regulatory limits. Therefore, no proposed tank closure activities would result in an exceedance of standards.

The air quality impacts at the location of a hypothetical noninvolved worker in the vicinity of F and H Areas are presented in Table 4.1.3-4. As with the modeled concentrations at the Site boundary, ambient concentrations of the Occupational Health and Safety Administration (OSHA)-regulated pollutants (milligrams per cubic meter) at the location of the noninvolved worker would be highest for the Fill with Saltstone Option. All concentrations

Table 4.1.3-2. Estimated maximum concentrations (in micrograms per cubic meter) at the SRS boundary for SCDHEC Standard 2 Air Pollutants.[a]

				Maximum concentration increment				
					Stabilize Tanks Alternative			
Air pollutant	Averaging time	South Carolina Standard[b]	SRS baseline[c]	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	Clean and Remove Tanks Alternative (TC)
Sulfur dioxide (as SO_x)	3-hr	1,300	1,200	(d)	0.2	0.2	0.6	(d)
	24-hr	365	350	(d)	0.04	0.04	0.12	(d)
	Annual	80	34	(d)	0.002	0.002	0.006	(d)
Total suspended particulates	Annual Geometric Mean	75	67	(d)	ND	ND	0.005	(d)
Particulate matter (≤10 μm)	24-hr	150 (65)[e]	130	(d)	0.08	0.06	0.06	(d)
	Annual	50 (15)[e]	25	(d)	0.004	0.003	0.003	(d)
Carbon monoxide	1-hr	40,000	10,000	(d)	1.2	1.2	3.4	(d)
	8-hr	10,000	6,900	(d)	0.3	0.3	0.8	(d)
VOCs	1-hr	(f)	(f)	(d)	0.5	0.5	2.0	(d)
Ozone	1-hr	235	NA	(d)	(g)	(g)	(g)	(d)
Nitrogen dioxide (as NO_x)	Annual	100	26	(d)	0.03	0.03	0.07	(d)
Lead	Calendar Quarter Mean	1.5	0.03	(d)	1.2×10^{-6}	1.2×10^{-6}	4.1×10^{-6}	(d)

NA = Not applicable; ND = Not detectable; maximum concentration below detectable limit; VOC = volatile organic compounds.

a. Source: Hunter (1999).
b. Source: SCDHEC Air Pollution Regulation 61-62.5, Standard 2, "Ambient Air Quality Standards."
c. Sum of (1) an estimated maximum Site boundary concentration from modeling all sources of the indicated pollutant at SRS not exempt from Clean Air Act Title V modeling requirements (maximum potential emissions from the 1998 Air Emissions Inventory data base) and (2) observed concentrations from nearby ambient air monitoring stations.
d. No emissions of this pollutant are expected.
e. New NAAQS for particulate matter ≤2.5 microns (24-hour limit of 65 $\mu g/m^3$ and an annual average limit of 15 $\mu g/m^3$) may become enforceable during the life of this project.
f. There is no standard for ambient concentrations of volatile organic compounds, but their concentrations are relevant to estimating ozone concentrations.
g. Ozone is a regional pollutant resulting from complex photochemical reactions involving oxides of nitrogen (NO_x) and volatile organic compounds (VOCs). Because estimated NO_x and VOCs emissions are below Prevention of Significant Deterioration (PSD) significant emissions rates, corresponding ozone increases are expected to be insignificant.

Table 4.1.3-3. Estimated maximum concentrations (in micrograms per cubic meter) at the SRS boundary for SCDHEC Standard 8 Toxic Air Pollutants.

				Maximum concentration increment				
					Stabilize Tanks Alternative			TC
Air pollutant	Averaging time	South Carolina Standard[a]	SRS baseline[b]	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	Clean and Remove Tanks Alternative
Beryllium	24-hr	0.01	0.009	(c)	3.2×10^{-6}	3.2×10^{-6}	1.1×10^{-5}	(c)
Mercury	24-hr	0.25	0.03	(c)	4.0×10^{-6}	4.0×10^{-6}	1.6×10^{-5}	(c)
Benzene	24-hr	150	4.6	(c)	3.8×10^{-4}	3.8×10^{-4}	2.0×10^{-2}	(c)

a. From SCDHEC Air Pollution Regulation 61-62.5, Standard 8, Part II, Paragraph E, "Toxic Air Pollutants."
b. Estimated maximum Site boundary concentrations from modeling all sources of the indicated pollutant at SRS not exempt from Clean Air Act Title V modeling requirements (maximum potential emissions from the 1998 Air Emissions Inventory database).
c. No emissions of this pollutant are expected.

Table 4.1.3-4. Estimated maximum concentrations (in milligrams/cubic meter) of OSHA-regulated nonradiological air pollutants at hypothetical noninvolved worker location.

			Maximum concentration[b]				
				Stabilize Tanks Alternative			
Air pollutant	Averaging time	OSHA Standard[a]	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	Clean and Remove Tanks Alternative
Sulfur dioxide (as SO_x)	8-hr TWA	13	-	5.0×10^{-3}	5.0×10^{-3}	0.02	-
Total suspended particulates	8-hr TWA	15	-	ND	ND	0.01	-
Particulate matter (≤10 µm)	8-hr TWA	5	-	9.0×10^{-3}	6.0×10^{-3}	8.0×10^{-3}	-
Carbon monoxide	8-hr TWA	55	-	0.01	0.01	0.04	-
Oxides of nitrogen (as NO_x)	Ceiling	9	-	0.7	0.7	1.4	-
Lead	8-hr TWA	0.05	-	2.1×10^{-6}	2.1×10^{-6}	6.5×10^{-6}	-
Beryllium	8-hr TWA	2.0×10^{-3}	-	4.1×10^{-7}	4.1×10^{-7}	1.3×10^{-6}	-
	Ceiling	5.0×10^{-3}	-	3.4×10^{-6}	3.4×10^{-6}	1.1×10^{-5}	-
Mercury	Ceiling	1.0		4.2×10^{-6}	4.2×10^{-6}	1.4×10^{-5}	-
Benzene	8-hr TWA	3.1	-	4.8×10^{-5}	4.8×10^{-5}	1.0×10^{-3}	-
	Ceiling	15.5	-	3.9×10^{-4}	3.9×10^{-4}	3.3×10^{-3}	-

TC

ND = Not detectable; maximum concentration below detectable limit.

a. Air pollutants regulated under 29 CFR 1910.1000. Averaging values listed are 8-hour time-weighted averages (TWA) except for oxides of nitrogen, mercury, benzene, and beryllium, which also include not-to-be exceeded ceiling (29 CFR 1910.1000 values).

b. Hunter (1999). Maximum estimated concentrations for a noninvolved worker at a distance of 2,100 feet from source and a breathing height of 2 meters.

would be below OSHA limits; all concentrations with the exception of nitrogen dioxide (as NO_x) would be less than 1 percent of the regulatory limit. Nitrogen dioxide (as NO_x) could reach 8 percent of the regulatory limit for the Fill with Grout and Fill with Sand Options, while nitrogen dioxide levels under the Fill with Saltstone Option could reach approximately 16 percent of the OSHA limit. All emissions of nitrogen dioxide are attributable to the operation of the diesel generators.

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Emissions of regulated nonradiological air pollutants resulting from tank closure activities would not exceed PSD limits enforced under SCDHEC Standard 7. Likewise, air concentrations at the SRS boundary of the emitted pollutants under all options would not exceed SCDHEC or Clean Air Act regulatory limits. Any impacts to human health from these pollutants are discussed in Section 4.1.8.2 – Nonradiological Health Effects.

4.1.3.2 Radiological Air Quality

Routine radiological air emissions that would be associated with tank closure activities were assumed to be equivalent to the current level of releases from the F- and H-Area Tank Farms. Annual emissions were based on the previous 5 years of measured data for the tank farms (predominantly Cs-137). For No Action and each of the fill alternatives, all the air exiting the tanks would be filtered through HEPA filters. For the Clean and Remove Tanks Alternative, the top of the tank would have HEPA-filtered enclosures or airlocks during removal of the metal from the tank. The tank would remain under negative pressure during cutting operations, and the exhaust would be filtered through HEPA filtration (Johnson 1999). Therefore, emissions from the tanks in F Area and H Area would not vary substantially among alternatives. The Fill with Saltstone Option under the Stabilize Tanks Alternative would require two new saltstone mixing facilities that would result in additional radionuclide emissions. The estimated Saltstone Manufacturing and Disposal Facility radionuclide emission rates presented in the *DWPF Supplemental EIS* (DOE 1994) were assumed to bound the emissions from both saltstone mixing facilities. The total estimated radiological air emissions for each alternative are shown in Table 4.1.3-5. The relevance to human health of these emissions are presented in Section 4.1.8 – Worker and Public Health.

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After determining routine emission rates, DOE used the MAXIGASP and POPGASP computer codes to estimate radiological doses to the maximally exposed individual, the hypothetical noninvolved worker, and the offsite population surrounding SRS. Both codes utilize the GASPAR (Eckerman et al. 1980) and XOQDOQ (Sagendorf, Croll and Sandusky 1982) modules that have been adapted and verified for use at SRS (Hamby 1992 and Bauer 1991, respectively). MAXIGASP and POPGASP are both Site-specific computer programs that have SRS-specific meteorological parameters (e.g., wind speeds and directions) and population distribution parameters (e.g., number of people in sectors around the Site). The 1990 census population database was used to represent the population living within a 50-mile radius of the center of SRS.

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Table 4.1.3-6 presents the calculated annual maximum radiological doses associated with tank closure activities for all the analyzed alternatives and options. Based on the dispersion modeling, the maximally exposed individual was identified as being located in the northern sector at the SRS boundary (Simpkins 1996). The maximum committed effective dose equivalent for the maximally exposed individual would be 2.6×10^{-5} millirem per year for the Fill with Saltstone Option, which is slightly higher than the other alternatives due to the additional emissions from operation of the saltstone batch plants. A majority of the dose to the maximally exposed individual, 70 percent, is associated with emissions from the tanks in H Area. The annual maximally exposed individual dose under all the alternatives is well below the established annual dose limit of 10 millirem for SRS atmospheric releases (40 CFR 61.92). The maximum estimated dose to the offsite population residing within a 50-mile radius is calculated as 1.5×10^{-3} person-rem per year for the Fill with Saltstone Option. As with the

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Table 4.1.3-5. Annual radionuclide emissions (curies/year) resulting from tank closure activities.

	Annual emission rate				
		Stabilize Tanks Alternative			
	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	Clean and Remove Tanks Alternative
F Area [a]	3.9×10^{-5}	3.9×10^{-5}	3.9×10^{-5}	3.9×10^{-5}	3.9×10^{-5}
H Area [a]	1.1×10^{-4}	1.1×10^{-4}	1.1×10^{-4}	1.1×10^{-4}	1.1×10^{-4}
Saltstone Facility[b]	NA	NA	NA	0.46	NA
Total	1.5×10^{-4}	1.5×10^{-4}	1.5×10^{-4}	0.46	1.5×10^{-4}

a. Source: Arnett and Mamatey (1997 and 1998), Arnett (1994, 1995, and 1996).
b. Source: DOE (1994).

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Table 4.1.3-6. Annual doses from radiological air emissions from tank closure activities.[a]

	Maximum dose				
		Stabilize Tanks Alternative			
	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	Clean and Remove Tanks Alternative
Noninvolved worker dose (millirem/year)	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}
Maximally exposed individual dose (millirem/year)	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	2.6×10^{-5}	2.5×10^{-5}
Offsite population dose (person-rem/year)	1.4×10^{-3}	1.4×10^{-3}	1.4×10^{-3}	1.5×10^{-3}	1.4×10^{-3}

a. Source: Based on emissions values listed in Table 4.1.3-5 and Simpkins (1996).

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maximally exposed individual dose, the tank farm emissions from H Area comprise a majority (71 percent) of the total dose.

Table 4.1.3-6 also reports a dose to the hypothetical onsite worker from the estimated annual radiological emissions. The Fill with Saltstone Option is slightly higher than the other alternatives, 2.64×10^{-3} versus 2.57×10^{-3} millirem per year, with 74 percent of the total dose due to emissions from the H-Area Tank Farm.

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Radionuclide doses from tank closure activities for all alternatives and options considered would not exceed any regulatory limit. Potential human health impacts from these doses are presented in Section 4.1.8.

4.1.4 ECOLOGICAL RESOURCES

Most of the closure activities described in Chapter 2 (e.g., excavation and removal of transfer lines) would take place within the fenced boundaries of the F- and H-Area Tank Farms, heavily industrialized areas that provide limited wildlife habitat (see Figures 3.5-1 and 3.5-2). However, wildlife in undeveloped woodland areas adjacent to the F- and H-Area Tank Farms could be intermittently disturbed by construction activity and noise over the approximately 30-year period when 49 HLW tanks would be emptied (under all alternatives, including No Action), stabilized (under the Stabilize Tanks Alternative), or cleaned and

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removed (under the Clean and Remove Tanks Alternative).

Construction would involve the movement of workers and construction equipment and would be associated with relatively loud noises from earth-moving equipment, portable generators, cutting tools, drills, hammers, and the like. Although noise levels in construction areas could be as high as 110 decibels (dBA), these high local noise levels would not extend far beyond the boundaries of the project sites.

Table 4.1.4-1 shows the attenuation of construction noise over relatively short distances. At 400 feet from the construction sites, construction noises would range from approximately 60 to 80 dBA. Golden et al. (1980) suggest that noise levels higher than 80 to 85 dBA are sufficient to startle or frighten birds and small mammals. Thus, there would be minimal potential for disturbing birds and small mammals outside a 400-foot radius of the construction sites.

Although noise levels would be relatively low outside the immediate areas of construction, the combination of construction noise and human activity probably would displace small numbers of animals (e.g., songbirds and small mammals) that forage, feed, nest, rest, or den in the woodlands to the south and west of the F-Area Tank Farm and to the south of the H-Area Tank Farm. Construction-related disturbances are likely to create impacts to wildlife that would be small, intermittent, and localized. Some animals could be driven from the area permanently, while others could become accustomed to the increased noise and activity and return to the area. Species likely to be affected (e.g., gray squirrel, opossum, white-tailed deer) are common to ubiquitous in these areas.

Lay-down areas (approximately one to three acres in size) would be established in previously disturbed areas immediately adjacent to the F- and H-Area Tank Farms to support construction activities under the Stabilize Tanks Alternative and the Clean and Remove Tanks Alternative. These lay-down areas would serve as staging and equipment storage areas. The specialized equipment required for handling and conveying fill material under the Stabilize Tanks

Table 4.1.4-1. Peak and attenuated noise (in dBA) levels expected from operation of construction equipment.[a]

Source	Noise level (peak)	Distance from source 50 feet	100 feet	200 feet	400 feet
Heavy trucks	95	84-89	78-83	72-77	66-71
Dump trucks	108	88	82	76	70
Concrete mixer	105	85	79	73	67
Jackhammer	108	88	82	76	70
Scraper	93	80-89	74-82	68-77	60-71
Dozer	107	87-102	81-96	75-90	69-84
Generator	96	76	70	64	58
Crane	104	75-88	69-82	63-76	55-70
Loader	104	73-86	67-80	61-74	55-68
Grader	108	88-91	82-85	76-79	70-73
Dragline	105	85	79	73	67
Pile driver	105	95	89	83	77
Fork lift	100	95	89	83	77

a. Source: Golden et al. (1980).

Alternative (e.g., the batch plants and diesel generators) would also be placed in these lay-down areas. Creating these lay-down areas would have the effect of extending the zone of potential noise impact several hundred feet, but noise-related impacts would still be limited to a relatively small area (less than 20 acres) adjacent to the F- and H-Area Tank Farms.

As noted in Section 3.4.1, no threatened or endangered species, or critical habitat occurs in or near the F- and H-Area Tank Farms, which are heavy-industrial sites surrounded by roads, parking lots, construction shops, and construction lay-down areas and are continually exposed to high levels of human disturbance. DOE will continue to monitor the tank farm area, and all of the SRS, for the presence of threatened or endangered species. If a listed species is found, DOE will determine if tank closure activities would affect that species. If DOE were to determine that adverse impacts may occur, DOE would initiate consultation with the U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act.

DOE has not selected a location for the onsite borrow area, but suitability of a potential sites would be based on proximity to F and H Area, topography, characteristics of soil in an area, accessibility (whether or not access roads are present), and the presence/absence of sensitive resources such as wetlands and archaeological sites. DOE would attempt to locate a source of soil in a previously developed area (or adjacent to a previously developed area) in order to minimize disturbance to plant and animal communities. Representative impacts from borrow pit development would include the physical alteration of 7 to 14 acres of land (and attendant loss of potential wildlife habitat) and noise disturbances to nearby wildlife.

DOE would require approximately 51 acres of land in E Area for use as low-activity waste storage vaults under the Clean and Remove Tanks Alternative. A total of 70 acres of developed land in E Area was identified as available for waste management activities in the *SRS Waste Management EIS*. The analysis in *SRS Waste Management EIS* found that the construction and operation of storage and disposal facilities within the previously cleared and graded portions of E Area (i.e., developed) would have little effect on terrestrial wildlife. Wildlife habitat in these areas is poor and characterized by mowed grassy areas with few animals. Birds and mammals that use these areas, mostly for feeding, would be displaced by construction activities, but it is unlikely that they would be physically harmed or killed.

4.1.5 LAND USE

As can be see from Figures 3.5-1 and 3.5-2, the tank farms are in a highly industrialized portion of the SRS. Since bulk material removal would continue until completed, the transition of tanks to the HLW tank closure project would be phased over an approximately 30-year period. Consequently, closure activities would not result in short-term changes to the land use patterns of the SRS or alter the use or character of the tank farm areas.

A substantial volume of soil (6 to 12.5 million cubic feet) could be required for backfill under the Stabilize Tanks Alternative or the Clean and Remove Tanks Alternative. DOE would obtain this soil from an onsite borrow area. Assuming an average depth of 20 feet for the borrow pit, the borrow area would be approximately 7 to 14 acres in surface area.

DOE has not selected a location for the onsite borrow area, but suitability of potential sites would be based on proximity to F and H Area, topography (ridges and hilltops would be avoided to limit erosion), characteristics of soil in an area, accessibility (whether or not access roads are present), and the presence/absence of sensitive resources such as wetlands and archaeological sites. DOE would attempt to locate a source of soil in a previously developed area (or adjacent to a previously developed area) in order to minimize the amount of undeveloped land converted to industrial use. Consistent with SRS long-term land use plans, any site selected would be within the central developed core of the SRS, which is dedicated to industrial facilities (DOE 1998). There would be no change in overall land use patterns on the SRS.

As discussed in Section 2.1.2, this amount of solid low-level waste generated under the Clean and Remove Tanks Alternative would require about 16 new low-activity waste vaults. The land use impacts of constructing and operating the required low-activity-waste vaults were described and presented in the *SRS Waste Management EIS* (DOE/EIS-0217) and were based on constructing up to 31 low-activity waste vaults. Based on design information presented in the *Waste Management EIS*, the 16 vaults under the Clean and Remove Tanks Alternative would require just over 51 acres of land. In the *SRS Waste Management EIS*, DOE identified 70 acres of previously developed land in E Area that is available for waste storage use. Since completion of the *SRS Waste Management EIS* in July 1995, DOE has not identified the remaining land as a potential site for other activities; therefore, there are no conflicting land uses and the analysis presented in the *SRS Waste Management EIS* is still valid. However, should future land uses change, these changes would be made by DOE through the site development, land-use, and future-use planning processes, including public input through various avenues, such as the Citizens Advisory Board. Finally, any land use changes would be in accordance with the current Future Use Plan (DOE 1998).

4.1.6 SOCIOECONOMIC IMPACTS

Table 4.1.6-1 presents the estimated employment levels associated with each tank closure alternative.

For the No Action Alternative, operators, supervisors, technical staff and maintenance personnel would be required to monitor the tanks and maintain equipment and instruments. These activities are estimated to require about 40 personnel from the existing work force to cover shift and day operations (Johnson 1999).

As seen in Table 4.1.6-1, approximately 85 employees, on average, would be required to perform closure activities for the Fill with Grout and Fill with Sand Options under the Stabilize Tanks Alternative. The Fill with Saltstone Option would require approximately 130 employees (Caldwell 1999). The Clean and Remove Tanks Alternative would require, on average, over 280 employees. In each case, it is assumed two tanks will be closed per year. The employment estimates include all employee classifications: operations, engineering, design, construction, support, and project management.

Table 4.1.6-1. Estimated HLW tank closure employment.

		Stabilize Tanks Alternative			
	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	Clean and Remove Tanks Alternative
Annual employment (Full-time equivalent employees)[a,b]	40	85	85	131	284
Life of project employment (Full-time equivalent employees – years)[c]	980	2,078	2,078	3,210	6,963

a. Source: Caldwell (1999).
b. Assumes two tanks closed per year.
c. Total for all 49 tanks.

The maximum peak annual employment would occur under the Clean and Remove Tanks Alternative. This alternative would require less than 2 percent of the existing SRS workforce. EC All options under the Stabilize Tanks Alternative would require less than 1 percent of the existing SRS workforce.

Given the size of the economy in the six-county region of influence (described in Section 3.6), the estimated SRS workforce, and the size of the regional population and workforce, tank closure activities are not expected to result in any measurable socioeconomic impacts for any of the alternatives. Likewise, impacts to low-income or minority areas (as described in Section 3.6) are also not expected.

4.1.7 CULTURAL RESOURCES

As discussed in Chapter 2, activities associated with the tank closure alternatives at SRS would occur within the current F- and H-Area Tank Farms. Although there may have been prior human occupation at or near the F- and H-Area Tank Farms, the likelihood of historic resources surviving the construction of the tank farms in the early 1950s, before the enactment of regulations to protect such resources, would be small. EC The potential for the presence of a prehistoric site in the candidate locations also is limited. As with any historic sites, tank farm construction activities probably destroyed or severely damaged prehistoric deposits. Therefore, tank closure activities would not be expected to further impact historic or prehistoric resources.

Under the Clean and Remove Tanks Alternative, 16 new low-activity waste vaults would be constructed in E Area. As with the tank farm areas, previous DOE activities in E Area probably destroyed or severely damaged any historic or prehistoric resources. Therefore, construction of these low-activity waste vaults would not be expected to further impact historic or prehistoric resources.

If any historic or archaeological resources should become threatened, however, DOE would take appropriate steps to identify the resources and contact the Savannah River Archaeological Research Program, the South Carolina Institute of Archaeology and Anthropology at the University of South Carolina, and the State Historic Preservation Officer to comply with Section 106 of the National Historic Preservation Act.

4.1.8 WORKER AND PUBLIC HEALTH

This section discusses potential radiological and nonradiological health effects to SRS workers and the surrounding public from the HLW tank closure alternatives; it does not include impacts of potential accidents, which are discussed in Section 4.1.12. DOE based its calculations of health effects from the airborne radiological releases on (1) the dose to the hypothetical maximally exposed offsite individual; (2) the dose to the maximally exposed noninvolved worker (i.e., SRS employees who may work in the vicinity of the HLW tank closure facilities, but are not directly involved in tank closure work); (3) the collective dose to the population within a 50-mile radius around the SRS (approximately 620,000 people); and (4) the collective dose to workers involved in implementing a given alternative (i.e., the workers involved in tank closure activities). All radiation doses mentioned in this EIS are effective dose equivalents; internal exposures are committed effective dose equivalents. This discussion characterizes health effects as additional lifetime latent cancer fatalities likely to occur in the general population around SRS and in the population of workers who would be associated with the alternatives.

Nonradiological health effects discussed in this section include health effects from nonradiological air emissions. In addition, occupational health impacts are presented in terms of estimated work-related illness and injury rates associated with each of the tank closure alternatives.

4.1.8.1 Radiological Health Effects

Radiation can cause a variety of health effects in people. The major effects that environmental and occupational radiation exposures could cause are delayed cancer fatalities, which are called latent cancer fatalities because the cancer can take many years to develop and cause death.

To relate a dose to its effect, DOE has adopted a dose-to-risk conversion factor of 0.0004 latent cancer fatality per person-rem for workers and 0.0005 latent cancer fatality per person-rem for the general population (NCRP 1993). The factor for the population is slightly higher, due to the presence of infants and children who are believed to be more sensitive to radiation than the adult worker population.

DOE uses these conversion factors to estimate the effects of exposing a population to radiation. For example, in a population of 100,000 people exposed only to background radiation (0.3 rem per year), DOE would calculate 15 latent cancer fatalities per year caused by radiation (100,000 persons × 0.3 rem per year × 0.0005 latent cancer fatality per person-rem).

Calculations of the number of latent cancer fatalities associated with radiation exposure might not yield whole numbers and, especially in environmental applications, might yield values less than 1. For example, if a population of 100,000 were exposed to a dose of 0.001 rem per person, the collective dose would be 100 person-rem, and the corresponding number of latent cancer fatalities would be 0.05 (100,000 persons × 0.001 rem × 0.0005 latent cancer fatality per person-rem).

Vital statistics on mortality rates for 1997 (CDC 1998) indicate that the overall lifetime fatality rate in the United States from all forms of cancer is about 23.4 percent (23,400 fatal cancers per 100,000 deaths).

In addition to latent cancer fatalities, other health effects could result from environmental and occupational exposures to radiation; these include nonfatal cancers among the exposed population and genetic effects in subsequent generations. Previous studies have concluded that these effects are less probable than fatal cancers as consequences of radiation exposure (NCRP 1993). Dose-to-risk conversion factors for nonfatal cancers and hereditary genetic effects (0.0001 per person-rem and 0.00013 per person-rem, respectively) are substantially lower than those for fatal cancers. This EIS presents estimated effects of radiation only in terms of latent cancer fatalities because that is the major potential health effect from exposure to radiation. Estimates of nonfatal cancers and hereditary genetic effects can be estimated by multiplying the radiation doses by the appropriate dose-to-risk conversion factors for these effects.

DOE expects minimal worker and public health impacts from the radiological consequences of tank closure activities under any of the closure alternatives. All closure alternatives are expected to result in similar radiological release levels in the near-term. Public radiation doses would likely occur from airborne releases only (Section 4.1.3). Table 4.1.8-1 lists incremental radiation doses estimated for the noninvolved worker (a worker not directly involved with implementing the option, but located 2,100 feet [a standard distance used for consistency with other SRS for NEPA evaluations] from the HLW tank farm) and the public (maximally exposed offsite individual and collective population dose) and corresponding incremental latent cancer fatalities, for each closure alternative. DOE based estimated worker doses on past HLW tank operating experience and the projected number of employees associated with each action (Newman 1999a; Johnson 1999). For the maximally exposed worker, DOE assumed that no worker would receive an annual dose greater than 500 millirem from any alternative because SRS uses the 500 millirem value as an administrative limit for normal operations: that is, an employee who receives an annual dose approaching the administrative limit normally is reassigned to duties in a nonradiation area. Table 4.1.8-2 estimates radiation doses for the collective population of workers who would be directly involved in implementing the options. This estimation was derived by assigning a specific number of workers for each tank closure task and then combining the tasks for each option/alternative. An average collective dose was then assigned for the closure of all 49 HLW tanks. Latent

Table 4.1.8-1. Estimated radiological dose and health impacts to the public and noninvolved worker based on tank emissions in F Area and H Area.

Receptor	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	Clean and Remove Tanks Alternative	
Maximally exposed offsite individual dose (millirem/year)	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	2.6×10^{-5}	2.5×10^{-5}	TC
Maximally exposed offsite individual dose over entire period of analysis (millirem)	6.1×10^{-4}	6.1×10^{-4}	6.1×10^{-4}	6.4×10^{-4}	6.1×10^{-4}	
Maximally exposed offsite individual estimated latent cancer fatality risk	3.0×10^{-10}	3.0×10^{-10}	3.0×10^{-10}	3.2×10^{-10}	3.0×10^{-10}	L-13-3 L-11-9
Noninvolved worker dose (millirem/year)	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}	2.6×10^{-3}	
Noninvolved worker individual dose over entire period of analysis (millirem)	6.3×10^{-2}	6.3×10^{-2}	6.3×10^{-2}	6.5×10^{-2}	6.3×10^{-2}	
Noninvolved worker estimated latent cancer fatality risk	2.5×10^{-8}	2.5×10^{-8}	2.5×10^{-8}	2.6×10^{-8}	2.5×10^{-8}	TC
Dose to population within 50 miles of SRS (person-rem/year)	1.4×10^{-3}	1.4×10^{-3}	1.4×10^{-3}	1.5×10^{-3}	1.4×10^{-3}	
Dose to population within 50 miles of SRS over entire period of analysis (person-rem)	3.5×10^{-2}	3.5×10^{-2}	3.5×10^{-2}	3.6×10^{-2}	3.5×10^{-2}	
Estimated increase in number of latent cancer fatalities in population within 50 miles of SRS	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.8×10^{-5}	1.7×10^{-5}	

Table 4.1.8-2. Estimated radiological dose and health impacts to involved workers by alternative.

	No Action Alternative[a]	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	Clean and Remove Tanks Alternative	TC
Total workload per tank closure (person-year)[b]	NA	2.8	2.8	3.1	11.0	
Collective involved worker dose (person-rem)[c]	29.4[d]	1,600	1,600	1,800	12,000	
Estimated increase in number of latent cancer fatalities	0.012	0.65	0.65	0.72	4.9	

NA = Not applicable.

a. For the No Action Alternative, a work level of 40 persons would be required per year for both tank farms. Source: Newman (1999a).

b. Source: Caldwell (1999).

c. Collective dose is for closure of all 49 tanks.

d. Collective dose for the No Action Alternative is for the period of closure activities for the other alternatives. This dose would continue indefinitely at a rate of approximately 1.2 person-rem per year.

cancer fatalities likely attributable to the doses are also listed in this table. Individual worker doses were not calculated or assigned by this method. Total dose to the involved worker population was not evaluated by DOE, due to the speculative nature of worker locations at the site. As expected, the Clean and Remove Tanks Alternative would result in larger radiological dose and health impacts, due to larger manpower needs. However, impacts are well within the administrative control limit for SRS workers.

L-4-8

The estimated number of latent cancer fatalities in the public listed in Table 4.1.8-1 from airborne emissions for each alternative and/or EC option can be compared to the projected number of fatal cancers (143,863) in the public around the SRS from all causes (as discussed in Section 3.8.1). In all cases, the incremental impacts from the options would be small.

4.1.8.2 Nonradiological Health Effects

DOE evaluated the range of chemicals to which the public and workers would be exposed due to HLW tank closure activities and expects minimal health impacts from nonradiological exposures. The onsite and offsite chemical concentrations from air emissions were discussed in Section 4.1.3. DOE estimated noninvolved worker impacts and Site boundary concentrations to which a maximally exposed member of the public could be exposed.

OSHA limits (29 CFR Part 1910.1000) are time-weighted average concentrations that a facility cannot exceed in any 8-hour work shift of a 40-hour week. In addition, there are OSHA ceiling concentrations that may not be exceeded during any part of the workday. These exposure limits refer to airborne concentrations of substances and represent conditions under which nearly all workers could be exposed day after day without adverse health effects. However, because of the wide variation in individual susceptibility, a small percentage of workers could experience discomfort from concentrations of some substances at or below the permissible limit.

After analysis of expected activities during tank closure, DOE expects little possibility of involved workers in the tank farms and associated facilities being exposed to anything other than incidental concentrations of airborne nonradiological materials. Transfer of oxalic acid to and from the HLW tanks will be by sealed pipeline. Tank cleaning will be performed remotely. Normal industrial practices (e.g., wearing acid aprons and goggles) will be followed for all workers involved in acid handling. For routine operations, no exposure of personnel to oxalic acid would be expected. Therefore, health effects from exposure to nonradiological material inside the facilities or directly around the waste tanks would be small for all options.

The noninvolved worker concentrations were compared to OSHA permissible exposure limits or ceiling limits for protecting worker health, and DOE concluded that all pollutant concentrations were negligible compared to the OSHA standards except for oxides of nitrogen (NO_x).

The NO_x emissions result in ambient concentrations that are about 10 to 15 percent of the standard for all three options within the Stabilize Tanks Alternative. TC

Estimated pollutant releases for beryllium, benzene, and mercury are also expected to be within OSHA guidelines. The maximum excess lifetime cancer risk to the noninvolved worker from exposure to beryllium emissions was estimated to be 3.1×10^{-9}, based on the EPA's Integrated Risk Information System (IRIS) database unit risk factor for beryllium of 2.4×10^{-3} excess cancer risk per microgram per cubic meter. The maximum excess lifetime cancer risk to the noninvolved worker from benzene was estimated to be 8.3×10^{-9}, based on a unit risk factor for benzene of 8.3×10^{-6} excess cancer risk per microgram per cubic meter. These values are less than 1 percent of the 1.0×10^{-6} risk value that EPA typically uses as the threshold of concern. For mercury, there are inconclusive data relating to cancer studies. Therefore, EPA does not report unit risk factors for mercury. However, the mercury concentrations for the noninvolved worker and at the Site boundary are less than 1 percent of their respective OSHA and SCDHEC standards, respectively, for all options. The pollutant values are for the maximum option presented, TC which is the Fill with Saltstone Option. All other options are expected to have lower impact values. See Table 4.1.3-4 for nonradiological pollutant concentrations discussed above.

Exposure to nonradiological contaminants such as beryllium and mercury could also result in adverse health effects other than cancer. For example, exposure to beryllium could result in the development of a scarring lung disease, chronic beryllium disease (also known as berylliosis). However, the beryllium and mercury concentrations at the noninvolved worker locations would be so low that adverse health effects would not be expected.

Likewise, Site boundary concentrations were compared to the SCDHEC standards for ambient concentrations, and DOE concluded that all air emission concentrations were below the applicable standard. See Section 4.1.3 for comparison of estimated concentrations at the Site boundary with SCDHEC standards.

4.1.8.3 Occupational Health and Safety

Table 4.1.8-3 provides estimates of the number of total recordable cases (TRCs) and lost workday cases (LWCs) that could occur during the entire tank closure process. The projected injury rates are based on historic SRS injury rates over a 5-year period from 1994 through 1998 multi-plied by the employment levels for each alternative.

The TRC value includes work-related death, illness, or injury that resulted in loss of consciousness, restriction from work or motion, transfer to another job, or required medical treatment beyond first aid. The data for LWCs represent the number of workdays beyond the day of injury or onset of illness that the employee was away from work or limited to restricted work activity because of an occupational injury or illness.

The results that are presented in Table 4.1.8-3 show that the Clean and Remove Tanks Alternative has the highest number of total TRCs and LWCs (400 and 200, respectively) because it would require the largest number of workers. EC The injury rate for the No Action Alternative is caused by the number of workers that are needed to continue to conduct operations if no action is taken in regard to tank closure activities.

Table 4.1.8-3. Estimated Occupational Safety impacts to involved workers by alternative. TC

		Stabilize Tanks Alternative			
	No Action Alternative[a]	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	Clean and Remove Tanks Alternative
Total workload per tank closure (person-years)[b]	40	42	42	66	140
Total recordable cases of accident or injury[c]	110	120	120	190	400
Lost workday cases[c]	60	62	62	96	210

a. For the No Action Alternative, workload, TRC, and LWC estimates are for the period of closure activities for the other alternatives. These would continue indefinitely. Workload source: Johnson (1999).
b. Total manpower estimates are per tank. Source: Caldwell (1999).
c. TRC and LWC rates basis source: Newman (1999b).

4.1.8.4 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, directs each Federal agency to "make…achieving environmental justice part of its mission" and to identify and address "…disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations." The Presidential Memorandum that accompanied Executive Order 12898 emphasized the importance of using existing laws, including the National Environmental Policy Act (NEPA), to identify and address environmental justice concerns, "including human health, economic, and social effects, of Federal actions."

The Council on Environmental Quality (CEQ), which oversees the Federal government's compliance with Executive Order 12898 and the NEPA, subsequently developed guidelines to assist Federal agencies in incorporating the goals of Executive Order 12898 in the NEPA process. This guidance, published in 1997, was intended to "…assist Federal agencies with their NEPA procedures so that environmental justice concerns are effectively identified and addressed."

As part of this process, DOE identified (in Section 3.6.2) minority and low-income populations within a 50-mile radius of the SRS (plus areas downstream of the Site that withdraw drinking water from the Savannah River), which was defined as the region of influence for the environ-mental justice analysis. The section that follows discusses whether implementing the alternatives described in Chapter 2 would result in disproportionately high or adverse impacts to minority and low-income populations.

Methodology

The CEQ guidance (CEQ 1997) does not provide a standard approach or formula for identifying and addressing environmental justice issues. Instead, it offers Federal agencies general principles for conducting and environmental analysis under NEPA:

- Federal agencies should consider the population structure in the region of influence to determine whether minority populations, low-income populations, or Indian tribes are present, and if so, whether there may be disproportionately high and adverse human health or environmental effects on any of these groups.

- Federal agencies should consider relevant public health and industry data concerning the potential for multiple or cumulative exposure to human health or environmental hazards in the affected population and historical patterns of exposure to environmental hazards, to the extent such information is available.

- Federal agencies should recognize the interrelated cultural social, occupational, historical, or economic factors that may amplify the effects of the proposed agency action. These would include the physical sensitivity of the community or population to particular impacts.

- Federal agencies should develop effective public participation strategies that seek to overcome linguistic, cultural, institutional, and geographic barriers to meaningful participation, and should incorporate active outreach to affected groups.

- Federal agencies should assure meaningful community representation in the process, recognizing that diverse constituencies may be present.

- Federal agencies should seek tribal representation in the process in a manner that is consistent with the government-to-government relationship between the United States and tribal governments, the Federal government's trust responsibility to Federally-recognized tribes, and any treaty rights.

First, DOE assessed the impacts of the proposed action and alternatives to the general population, which near the SRS includes minority and low-income populations. No special considerations, such as unique exposure pathways or cultural practices, contribute to any discernible disproportionate impacts. The only identified cultural practice (or unusual pathway) potentially associated with minority and low-income populations is use of the Savannah River for subsistence fishing. For the *Draft and Final Accelerator Production of Tritium EIS* (issued in 1999), DOE reviewed the limited body of literature available on subsistence activities in the region. DOE concluded that, because the identified communities downstream from the SRS are widely distributed and the potential impact to the general population is not discernible, there would be no potential for disproportionate impacts among minority or low-income populations. Second, having concluded that the potential offsite consequences to the general public of the proposed action and the alternatives would be small, DOE concluded there would be no disproportionately high and adverse impacts to minority or low-income populations.

The above-stated conclusions are based on the comparison of HLW actions to past actions for which environmental justice issues were evaluated in detail. In 1995, DOE conducted an analysis of economic and racial characteristics of the population potentially affected by SRS operations within a 50-mile radius of the Site, *Interim Management of Nuclear Materials EIS* (DOE 1995). In addition, DOE examined the population downstream of the site that withdraws drinking water from the Savannah River. The economic and racial characterization was based on 1990 census tract data from the U.S. Bureau of the Census. More recent census tract data are not available. The nearest minority and low-income populations to SRS are to the south of Augusta, Georgia, northwest of the site.

This environmental justice analysis was based on the assessment of potential impacts associated with the various tank closure alternatives to determine if there would be high and adverse human health or environmental impacts. In this assessment, DOE reviewed potential impacts arising under the major disciplines and resource areas including socioeconomics, cultural resources, air resources, water resources, ecological resources, and public and worker health over the short term (approximately the years 2000 to 2030), and the long term (approximately 10,000 years after the HLW tanks are closed). Regarding health effects, both normal facility operations and postulated accident conditions were analyzed, with accident scenarios evaluated in terms of risk to workers and the public.

Although no high and adverse impacts were predicted for the activities analyzed in this EIS, DOE nevertheless considered whether there were any means for minority or low-income populations to experience disproportionately high and adverse impacts. The basis for making this determination would be a comparison of areas predicted to experience human health or environmental impacts with areas in the region of influence known to contain high percentages of minority or low-income populations.

The environmental justice analysis for the tank closure alternatives was assessed for a 50-mile area surrounding SRS (plus downstream areas), as discussed in Section 3.6.2.

Short-Term Impacts

For environmental justice concerns to be implicated, high and adverse human health or environmental impacts must disproportionately affect minority populations or low-income populations.

None of the proposed tank closure alternatives would produce significant short-term impacts to surface water (see Section 4.1.2.1) or groundwater (see Section 4.1.2.2). Emissions of non-radiological and radiological air pollutants from tank closure activities would be below regulatory limits (see Section 4.1.3) and would result in minimal impacts to workers and the public (see Sections 4.1.8.1 and 4.1.8.2). The estimated radiological doses and health impacts to the noninvolved worker and the public are very small (highest dose is 0.0026 millirem per

TC year to the noninvolved worker, under the Fill with Saltstone Option of the Stabilize Tanks Alternative).

Because all tank closure activities would take place in an area that has been dedicated to industrial use for more than 40 years, no short-term impacts to ecological resources (see Section 4.1.4), existing land uses (see Section 4.1.5) or cultural resources (see Section 4.1.7) are expected.

Relatively small numbers of workers would be required to carry out tank closure activities regardless of the alternative(s) selected (see Section 4.1.6); as a result, none of the tank closure alternatives would affect socioeconomic trends (i.e., unemployment, wages, housing) in the region of influence.

As noted in Section 4.2, no long-term environmental justice impacts are anticipated.

Because short-term impacts would not significantly impact the surrounding population, and no means were identified for minority or low-income populations to be disproportionately affected, no disproportionately high and adverse impacts would be expected for minority or low-income populations under any of the alternatives.

Subsistence Consumption of Fish, Wildlife, and Game

Section 4-4 of Executive Order 12898 directs Federal agencies "whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence and that Federal governments communicate to the public the risks of these consumption patterns." There is no evidence to suggest that minority or low-income populations in the SRS region of influence are dependent on subsistence fishing, hunting, or gathering. DOE nevertheless considered whether there were any means for minority or low-income populations to be disproportionately affected by examining levels for contaminants in vegetables, fruit, livestock, and game animals collected from the SRS and from adjacent lands. In addition, DOE assessed concentrations of contaminants in fish collected from SRS waterbodies and from the Savannah River up- and downstream of the Site.

Based on recent monitoring results, concentrations of radiological and nonradiological contaminants in vegetables, fruit, livestock, game animals, and fish from the SRS and surrounding areas are generally low, in virtually all instances below applicable DOE standards (Arnett and Mamatey 1999). Consequently, no disproportionately high and adverse human health impacts would be expected in minority or low-income populations in the region that rely on subsistence consumption of fish, wildlife, or native plants.

It should be noted that mercury, which is present in relatively high concentrations in fish collected from SRS and the middle reaches of the Savannah River, could pose a potential threat to individuals and populations that rely on subsistence fishing. This mercury in fish has been attributed to upstream (non-DOE) industrial sources and natural sources (DOE 1997). The tank closure alternatives under consideration would not affect mercury concentrations in SRS waterbodies or the Savannah River.

4.1.9 TRANSPORTATION

SRS is served by more than 199 miles of primary roads and more than 995 miles of unpaved secondary roads. The primary highways used by SRS commuters are State Routes 19, 64, and 125; 40, 10, and 50 percent of the workers use these routes, respectively. Significant congestion can occur during peak traffic periods onsite on SRS Road 1-A, State Routes 19 and 125, and U.S. Route 278 at SRS access points. Construction vehicles associated with this action would use these same routes and access points.

Cement (grout), saltstone, and sand are the different materials that could be used to fill the tanks. The trucks could come to the site with premixed fill material batched at the vendor's facility. If the Fill with Grout Option under the Stabilize Tanks Alternative were used, approximately 654 truckloads would be required to fill each waste tank, which would result in 654 round trips. The total trips for all 49 tanks would be 32,046. The Fill with Sand Option would require approximately 653 truckloads; therefore, 653 round trips would be necessary. The total trips for all 49 tanks would be 31,997. The Fill with Saltstone Option would result in approximately 19 truck loads and 19 round trips leading to 931 total trips for all the tanks. The No Action Alternative would not require any truckloads of material. Lastly, the Clean and Remove Tanks Alternative would require 5 truckloads of material, which would result in 5 round trips and 245 trips for all the tanks because only oxalic acid would be transported from offsite. See Table 4.1.9-1 for summary of data used to obtain the above information.

Assuming that the material is supplied by vendor facilities in Jackson and New Ellenton (i.e., a round-trip distance of 18 miles), closure of the tanks using each alternative would result in approximately 576,828 miles traveled for the grout fill option under the Stabilize Tanks Alternative, 575,946 miles for the sand fill option, 16,758 miles for the saltstone fill option, 0 miles for the No Action Alternative, and 4,410 miles for the Clean and Remove Tanks Alternative. Using Federal Aid Primary Highway System statistics for South Carolina from 1986 to 1988 (Saricks, and Kvitek 1994), DOE calculated the impacts of potential transportation accidents for each alternative, which are presented in Table 4.1.9-2.

Table 4.1.9-1. Estimated maximum volumes of materials consumed and round trips per tank during tank closure.

Materials	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	Clean and Remove Tanks Alternative
Oxalic acid (4 weight percent) (gallons)	-	225,000	225,000	225,000	500,000
Soil (cubic meters)[a]	-	170,000	170,000	170,000	356,000
Sand (gallons)	-	-	2,640,000	-	-
Cement (gallons)	-	2,640,000	-	52,800	-
Fly ash (gallons)	-	-	-	Included in	-
Boiler slag (gallons)	-	-	-	saltstone	-
Additives (grout) (gallons)	-	500	-	-	-
Saltstone (gallons)	-	-	-	2,640,000	-
Round trips/tank	-	654	653	19	5

a. Soil values represent the total volume needed for the eight tanks requiring backfill under the Stabilize Tanks Alternative and the voids for all 49 tanks under the Clean and Remove Tanks Alternative.

\- = not used in that option/alternative.

Table 4.1.9-2. Estimated transportation accidents, fatalities, and injuries during tank closure.

	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	Clean and Remove Tanks Alternative
Accidents	NA	0.6	0.6	0.02	0.005
Fatalities	NA	0.08	0.08	0.002	0.0006
Injuries	NA	0.6	0.6	0.02	0.005

NA = Not applicable.

Regardless of the alternative chosen, it is anticipated that one tank would be closed at a time; therefore, the existing transportation structure would be adequate to accommodate this projected traffic volume. None of the routes associated with this transportation would require additional traffic controls and/or highway modifications. The surrounding area already has a certain volume of truck and car traffic associated with SRS logging, agriculture, and industrial activity. The amount of traffic associated with the proposed action would increase traffic volume by 0.025 percent, based on traffic counts from the South Carolina Highway Department.

4.1.10 WASTE GENERATION AND DISPOSAL CAPACITY

This section describes impacts to the existing or planned SRS waste management systems resulting from closure of the HLW tank systems. Waste generation estimates are provided for each tank closure alternative that DOE considered in this EIS. Impacts are described in terms of increases in waste generation beyond that expected from other SRS activities during the same period and the potential requirements for new waste management facilities or expanded capacity at existing or planned facilities.

The SRS HLW tank systems include four tank designs (Types I, II, III, and IV). Estimates were developed for the volume of waste generated from closure of a single Type III tank system. Closure of a Type III tank system represents the maximum waste generation relative to the other tank designs. Waste generation estimates for closure of the other tank designs are assumed to be: Type I – 60 percent of Type III estimate, Type II – 80 percent of Type III estimates, and Type IV – 90 percent of Type III estimate. Table 4.1.10-1 provides estimates of the maximum annual waste generation. These annual values assume that two Type III tanks would be closed in one year. Table 4.1.10-2 provides the total waste volumes that would be generated from closure of the 49 remaining SRS HLW tank systems for each of the alternatives.

Table 4.1.10-1. Maximum annual generation for the HLW tank closure alternatives.[a]

TC

	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	Clean and Remove Tanks Alternative
Radioactive liquid waste (gallons)	0	600,000	600,000	600,000	1,200,000
Nonradioactive liquid waste (gallons)	0	20,000	20,000	20,000	0
Transuranic waste (cubic meters)	0	0	0	0	0
Low-level waste (cubic meters)	0	60	60	60	900
Hazardous waste (cubic meters)	0	2	2	2	2
Mixed low-level waste (cubic meters)	0	12	12	12	20
Industrial waste (cubic meters)	0	20	20	20	20
Sanitary waste (cubic meters)	0	0	0	0	0

a. Source: Johnson (1999a,b).

Table 4.1.10-2. Total estimated waste generation for the HLW tank closure alternatives.[a]

TC

	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	Clean and Remove Tanks Alternative
Radioactive liquid waste (gallons)	0	12,840,000	12,840,000	12,840,000	25,680,000
Nonradioactive liquid waste (gallons)	0	428,000	428,000	428,000	0
Transuranic waste (cubic meters)	0	0	0	0	0
Low-level waste (cubic meters)	0	1,284	1,284	1,284	19,260
Hazardous waste (cubic meters)	0	42.8	42.8	42.8	42.8
Mixed low-level waste (cubic meters)	0	257	257	257	428
Industrial waste (cubic meters)	0	428	428	428	428
Sanitary waste (cubic meters)	0	0	0	0	0

a. Source: Johnson (1999a,b).

4.1.10.1 Liquid Waste

Radioactive liquid wastes would be generated as a result of tank cleaning activities under the Stabilize Tanks Alternative and Clean and Remove Tanks Alternative. The waste consists of the spent oxalic acid cleaning solutions and water rinses. This material would be managed as part of ongoing operations in the SRS HLW management system (e.g., evaporation and treatment of the evaporator overheads in the Effluent Treatment Facility). The projected volume of radioactive liquid waste under the Stabilize Tanks Alternative is 3.4 times the forecasted SRS HLW generation through 2029 (see Section 3.9, Table 3.9-1). The projected volume under the Clean and Remove Tanks Alternative is 6.9 times the forecasted SRS HLW generation for that period. This liquid waste would contain substantially less radioactivity than HLW and would not affect the environ-mental impacts of tank farm operations (i.e., there would be no increase in airborne emissions or worker radiation exposure).

TC

TC

DOE would need to evaluate the current schedule for closure of the HLW tank systems to ensure that adequate capacity remained in the tank farms to manage the amount of radioactive liquid waste generated from tank cleaning activities. A *High-Level Waste System Plan* (WSRC 1998) has been developed to present the integrated operating strategy for the various components (tank farms, DWPF, salt disposition) comprising the HLW system. The *High-Level Waste System Plan* integrates budgetary information, regulatory considerations (including waste removal and closure schedules), and production planning data (e.g., projected tank farm influents and effluents, evaporator operations, DWPF canister production). DOE uses computer simulations to model the operation of the HLW system. The amount of available tank farm storage space is an important parameter in those simulations. Other elements in the HLW system are adjusted to ensure the tank farms will have adequate waste storage capacity to support operations. The *High-Level Waste System Plan* assumes that a salt processing process will be operational by the year 20l0. However, if the salt processing process startup is delayed, the tank closure schedule may need to be extended because there would not be sufficient space in the tank farms to manage the large amounts of dilute liquid wastes generated by waste removal activities. The volume of this dilute waste can readily be reduced by using the tank farm evaporators. The salt processing process should be adequate to handle the additional radioactive liquid waste volume for the most water-intensive of the HLW tank closure alternatives (Clean and Remove Tanks) without schedule delays. The bulk of this wastewater would be generated at a time when other contributors to the tank farm inventory have stopped producing waste or dramatically reduced their generation rates. Delaying startup of the salt processing process would result in about a year-for-year slip in the current waste removal schedule with a corresponding delay in tank closures. The need for any schedule modification would be identified through the *High-Level Waste System Plan.*

Nonradioactive liquid wastes would be generated under the Stabilize Tanks Alternative as a result of flushing activities associated with the preparation and transport of all the fill material. This wastewater would be managed in existing SRS treatment facilities.

4.1.10.2 <u>Transuranic Waste</u>

DOE does not expect to generate transuranic wastes as a result of the proposed HLW tank system closure activities.

4.1.10.3 <u>Low-Level Waste</u>

Under the Stabilize Tanks Alternative and Clean and Remove Tanks Alternatives, approximately 30 cubic meters of solid low-level waste (LLW) would be generated per Type III tank closure. This would consists of job control wastes (e.g., personnel protective equipment) generated from activities performed in the area of the tank top. Under the Clean and Remove Tanks Alternative, an additional 420 cubic meters of solid LLW would be generated as a result of each Type III tank removal. DOE assumed that any steel in direct contact with the waste would be removed (e.g., primary tank walls, cooling coils). The concrete shell and secondary containment liner would be left in place and the void space filled with soil. The steel components that are removed would be cut to a size that would fit into standard SRS LLW disposal boxes. The LLW would be disposed at existing SRS disposal facilities. The projected volume of LLW under the Stabilize Tanks Alternative is less than 1 percent of the forecasted SRS LLW generation through 2035. The projected volume under the Clean and Remove Tanks Alternative is about 11 percent of the forecasted SRS LLW generation for that period.

4.1.10.4 <u>Hazardous Waste</u>

Under the Stabilize Tanks Alternative and Clean and Remove Tanks Alternatives, a small amount (about 1 cubic meter) of nonradioactive lead waste would be generated from each Type III tank closure. The projected volume represents less than 1 percent of the forecasted SRS hazardous waste generation through 2035.

4.1.10.5 <u>Mixed Low-Level Waste</u>

Under the Stabilize Tanks Alternative, about 6 cubic meters of radioactive lead waste would be generated for each Type III tank closure. A slightly larger volume (10 cubic meters) would be generated from each Type III tank closure under the Clean and Remove Tanks Alternative. These projected volumes represent 7 and 12 percent, respectively, of the forecasted SRS mixed LLW generation through 2035.

4.1.10.6 <u>Industrial Waste</u>

DOE estimates that about 10 cubic meters of industrial (nonhazardous, nonradioactive) waste would be generated for each Type III tank closure under the Stabilize Tanks Alternative and Clean and Remove Tanks Alternatives.

4.1.10.7 <u>Sanitary Waste</u>

DOE does not expect to generate sanitary wastes as a result of the proposed HLW tank system closure activities.

4.1.11 UTILITIES AND ENERGY

This section describes the estimated utility and energy impacts associated with each of the HLW tank system closure alternatives that DOE considered in this EIS. Water, steam, and diesel fuel would be required to support many of the alternatives. Estimates of water use include preparation of cleaning solutions and rinsing of the tank systems. Steam is used primarily to operate the ventilation systems and to heat the cleaning solutions prior to use. Fuel consumption is based on use of diesel-powered equipment during tank closure activities. Total utility costs are also provided. The utility costs are primarily associated with fossil fuel consumption and steam generation. Water consumption is not a substantial contributor to the overall utility costs.

Table 4.1.11-1 lists the total estimated utility and energy requirements for each tank closure alternative. DOE used applicable past SRS EC operations or engineering judgments to estimate the utility consumption for new closure methods. The following paragraphs describe estimated utility requirements for the alternatives.

4.1.11.1 Water Use

TC Under the Stabilize Tanks Alternative, the estimated quantities of water are based on an assumption that three oxalic acid flushes (75,000 gallons each) and one water rinse (75,000 gallons) would be required to clean the tanks to the extent technically and economically feasible. Oxalic acid would be purchased in bulk and diluted with water to the desired strength (about 4 weight percent) prior to use in the tank farms. Under the Clean and Remove Tanks Alternative, DOE assumed that the quantities of cleaning solutions required to clean the HLW tank systems sufficiently to allow removal would be twice that required under the TC Stabilize Tanks Alternative. No water usage would be required under the No Action Alternative, except for ballast water in those tanks that reside in the water table.

Additional water would be required for the Fill with Grout Option under the Stabilize Tanks TC Alternative. Water would be used to pro-duce the reducing grout, controlled low-strength material (known as CLSM), and strong (high compressive strength) grout used to backfill the tank after cleaning is completed. Assuming a closure configuration of 5 percent reducing grout, 80 percent CLSM, and 15 percent strong grout, about 840,000 gallons of water would be required per Type III tank system (Johnson 1999c).

Table 4.1.11-1. Total estimated utility and energy usage for the HLW tank closure alternatives.[a] TC

	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	Clean and Remove Tanks Alternative
Water (gallons)	7,120,000	48,930,000	12,840,000	12,840,000	25,680,000
Electricity	NA[b]	NA	NA	NA	NA
Steam (pounds)	NA	8,560,000	8,560,000	8,560,000	17,120,000
Fossil fuel (gallons)	NA	214,000	214,000	214,000	428,000
Total utility cost	NA	$4,280,000	$4,280,000	$4,280,000	$12,840,000

a. Source: Johnson (1999a,b,c,d).
b. NA = Not applicable to this alternative. Utility and energy usage for these alternatives would not differ significantly from baseline consumption.

The largest annual water consumption, approximately 2.3 million gallons, would occur for closure of two Type III tanks in a given year. This volume represents less than 1 percent of current SRS groundwater production from industrial wells in the tank farms area (see Section 4.1.2.2).

4.1.11.2 Electricity Use

DOE assumed that there would be no significant additional electrical usage beyond that associated with current tank farm operations. This assumption is supported by DOE's closure of Tanks 17 and 20. Major power requirements associated with the HLW tank closure activities would be met by the use of diesel-powered equipment. Fuel consumption to power the equipment is addressed in Section 4.1.11.4.

4.1.11.3 Steam Use

The two main uses for steam are operation of the ventilation systems on the waste tanks during closure operations and heating of the cleaning solutions prior to use. Operation of the ventilation system uses about 100,000 pounds of 15 psig (pounds per square inch above atmospheric pressure) steam per year. The ventilation system operates as part of current tank farm operations. Thus, steam usage by the ventilation system was not included in this evaluation of tank closure alternatives.

TC Under the Stabilize Tanks Alternative, heating of the oxalic acid cleaning solution would use about 200,000 pounds of 150 psig steam per Type III tank system. The Clean and Remove Tanks Alternative would require twice as much oxalic acid cleaning solution and therefore would use twice (400,000 pounds per Type III TC tank system) as much steam as the Stabilize Tanks Alternative. There would be no additional steam requirements for the No Action Alternative (Johnson 1999c).

4.1.11.4 Diesel Fuel Use

Major power requirements would be covered by the use of diesel-powered equipment. Approximately 5,000 gallons of diesel fuel would be required for each Type III tank system closure under the Stabilize Tanks Alternative. TC The Clean and Remove Tanks Alternative would have twice the number of equipment operating hours as the Stabilize Tanks Alternative and TC would use 10,000 gallons of diesel fuel per Type III tank system closure. There would be no additional diesel fuel requirements for the No Action Alternative (Johnson 1999c,d).

4.1.12 ACCIDENT ANALYSIS

This section summarizes risks to the public and workers from potential accidents associated with the various alternatives for HLW tank closure at the SRS.

Accidents are explicitly analyzed as part of short-term impacts, and are postulated to occur during the storage, cleaning, transfer, or processing operations conducted prior to final tank closure. L-7-80 While accidents are not considered explicitly as part of the long-term impacts, any accident leading to post-closure tank failure would result in the same long-term impacts described in Section 4.2 and Appendix C.

An accident is a sequence of one or more unplanned events with potential outcomes that endanger the health and safety of workers and the public. An accident can involve a combined release of energy and hazardous materials (radiological or chemical) that might cause prompt or latent health effects. The sequence usually begins with an initiating event, such as a human error, equipment failure, or earthquake, followed by a succession of other events that could be dependent or independent of the initial event, which dictate the accident's progression and the extent of materials released. Initiating events fall into three categories:

- *Internal initiators* normally originate in and around the facility, but are always a result of facility operations. Examples include equipment or structural failures and human errors.

- *External initiators* are independent of facility operations and normally originate from outside the facility. Some external initiators affect the ability of the facility to maintain its confinement of hazardous materials because of potential structural damage. Examples include aircraft crashes, vehicle crashes, nearby explosions, and toxic chemical releases at nearby facilities that affect worker performance.

- *Natural phenomena initiators* are natural occurrences that are independent of facility operations and occurrences at nearby facilities or operations. Examples include earthquakes, high winds, floods, lightning, and snow. Although natural phenomena initiators are independent of external facilities, their occurrence can involve those facilities and compound the progression of the accident.

Table 4.1.12-1 summarizes the estimated impacts to workers and the public from potential accidents for each HLW tank closure alternative. Appendix B contains details of each accident, including the scenario description, probability, source term, and consequence. Table 4.1.12-1 lists potential accident consequences as latent cancer fatalities, without consideration of the accident's probability. Accidents involving non-radiological, hazardous materials were evaluated in Appendix B; however, these other accidents were shown to result in no significant impacts to the onsite or offsite receptors. Therefore, the accidents contained in Table 4.1.12-1 are limited to those involving the release of radiological materials.

DOE estimated impacts to three receptors: (1) a noninvolved worker 2,100 feet from the accident location, (2) the maximally exposed individual at the SRS boundary, and (3) the offsite population within 50 miles. DOE did not evaluate total dose to noninvolved worker population, due to the speculative nature of worker locations at the site. EC

Table 4.1.12-1. Estimated accident consequences by alternative.

		Consequences					
Alternative	Accident frequency	Noninvolved worker (rem)	Latent cancer fatalities	Maximally exposed offsite individual (rem)	Latent cancer fatalities	Offsite population (person-rem)	Latent cancer fatalities
TC Stabilize Tanks Alternative							
Transfer errors during cleaning	Once in 1,000 years	7.3	2.9×10^{-3}	0.12	6.0×10^{-5}	5,500	2.8
Seismic event (DBE)[a] during cleaning	Once in 53,000 years	15	6.0×10^{-3}	0.24	1.2×10^{-4}	11,000	5.5
Failure of Salt Solution Hold Tank (Fill with Saltstone Option only) TC	Once in 20,000 years	0.02	8.0×10^{-6}	4.2×10^{-4}	2.1×10^{-7}	17	8.4×10^{-3} L-11-10
Clean and Remove Tanks Alternative							
Transfer errors during cleaning	Once in 1,000 years	7.3	2.9×10^{-3}	0.12	6.0×10^{-5}	5,500	2.8
Seismic event (DBE) during cleaning	Once in 53,000 years	15	6.0×10^{-3}	0.24	1.2×10^{-4}	11,000	5.5

a. DBE = Design basis earthquake.

DOE identified potential accidents in Yeung (1999) and estimated impacts using the AXAIRQ computer model (Simpkins 1995a,b), as discussed in Appendix B.

For all of the accidents, there is a potential for injury or death to involved workers in the vicinity of the accident. In some cases, the impacts to the involved worker would be greater than to the noninvolved worker. However, prediction of latent potential health effects becomes increasingly difficult to quantify as the distance between the accident location and the receptor decreases because the individual worker exposure cannot be precisely defined with respect to the presence of shielding and other protective features. The worker also may be acutely injured or killed by physical effects of the accident itself.

4.2 Long-Term Impacts

Section 4.2 presents a discussion of impacts associated with residual radioactive and non-radioactive material remaining in the closed HLW tanks. DOE has estimated long-term impacts by completing a performance evaluation that includes fate and transport modeling over a long time span (10,000 years) to determine when certain measures of impacts (e.g., radiation dose) reach their peak value. More details on the methodology for long-term closure modeling analysis, and the uncertainties associated with this long-term modeling, are provided in Appendix C. The overall methodology for this long-term closure modeling is the same as the modeling used in the closure modules for Tanks 17 and 20 (DOE 1997a,b), which have been approved by SCDHEC and EPA Region IV. DOE intends to restrict the area around the tank farms from residential use for the entire 10,000-year period of analysis, but has also assessed the potential impacts if institutional controls are lost and residents move into or intruders enter the tank farm areas.

Certain resources involve no long-term impacts and are therefore not included in the long-term analysis. These include air resources, socio-economics, worker health, environmental justice, traffic and transportation, waste generation, and utilities and energy. Therefore, Section 4.2 presents impacts only for the following discipline areas: geologic resources, water resources, ecological resources, land use, and public health. EC

If the Clean and Remove Tanks Alternative were chosen, residual waste would be removed from the tanks and the tank systems themselves would be removed and transported to SRS waste disposal facilities. Long-term impacts at these facilities are evaluated in the *Savannah River Site Waste Management EIS* (DOE 1995). In that EIS, potential impacts of releases from disposal facilities over the long term were evaluated by calculating the concentration of radionuclides in groundwater at a hypothetical well 100 meters (328 feet) downgradient from the vaults. Modeling results for that well predicted that drinking water doses from radioactive constituents would not exceed 4 millirem per year (the drinking water maximum contaminant level for beta- and gamma-emitting radionuclides) at any time after disposal. This dose, and therefore the resulting health impacts, is much smaller than any of the 100-meter-well doses calculated for the Stabilize Tanks Alternative or the No Action Alternative, as presented in the following subsections. Other long-term human health and safety impacts from disposal of tanks in the vaults under the Clean and Remove Tanks Alternative would be small. EC TC

4.2.1 GEOLOGIC RESOURCES

No geologic deposits within F and H Areas have been economically or industrially developed, and none are known to have significant potential for development. The Clean and Remove Tanks Alternative would result in backfilling the tank excavations. Because the backfill material would be locally derived from borrow pits at SRS (see Section 4.1.1), it is assumed to be similar to the natural soils and sediments encountered in the excavations; therefore, no long-term impacts to geologic deposits would occur.

The other tank closure alternatives include closing the tanks in place, which would result in residual waste remaining in the tanks. Upon failure of the tanks as determined by each of the alternatives described in Appendix C, the waste in the tanks would have the potential to contaminate the surrounding soils. The inventory and concentration of the residual waste is expected to be less than that listed in Appendix C Tables C.3.1-1 and C.3.1-2, which are based on conservative assumptions for the waste that would remain in the tanks after waste removal and washing. The residual waste has the potential to contaminate percolating groundwater at some point in the future due to leaching. The water-borne transport of contaminants would contaminate geologic deposits that lie below the tanks. The contamination would not result in any significant physical alteration of the geologic deposits. Filling the closed-in-place tanks with ballast water, sand, saltstone, or grout may also increase the infiltration of precipitation at some point in the future, allowing a greater percolation of water into the underlying geologic deposits. No detrimental effect on surface soils, topography, or to the structural or load-bearing properties of geologic deposits would occur from these actions. There are no anticipated long-term impacts to geologic resources from the Clean and Remove Tanks Alternative. The No Action Alternative and all options under the TC Stabilize Tanks Alternative would allow the soils in the vicinity of the tanks to be impacted.

4.2.2 WATER RESOURCES

4.2.2.1 Surface Water

TC Because the No Action Alternative and Stabilize Tanks Alternative would leave some residual radioactive and non-radioactive material in waste tanks, the potential would exist for long-term impacts to groundwater. Contaminants in groundwater could then be transported through the Water Table, Barnwell-McBean, or Congaree Aquifers to the seeplines along Fourmile Branch and Upper Three Runs, respectively (see Section 4.2.2.2 for a more detailed discussion). The factors governing the movement of contaminants through groundwater (i.e., the hydraulic conductivity, hydraulic gradient, and effective porosity of aquifers in the area) and the processes resulting in attenuation of radiological and non-radiological contaminants (i.e., radioactive decay, ion exchange in the soil, and adsorption to soil particles) would be expected to mitigate subsequent impacts to surface water resources.

DOE used the Multimedia Environmental Pollution Assessment System (MEPAS) computer code (Buck et at. 1995) to model the fate and transport of contaminants in groundwater and subsequent flux to surface waters. Maximum annual concentrations of contaminants at various locations) were estimated and compared to appropriate water quality criteria for the protection of aquatic life.

EPA periodically publishes water quality criteria, which are concentrations of substances that are known to affect "diversity, productivity, and stability" of aquatic communities including "plankton, fish, shellfish, and wildlife" (EPA 1986, 1999). These recommended criteria provide guidance for state regulatory agencies in the development of location-specific water quality standards to protect aquatic life (SCDHEC 1999). Such standards are used in implementing a number of environmental programs, including setting discharge limits in National Pollutant Discharge Elimination EC System (NPDES) permits. Water quality criteria and standards are generally not legally enforceable; however, NPDES discharge limits based on these criteria and standards are legally binding and are enforced by SCDHEC.

The results of the fate and transport modeling of non-radiological contaminants are presented in Tables 4.2.2-1 (Upper Three Runs) and 4.2.2-2 (Fourmile Branch). Based on the modeling, any of the three tank stabilization options under the Stabilize Tanks Alternative would be effective TC in limiting the movement of residual contaminants in closed tanks to nearby streams via groundwater. Concentrations of non-radiological contaminants moving to Upper Three Runs via the Upper Three Runs seepline would be minuscule, in all cases several times lower than applicable standards. Concentrations of non-radiological contaminants reaching

Table 4.2.2-1. Maximum concentrations of non-radiological constituents of concern in Upper Three Runs (milligrams/liter).

	Stabilize Tanks Alternative					
	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative	Water Quality Criteria[a] Acute	Water Quality Criteria[a] Chronic
Aluminum	(b)	(b)	(b)	(b)	0.750	0.087
Chromium IV	(b)	(b)	(b)	(b)	0.016	0.011
Copper	(b)	(b)	(b)	(b)	0.0092	0.0065
Iron	(b)	(b)	(b)	3.7×10^{-5}	2.000	1.000
Lead	(b)	(b)	(b)	(b)	0.034	0.0013
Mercury	(b)	(b)	(b)	(b)	0.0024	1.2×10^{-5}
Nickel	(b)	(b)	(b)	(b)	0.790	0.088
Silver	(b)	(b)	(b)	1.2×10^{-6}	0.0012	-----

TC

a. Criteria to Protect Aquatic Life (SCR. 61-68, Appendix 1).
b. Concentration less than 1.0×10^{-6} milligrams/liter.

Table 4.2.2-2. Maximum concentrations of non-radiological constituents of concern in Fourmile Branch (milligram/liter).

	Stabilize Tanks Alternative					
	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative	Water Quality Criteria[a] Acute	Water Quality Criteria[a] Chronic
Aluminum	(b)	(b)	(b)	(b)	0.750	0.087
Chromium IV	(b)	(b)	(b)	(b)	0.016	0.011
Copper	(b)	(b)	(b)	(b)	0.0092	0.0065
Iron	3.0×10^{-5}	3.0×10^{-5}	3.0×10^{-5}	4.9×10^{-4}	2.000	1.000
Lead	(b)	(b)	(b)	(b)	0.034	0.0013
Mercury	(b)	(b)	(b)	(b)	0.0024	1.2×10^{-5}
Nickel	(b)	(b)	(b)	(b)	0.790	0.088
Silver	8.8×10^{-6}	6.5×10^{-6}	8.8×10^{-6}	1.1×10^{-4}	0.0012	-----

TC

a. Criteria to Protect Aquatic Life (SCR. 61-68, Appendix 1).
b. Concentration less than 1.0×10^{-6} milligram/liter.

Fourmile Branch via the Fourmile Branch TC seepline would also be low under the Stabilize Tanks Alternative. Concentrations of contaminants reaching Upper Three Runs and Fourmile Branch would be low under the No Action Alternative as well, but somewhat TC higher than those expected under the Stabilize Tanks Alternative. In all instances, predicted concentrations of non-radiological contaminants were well below applicable water quality standards.

Based on the modeling results, all three stabilization options under the Stabilize Tanks TC Alternative would be more effective than the No Action Alternative. The Fill with Grout TC Option would be most effective of the three tank

TC stabilization options under the Stabilize Tanks Alternative for reducing contaminant migration to surface water.

Table 4.2.2-3 shows maximum radiation doses to humans in surface (drinking) water at the points of compliance for Upper Three Runs and Fourmile Branch. Doses are low under all three tank stabilization options, and are well below the drinking water standard of 4 millirem per year (40 CFR 141.16). The 4-millirem-per-year standard applies only to beta- and gamma-emitting radionuclides but, because the total dose is less than 4 millirem per year, the standard is met. The DOE dose limit for native aquatic animals is 1 rad per day from exposure to radioactive materials in liquid wastes discharged to natural waterways (DOE Order 5400.5). The absorbed dose (see Table 4.2.3-3) from surface water would be a small fraction of the DOE dose limit under any of the alternatives, including No Action. EC

4.2.2.2 <u>Groundwater</u>

<u>Contamination Source</u>

Waste remaining in tanks as a result of the closure alternatives has been identified as the primary source for long-term impacts to groundwater quality. The physical configurations of the waste after closure and the chemical parameters associated with the resulting contamination source zone would, however, vary between the closure alternatives. The in-place closure alternatives consist of the following:

- No Action Alternative (bulk waste removal and fill with ballast water)
- Stabilize Tanks Alternative
  - Fill with Grout Option (Preferred Alternative)
  - Fill with Sand Option
  - Fill with Saltstone Option

TC

For the No Action Alternative, the contaminant inventory would be the highest because this alternative would not provide for tank cleaning following bulk waste removal. In addition, filling the tanks with ballast water would allow for the immediate generation of a large volume of contaminated leachate. For the three tank stabilization options under the Stabilize Tanks Alternative, cleaning of the tanks would result in lower initial volume and inventory of contaminants in the residual waste prior to filling. TC The Fill with Grout Option would produce a source zone that consists of the residual waste covered by a low-permeability reducing grout. TC The grout fill would lower the water infiltration until failure and would reduce the leach rate of chemicals, compared to the other options. The source zone for this option, therefore, would have more time to undergo radioactive decay prior to tank failure, compared to the other alternatives. The Fill with Sand Option would result in little physical alteration of the residual waste in the tanks other than some mixing and an overall increase in the volume of contaminated material. TC This option also would result in a higher leaching rate than the Fill with Grout or Saltstone Options. The Fill with Saltstone Option would bind the residual waste and create a low-permeability zone, compared to natural soils; however, the overall magnitude of the source term would be increased due to the presence of background contamination in the saltstone medium. TC

The evaluation and comparison of the in-place closure alternatives uses the results of long-term groundwater fate and transport modeling to interpret the potential impacts to groundwater resources beneath the F- and H-Area Tank Farms for each of the alternatives. Areas within the groundwater migration pathway to the downgradient point of compliance (the seepline along Upper Three Runs and Fourmile Branch) are also included in the evaluation. EC The analysis also presents the impacts to groundwater at 1 meter and 100 meters downgradient of the tank farm. Impacts are presented in tables in the following sections that compare the predicted (i.e., modeled) groundwater concentrations to regulatory limits or established SRS guidelines for the various contaminants of interest.

Table 4.2.2-3. Maximum drinking water dose from radionuclides in surface water (millirem/year).

	Stabilize Tanks Alternative			
	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Upper Three Runs	(a)	4.3×10^{-3}	9.6×10^{-3}	0.45
Fourmile Branch	9.8×10^{-3}	0.019	0.130	2.3

a. Radiation dose for this alternative is less than 1×10^{-3} millirem.

TC

EC The tank farms were modeled by assuming conditions that would exist after tank closure for each of the alternatives that included closure of the tanks in place. The identity and level of residual contaminants in each tank were derived from data provided by Johnson (1999).

The source term for the modeling described in this EIS was based on knowledge of the processes that generated the waste. DOE assumed that the residuals left behind after waste removal would have approximately the same composition as the waste currently in the tanks. The total amount of radionuclides in the tank farms is well known, so this approach should yield a reasonable estimate of tank-farm-wide doses, because overestimates in one tank should be balanced by underestimates in another tank. This modeling also considered residual material remaining in piping and ancillary equipment associated with the closed HLW tanks. This piping and ancillary equipment is assumed to contribute an additional 20 percent of the inventory in the closed tanks.

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Before each tank is closed, DOE will determine the actual residual in that tank and, through modeling, ensure that closure of the tank would be within requirements. In Tanks 17 and 20 (the two tanks that have been closed), this was done by separately estimating the volume and composition of the waste, and then combining these two pieces of information to develop tank inventories of each radionuclide of interest. A similar procedure will be followed in the future for residual waste in each tank. In Tanks 17 and 20, the depth of the solids was estimated at various points in the tank by comparing the sludge level to objects of known height in the tank, and this information was integrated over the area of the tank to yield a total tank volume of residual. The composition of the waste was estimated (1) by knowledge of the processes that sent waste to the tank and (2) by samples. If there was a discrepancy between the two methods, the method yielding the higher concentration was used for modeling. In the future, new techniques may need to be developed to accurately assess the residuals. For example, in tanks with high radionuclide concentration, the depth of the solids may be too small to accurately measure visually, so some other technique may need to be employed.

L-7-5

TC

Each of the closure alternatives proposed in Chapter 2, except for tank removal, includes actions that may result in potential long-term impacts to groundwater beneath the tank farms. Because groundwater is in a state of constant flux, impacts that occur directly above or below the tank farms may propagate to areas hydraulically downgradient of the tank farms. The primary action that would result in long-term impacts to groundwater is in-place tank closure that would result in some quantity of residual waste material remaining in the tanks. The residual waste has the potential to contaminate groundwater at some point in the future, due to leaching and water-borne transport of contaminants.

The tank farms are situated in highly developed industrial areas. Some of the tank groups were constructed in pits substantially lower in elevation than the surrounding terrain. The existing tank farm sites, therefore, include facilities and structures designed to prevent surface ponding and to manage precipitation runoff in a controlled manner. Reclamation of the tank farms after closure would require backfilling and grading to provide a suitable site for future industrial/commercial development, to prevent future ponding of water at the surface, and to promote non-erosional surface water runoff. Backfilling and grading would be performed using borrow material derived from local areas at the SRS (see Section 4.1.1). The material is assumed to be physically similar to the in-place materials. Therefore, there should be little or no impact to long-term groundwater recharge or quality as a result of the surface reclamation activities. Because the tanks would be completely removed from service at closure, there are no other long-term operations at the tank farms that could potentially impact groundwater resources.

Modeling Methodology

EC The modeling results are intended to be used to predict whether each closure alternative and option would meet the identified regulatory and SRS water quality criteria at the point of compliance (i.e., the seepline). For this EIS, DOE also used the model predictions as input to the assessment of potential health effects to hypothetical future residents in locations near
L-5-4 the streams, as well as estimated doses in hypothetical wells 1 and 100 meters downgradient from the tank farms. This process addresses the cumulative effect of all the tanks in a tank farm whose plumes may intersect. Because of the physical separation of the F- and H-Area Tank Farms and the hydrogeologic setting, no overlapping of plumes from the two tank farms is anticipated. The presence of a groundwater divide that runs through the H-Area Tank Farm required a separation of the tank groups in the H Area. This separation was necessary to identify impacts at various locations that are separated in both space and time as a result of the various groundwater flow directions and paths that leave different areas of the H-Area Tank Farm. Therefore the analysis and presentation of results are provided on a tank-farm or tank-grouping basis for each alternative.

Modeling the fate and transport of contaminants was performed using the Multimedia Environmental Pollutant Assessment System (MEPAS) computer model (Buck et al. 1995). The program is EPA-recognized and uses analytical methods to model the transport of contaminants from a source unit to any point at which the user desires to calculate the concentration. The modeling effort requires certain assumptions about the contaminant source term, source configuration, and hydrogeologic structure of the area between each of the tank farms, or tank groups, and the point where impacts are evaluated. Appendix C presents the major assumptions and inputs used in the long-term fate and transport modeling.

To account for overlapping of the contaminant plumes from separate tank groups that discharge to the same location, the modeled groundwater concentrations were summed as if the various tank groups were at the same initial physical location. Because of the size of the tank groups and the length of the groundwater flow paths, sensitivity analyses showed that the actual location of the contaminant source within the tank group had little impact at the point of analysis at the seepline, which is where the General Closure Plan for the tanks specifies that L-5-4 regulatory standards apply to groundwater. The impact analysis also summed the centerline concentrations from each tank-group plume at the point of analysis to ensure that the highest concentration was reported. Therefore, although the plumes from different tank groups may not overlap entirely, the calculation methodology provides an upper estimate for the predicted groundwater impacts. The simplification of treating all the tanks in a group as if they are at the same physical location has the effect of greatly exaggerating estimated groundwater concentrations and doses at close-in locations, including 1-meter and 100-meter wells.

For all of the tank groups in F Area and for several groups in H Area, the historical water level data showed that the tank bottoms are elevated above the zone of groundwater saturation. For these tanks, the modeling simulated leaching of contaminants from the waste zone and vertical migration to the water table. It was observed that some tank groups in the H-Area Tank Farm, due to their installation depth and the presence of a local high in the water table, lie partially or nearly entirely in the zone of groundwater saturation. The modeling simulation was adjusted for these sites to account for submergence of the contamination source zone.

Groundwater Quality Impacts

As described in detail in Appendix C, groundwater flowing beneath the tank farms flows in different directions and includes vertical flow components. In the analyzed alternatives, the mobile contaminants in the tanks would gradually migrate downward through unsaturated soil to the hydrogeologic units comprising the shallow aquifers underlying the tank farms. As identified above, because some tank groups in the H Area lie beneath the water table, the contaminants from these tanks would be released directly into the groundwater.

The first hydrogeologic unit impacted would be the Water Table Aquifer formally known as the upper zone of the Upper Three Runs Aquifer
EC (Aadland, Gellici, and Thayer 1995). Some contaminants from each tank farm would be transported by groundwater through the Water Table Aquifer to the seepline along Fourmile Branch. For tanks situated north of the groundwater divide in the H-Area Tank Farm, contaminants released to the Water Table Aquifer may discharge to unnamed tributaries of Upper Three Runs or migrate downward to underlying aquifers. Previous DOE modeling results for this portion of H-Area, (GeoTrans 1993), from which the model inputs were based, showed that approximately 73 percent of the contaminant mass released from these tanks would remain in the Water Table and Barnwell-McBean Aquifers and 27 percent would migrate to the Congaree Aquifer (i.e., Gordon Aquifer) to a point of discharge along Upper Three Runs.

For tank groups located in the F Area and for tank groups located south of the groundwater divide in H Area, the contaminant mass released was simulated to migrate both laterally and vertically, based on the hydrogeologic setting. Previous DOE modeling results for F Area (GeoTrans 1993), from which the model inputs were derived, showed that approximately 96 percent of the contaminant mass released from the F Area tanks would remain in the Water Table and Barnwell-McBean Aquifers and would discharge at the seepline along lower Fourmile Branch. Previous DOE modeling results for H Area (GeoTrans 1993) showed that approximately 78 percent of the released contaminant mass would remain in the Water Table and Barnwell-McBean Aquifers and would discharge at the seepline along upper Fourmile Branch. The remaining 22 percent of contaminant mass released from the H Area tanks was simulated as migrating downward and laterally through the Congaree Aquifer to a point of discharge at the seepline along Upper Three Runs.

Summary of Estimated Concentrations

The results of the groundwater fate and transport modeling for radiological and non-radiological contaminants for each tank farm are presented in Tables 4.2.2-4 through 4.2.2-8. The modeling calculated impacts for each aquifer layer. Because the concentrations in groundwater from the various aquifers are not additive, only the maximum value is presented in the tables. The results are presented for each alternative for the 1-meter and 100-meter wells, and for the seepline. Figure 4.2.2-1 illustrates some of the same results graphically. This figure shows the predicted concentrations over time at the Three Runs seepline (north of the groundwater divide) resulting from contamination transported from the H-Area Tank Farm through the Water Table and Barnwell-McBean Aquifers. Results at the other modeled exposure locations show similar patterns over time. The pattern of the peaks in the graph results from the simplified and conservative approach used in modeling, such as the simplifying assumption that the tanks would release their entire inventories simultaneously and completely. The specific concentrations for each radiological and nonradiological contaminant for each aquifer layer and each exposure point are presented in Appendix C. For radiological contaminants, the dose in

Table 4.2.2-4. Maximum radiological groundwater concentrations from contaminant transport from F-Area Tank Farm.[a]

Radiological emitter - exposure point	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option
Drinking water dose (millirem/yr)				
1-meter well	35,000	130	420	790
100-meter well	14,000	51	190	510
Seepline	430	1.9	3.5	25
Maximum Contaminant Level (millirem/yr)	4	4	4	4
Alpha concentration (picocuries per liter)				
1-meter well	1,700	13	13	13
100-meter well	530	4.8	4.7	4.8
Seepline	9.2	0.04	0.039	0.04
Maximum Contaminant Level (pCi/liter)	15	15	15	15

TC

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the tank farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the *SRS Waste Management EIS* (DOE 1995).

Table 4.2.2-5. Maximum radiological groundwater concentrations from contaminant transport from H-Area Tank Farm.[a]

Radiological emitter - exposure point	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option
Drinking water dose (millirem/yr)				
1-meter well	9.3×10^6	1×10^5	1.3×10^5	1×10^5
100-meter well	9.0×10^4	300	920	870
Seepline, North of Groundwater Divide	2,500	2.5	25	46
Seepline, South of Groundwater Divide	200	0.95	1.4	16
Maximum Contaminant Level (millirem/yr)	4	4	4	4
Alpha Concentration (picocuries per liter)				
1-meter well	13,000	24	290	24
100-meter well	3,800	7.0	38	7.0
Seepline, North of Groundwater Divide	34	0.15	0.33	0.15
Seepline, South of Groundwater Divide	4.9	0.02	0.019	0.02
Maximum Contaminant Level (pCi/liter)	15	15	15	15

TC

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the tank farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the *SRS Waste Management EIS* (DOE 1995). EC

Table 4.2.2-6. Maximum nonradiological groundwater concentrations from contaminant transport from F- and H-Area Tank Farms, 1-meter well.[a] EC

	Maximum concentration (percent of MCL)				
	Barium	Fluoride	Chromium	Mercury	Nitrate
No Action Alternative					
Water Table	0.0	18.5	320	6,500	150
Barnwell-McBean	0.0	47.5	380	0.0	270
Congaree	0.0	6.8	0.0	0.0	62
Fill with Grout Option (TC)					
Water Table	0.0	0.3	21	70	2.3
Barnwell-McBean	0.0	5	23	0.0	21
Congaree	0.0	0.1	0.0	0.0	0.5
Fill with Sand Option (TC)					
Water Table	0.0	1.6	8.5	37	6.7
Barnwell-McBean	0.0	5.3	19	0.0	22
Congaree	0.0	0.1	0.0	0.0	0.7
Fill with Saltstone Option (TC)					
Water Table	0.0	0.3	21	70	240,000
Barnwell-McBean	0.0	5	23	0.0	440,000
Congaree	0.0	0.1	0.0	0.0	160,000

Notes: MCL = Maximum Contaminant Level. Only those contaminants with current EPA Primary Drinking Water MCLs are included in table. A value of "100" for a given contaminant is equivalent to the MCL concentration.

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the tank farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the *SRS Waste Management EIS* (DOE 1995).

Table 4.2.2-7. Maximum nonradiological groundwater concentrations from contaminant transport from F- and H-Area Tank Farms, 100-meter well.[a] EC

	Maximum concentration (percent of MCL)				
100-Meter well	Barium	Fluoride	Chromium	Mercury	Nitrate
No Action Alternative					
Water Table	0.0	8.3	74	265	69
Barnwell-McBean	0.0	12.5	81	0.0	58
Congaree	0.0	1.2	0.0	0.0	11
Fill with Grout Option (TC)					
Water Table	0.0	0.1	2.7	1.5	0.7
Barnwell-McBean	0.0	1.1	4.4	0.0	4.7
Congaree	0.0	0.0	0.0	0.0	0.1
Fill with Sand Option (TC)					
Water Table	0.0	0.3	1.5	2.7	1.3
Barnwell-McBean	0.0	1.2	3.7	0.0	4.9
Congaree	0.0	0.0	0.0	0.0	0.1
Fill with Saltstone Option (TC)					
Water Table	0.0	0.1	2.7	1.5	68,000
Barnwell-McBean	0.0	1.1	4.4	0.0	180,000
Congaree	0.0	0.0	0.0	0.0	21,000

Notes: MCL = Maximum Contaminant Level. Only those contaminants with current EPA Primary Drinking Water MCLs are included in table. A value of "100" for a given contaminant is equivalent to the MCL concentration.

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the tank farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the *SRS Waste Management EIS* (DOE 1995).

Table 4.2.2-8. Maximum nonradiological groundwater concentrations from contaminant transport from F- and H-Area Tank Farms, seepline.[a] EC

Fourmile Branch seepline	Maximum concentration (percent of MCL)				
	Barium	Fluoride	Chromium	Mercury	Nitrate
No Action Alternative					
Water Table	0.0	0.4	1.0	0.0	3.4
Barnwell-McBean	0.0	0.5	0.8	0.0	2.4
Congaree	0.0	0.0	0.0	0.0	0.1
Fill with Grout Option					
Water Table	0.0	0.0	0.0	0.0	0.0
Barnwell-McBean	0.0	0.0	0.0	0.0	0.1
Congaree	0.0	0.0	0.0	0.0	0.0
Fill with Sand Option					
Water Table	0.0	0.0	0.0	0.0	0.1
Barnwell-McBean	0.0	0.0	0.0	0.0	0.2
Congaree	0.0	0.0	0.0	0.0	0.0
Fill with Saltstone Option					
Water Table	0.0	0.0	0.0	0.0	3,000
Barnwell-McBean	0.0	0.0	0.0	0.0	3,300
Congaree	0.0	0.0	0.0	0.0	300

TC (Fill with Grout Option)
TC (Fill with Sand Option)
TC (Fill with Saltstone Option)

Notes: Only those contaminants with current EPA Primary Drinking Water MCLs are included in table. A value of "100" for a given contaminant is equivalent to the MCL concentration.

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the tank farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the *SRS Waste Management EIS* (DOE 1995).

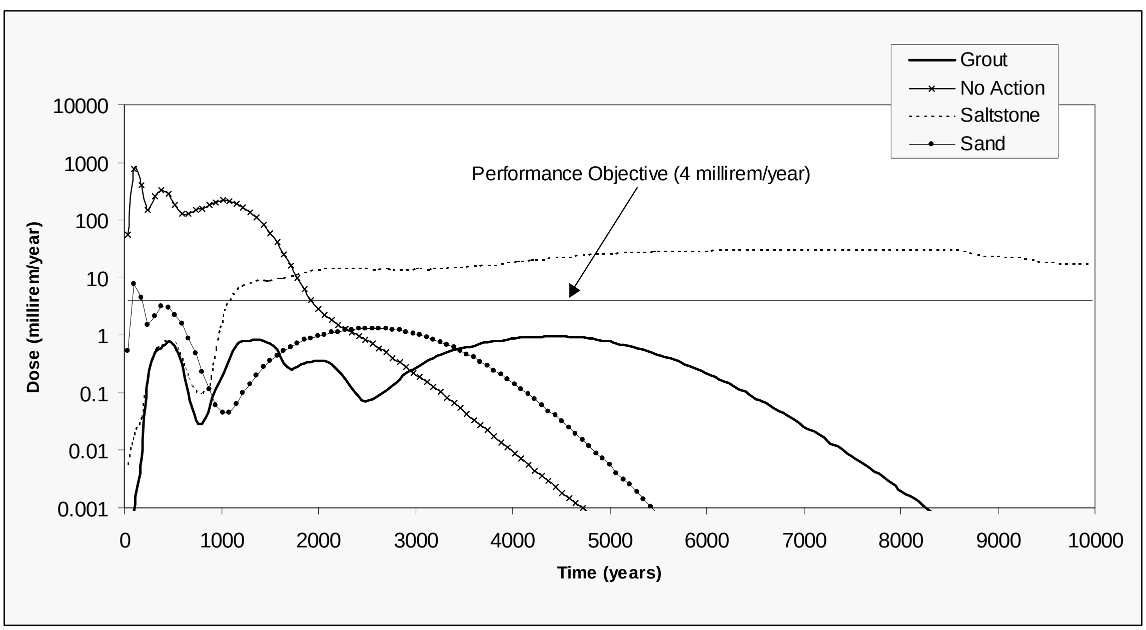

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Figure 4.2.2-1. Predicted drinking water dose over time at the H-Area seepline north of the groundwater divide in the Barnwell-McBean and Water Table Aquifers.

millirem per year from all radionuclides or the concentration of all alpha-emitting radionuclides are considered additive for any given aquifer layer at any exposure point. The maximum radiation dose (millirem per year) and maximum alpha concentration (picocuries per liter), regardless of the aquifer layer, are therefore presented in the tables for each exposure point. This data represents the increment in time when the sum of all beta-gamma or alpha emitters is greatest, but not necessarily when each species is at its maximum concentration. This method of data presentation shows the overall maximum dose or concentration that occurs at each exposure point.

For nonradiological contaminants, the effects of the contaminants are not considered to be additive. The maximum concentration of each nonradiological contaminant, regardless of time, was determined for each aquifer layer and for each exposure point. Only those contaminants with current EPA Drinking Water Standard Maximum Contaminant Levels (MCLs) are shown on the tables. For comparison among the different alternatives, the maximum value for each nonradiological contaminant was converted to its percentage of the MCL. This value provides a streamlined, quantitative method of comparing the impacts of the maximum concentrations for each alternative.

Comparison of Alternatives

The radiological results provided in Tables 4.2.2-4 and 4.2.2-5 and illustrated in Figure 4.2.2-1 consistently show that the greatest long-term impacts occur under the No Action Alternative. For this alternative, the Maximum Contaminant Level for beta-gamma radionuclides is exceeded at all points of exposure. On the other hand, the Fill with Grout Option shows the lowest long-term impacts at all exposure points. This option is the only one that meets the drinking water MCL of 4 mrem/year at the seepline, where the General Closure Plan for the tanks specifies that this standard applies to groundwater. Also, Figure 4.2.2-1 shows that impacts would occur later than under the No Action Alternative or the Fill with Sand Option. Peak dose under the Fill with Sand Alternative would be less than under the No Action Alternative and the MCL would be met at the seepline, but doses would be greater than under the Fill with Grout Option and would occur sooner. Like the Fill with Sand Option, the Fill with Saltstone Option would delay the impacts at the seepline, but it would result in a higher peak dose than either the Fill with Grout or Fill with Sand Options (the peak dose under this alternative would exceed the MCL at the seepline) and the peak doses would persist for a very long time due to the release of other radiological constituents from the saltstone.

The results for alpha-emitting radionuclides shown in Tables 4.2.2-4 and 4.2.2-5 also show that the greatest long-term impacts would occur for the No Action Alternative. For this alternative, the MCL is exceeded at the 1-meter and 100-meter wells. The grout, sand, and saltstone fill options show similar impacts at all most locations. For these three options, the MCL for alpha-emitting radionuclides would be exceeded only at the 1-meter well (all three options) and at the 100-meter well (Fill with Sand Option).

The nonradiological results presented in Tables 4.2.2-6 through 4.2.2-8 show a consistent trend for all points of exposure. Unlike the radiological results, however, the data show exceedances of the MCLs only for the No Action Alternative and Fill with Saltstone Option. The impacts are greatest in terms of the variety of contaminants that exceed the MCL for the No Action Alternative, but exceedances of the MCLs primarily occur at the 1-meter well. Impacts from the Fill with Saltstone Option occur at all exposure points, including the seepline; however, nitrate is the only contaminant that exceeds the MCL. This occurs because the saltstone would contain large quantities of nitrate that would not be present in the tank residual. The MCLs are not exceeded for any contaminant in any aquifer layer, at any point of exposure, for either the Fill with Grout or the Fill with Sand Options.

4.2.3 ECOLOGICAL RESOURCES

This section presents an evaluation of the potential long-term impacts of F- and H-Area Tank Farm closure to ecological receptors. DOE assessed the potential risks to ecological receptors at groundwater points of discharge (seeplines) to Upper Three Runs and Fourmile Branch, and the risks to ecological receptors in these streams downstream of the seeplines. This section presents a summary of this analysis; the detailed assessment is provided in Appendix C.

Groundwater-to-surface water discharge of tank farm-related contaminants was the only migration pathway evaluated because the closed tanks would be 4 to 7 meters underground, precluding overland runoff of contaminants and associated terrestrial risks. As a result, only aquatic and semi-aquatic receptors and associated risks were evaluated.

The habitat in the vicinity of the seeplines is bottomland hardwood forest. On the upslope side of the bottomland, the forest becomes a mixture of pine and hardwood.

The estimated 1.24 acre seepage areas are small, (DOE 1997a), so risk to plant populations would be negligible even if individual plants were harmed. The only case in which harm to individual plants might be a concern in such a small area would be if protected plant species are present. Because no protected plant species are known to occur in these areas, risks to terrestrial plants are not treated further in the risk assessment.

4.2.3.1 Nonradiological Contaminants

Exposure for aquatic receptors (e.g., fish, aquatic invertebrates) is expressed as the concentration of contaminants in the water surrounding them. Sediment can become contaminated from the influence of the surface water or from seepage that enters sediment directly. However, this exposure medium was not evaluated because estimating sediment contamination from surface water inputs would be highly speculative and seepage into sediment is not considered in the groundwater model; all of the transported material is assumed to come out at the seeplines. For aquatic receptors, risks were evaluated by comparing concentrations of contaminants in surface water downgradient of seeps with ecological screening guidelines indicative of potential risks to aquatic receptors. Guidelines used are presented in Appendix C. If the ratio of the surface water concentration to the guideline (called the "hazard quotient") exceeded 1.0, risks to aquatic receptors were considered possible.

Exposure for terrestrial (semi-aquatic) receptors is based on dose, expressed as milligrams of contaminant absorbed per kilogram of body mass per day. For this evaluation, the southern short-tailed shrew and mink were selected as representative receptors (see Appendix C). The exposure routes used for estimating dose were ingestion of food and water. The food of shrews is mainly soil invertebrates, and the mink eats small mammals, fish, and a variety of other small animals. Contaminants in seepage water were considered to be directly ingested as drinking water (shrew); ingested as drinking water after dilution in Fourmile Branch and Upper Three Runs (mink); ingested in aquatic prey (mink); and transferred to soil, soil invertebrates, shrews, and to mink through a simple terrestrial food chain. The short-tailed shrew was assumed to receive exposure at the seepline only, and the mink was modeled as obtaining half of its diet from shrews at the seep area and the other half from aquatic prey downstream of the seepline. The bioaccumulation factor for soil and soil invertebrates is 1.0 for all inorganics, as is the factor for accumulation in shrew tissue. Literature-based bioconcentration factors were used to estimate chemical concentrations in aquatic prey for the mink (see Appendix C).

For the short-tailed shrew and the mink, toxicity thresholds are based on the lowest oral doses found in the literature that are no-observed-adverse-effect-levels or lowest-observed-adverse-effect-levels for chronic endpoints that could affect population viability or fitness (Appendix C). Usually the endpoints are adverse effects on reproduction or development. The exposure calculation is a ratio of total EC contaminant intake to body mass, on a daily basis. This dose is divided by the toxicity threshold value to obtain a hazard quotient (HQ). Similar to the ratio used for the aquatic receptors, risks were considered possible when the ratio of the estimated dose to the toxicity threshold HQ exceeded 1.0.

Potential risks were evaluated for all of the analyzed scenarios, which are described in Appendix C. Each of the scenarios was evaluated using four methods for tank stabilization, which include the Fill with Grout Option, the Fill with Sand Option, the Fill with Saltstone Option, and the No Action Alternative (no stabilization). Comprehensive lists of all HQs for each analyzed scenario are presented in Appendix C. Table 4.2.3-1 presents a summary of the maximum hazard indices (HIs) for aquatic receptors by tank stabilization method. HQs for individual aquatic contaminants were summed to obtain HIs. All HI values for the Fill with Sand and Saltstone Options were less than 1.0, indicating negligible risks to aquatic receptors in Fourmile Branch and Upper Three Runs. The maximum HIs for the Fill with Grout Option and No Action Alternative were slightly greater than 1.0. As a result, risks to aquatic receptors are possible. However, the relatively low HI values indicate that although risks are present, they are somewhat low. Although no guidance exists regarding the interpretation of the magnitude of HI values, given the conservation inherent in all aspects of the assessment single-digit HI values are most likely associated with low risks.

Table 4.2.3-2 presents a summary of the HQs for the short-tailed shrew and mink by tank stabilization method. All terrestrial HQs were less than 1.0 for the grout, sand, and saltstone options, suggesting negligible risks to the shrew and mink (and similar species). The maximum HQ for silver for the No Action Alternative was slightly greater than 1.0. Hence, some risks are possible. Nevertheless, the relatively low maximum HQ suggests generally low risks.

As noted in Section 3.4, no Federally listed species are known to occur in the vicinity of the F- and H-Area Tank Farms, and none have been recorded near the Upper Three Runs and Fourmile Branch seeplines. The American alligator (threatened due to similarity of appearance to the American crocodile) is the only Federally protected species that could potentially occur in the area of the seeplines. Given that no Federally listed species are believed to be present and ecological risks to terrestrial and aquatic receptors are low, DOE does not expect any long-term impacts as a result of the proposed actions and alternatives.

4.2.3.2 <u>Radionuclides</u>

DOE calculated peak radiation dose to aquatic and terrestrial receptors at the seepline and receiving surface water from the tank closure alternatives. These radiation doses are compared to the limit of 1,000 millirad per day (365,000 millirad per year).

The following exposure pathways were chosen for calculating absorbed radiation dose to the terrestrial mammals of interest (shrew and mink) located on or near the seepline: ingestion of food (earthworms, slugs, insects and similar organisms for the shrew, and shrews for the mink), ingestion of soil, and ingestion of water. The following exposure pathways were chosen for calculating absorbed dose to aquatic animals of interest (sunfish) living in Fourmile Branch and Upper Three Runs: uptake of contaminants from water and direct irradiation from submersion in water. Standard values for parameters such as mass, food ingestion rate, water ingestion rate, water ingestion rate, soil ingestion rate, and bioaccumulation factors were used. Appendix C provides more details on the methodology and parameters used in this analysis.

Calculated absorbed doses to the referenced organisms are listed in Table 4.2.3-3. All calculated doses are below the regulatory limit of 365,000 millirad per year.

Table 4.2.3-1. Summary of maximum hazard indices for the aquatic assessment by tank closure alternative.

No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option
Max. HI	Max. HI	Max. HI	Max. HI
2.0	1.42	0.18	0.16

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4.2.4 LAND USE

DOE's primary planning document for land use at SRS is the *Savannah River Site Future Land Use Plan* (DOE 1998). This Plan analyzed several future use options, including residential future use. The residential use option would call for all of SRS, except for existing waste units with clean-up decisions under Resource Conservation and Recover Act (RCRA) or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) that preclude residential use, to be cleaned up to levels consistent with residential land use. Clean up of SRS to levels required for residential use would result in enormous costs and considerable time commitment. Many areas at the site are contaminated at low levels with various contaminants and it is probably not feasible with current technology to remediate these areas to standards acceptable for residential development. An integral Site future-use model that assumes no residential uses would be permitted in any area of the Site was identified as the basis for SRS future-use planning.

EC

EC

The General Separations Area includes several nuclear material processing and waste management areas. In addition to the tank farms, this area includes the F- and H-Area canyon buildings, radioactive waste storage and disposal facilities, and the DWPF vitrification and salt processing facilities. This area also contains numerous as yet unremediated waste sites (basins, pits, piles, tanks, and contaminated groundwater plumes). Soils and groundwater within the General Separations Area are contaminated with radionuclides and hazardous chemicals as a result of 40 years of Site operations. As described in Section 3.2.2.4, several contaminants in groundwater (tritium and other radionuclides, metals, nitrates, sulfates, and chlorinated and volatile organics) currently exceed the applicable regulatory or DOE guidelines. This area of the SRS is least amenable to remediation to the levels that would enable future residential use.

EC

Section 4.2.5 discusses impacts to humans using the land in or near the tank farms. DOE does not envision relinquishing control of this area. However, DOE recognizes that there is uncertainty in projecting future land use and the effectiveness of institutional controls considered in this EIS. For purposes of analysis, DOE assumes direct physical control in the General Separations Area only for the next 100 years. In accordance with agreements with the State of South Carolina and as reflected in the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems* (DOE 1996), DOE has calculated human health impacts based on doses that would be received over time at a point of compliance that is at the seepline, about a mile from the tank farms. However, recognizing the potential for exposure to groundwater and the fact that DOE's land use assumptions may be incorrect, DOE has also provided estimates of human health implications of doses that would be received directly adjacent to the boundary of the tank farm. This location is much closer to the tank farm than the point of compliance and the projected doses and consequent health effects are greater.

EC

With respect to the 100 years of physical control, the land use plan establishes a future use policy for the SRS. Several key elements of that policy would maintain the tank farm area and exclude its future use from non-conforming land

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Table 4.2.3-2. Summary of maximum hazard quotients for the terrestrial assessment by tank closure alternative.

	No Action Alternative		Stabilize Tanks Alternative: Fill with Grout Option		Stabilize Tanks Alternative: Fill with Sand Option		Stabilize Tanks Alternative: Fill with Saltstone Option	
	Max. HQ	Time of maximum exposure[a]	Max. HQ	Time of maximum exposure[a]	Max. HQ	Time of maximum exposure[a]	Max. HQ	Time of maximum exposure[a]
Aluminum	b	NA	b	NA	b	NA	b	NA
Barium	b	NA	b	NA	b	NA	b	NA
Chromium	0.04	4,235	0.02	3,955	b	NA	b	NA
Copper	b	NA	b	NA	b	NA	b	NA
Fluoride	0.20	105	0.08	105	0.01	105	0.01	1,015
Lead	b	NA	b	NA	b	NA	b	NA
Manganese	b	NA	b	NA	b	NA	b	NA
Mercury	b	NA	b	NA	b	NA	b	NA
Nickel	b	NA	b	NA	b	NA	b	NA
Silver	1.55	455	0.81	245	0.09	525	0.13	1,365
Uranium	b	NA	b	NA	b	NA	b	NA
Zinc	b	NA	b	NA	b	NA	b	NA

a. Years after closure.
b. HQ is less than 0.01.
NA = Not applicable.

Table 4.2.3-3. Calculated maximum absorbed radiation dose to aquatic and terrestrial organisms by tank stabilization method (millirad/year).[a]

		Stabilize Tanks Alternative		
	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option
Sunfish dose	0.89	0.0038	0.0072	0.053
Shrew dose	24,450	24.8	244.5	460.5
Mink dose	2,560	3.3	25.6	265

a. DOE limit is 365,000 millirad per year.

TC

uses (see Figure 4.2.4-1). The most notable elements are the following:

- Protection and safety of SRS workers and the public shall be a priority.
- The integrity of Site security shall be maintained.
- A "restricted use" program shall be developed and followed for special areas (e.g., CERCLA and RCRA regulated units).
- SRS boundaries shall remain unchanged, and the land shall remain under the ownership of the Federal government.
- Residential uses of all SRS land shall be prohibited in any area of the site.

In principle, industrial zones are ones in which the facilities pose either a potentially significant nuclear or non-nuclear hazard to employees or the general public. In the case of the Industrial-Heavy Nuclear zone, the facilities included: (1) produce, process, store and/or dispose of radioactive liquid or solid waste, fissionable materials, or tritium; (2) conduct separations operations; (3) conduct irradiated materials inspection, fuel fabrication, decontamination, or recovery operations; or (4) conduct fuel enrichment operations (DOE 1998).

The future condition of the F- and H-Area Tank Farms would vary among the alternatives. Under the No Action Alternative, structural collapse of the tanks would create unstable ground conditions and form holes into which workers or other site users could fall. Neither the Stabilize Tanks Alternative nor the Clean and Remove Tanks Alternative would have this safety hazard, although there could be some moderate ground instability with the Fill with Sand Option. For the Stabilize Tanks Alternative, four tanks in F Area and four tanks in H Area would require backfill soil to be placed over the tops of the tanks. The backfill soil would bring the ground surface at these tanks up to the surrounding surface elevations to prevent water from collecting in the surface depressions. This action would prevent ponding conditions over these tanks that could facilitate the degradation of the tank structure. For the Clean and Remove Tanks Alternative, the tank voids remaining after excavation would be filled in. The backfill material would consist of a soil type similar to the soils currently surrounding the tanks.

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4.2.5 PUBLIC HEALTH

This section presents the potential impacts on human health from residual contaminants remaining in the HLW tanks after closure following the period of institutional control of the H- Area and F-Area Tank Farms.

To determine the long-term impacts, DOE has reviewed data for both tank farms, including the following:

- Expected source inventory that would remain in the tanks
- Existing technical information on geological and hydrogeological parameters in the vicinity of the tank farms

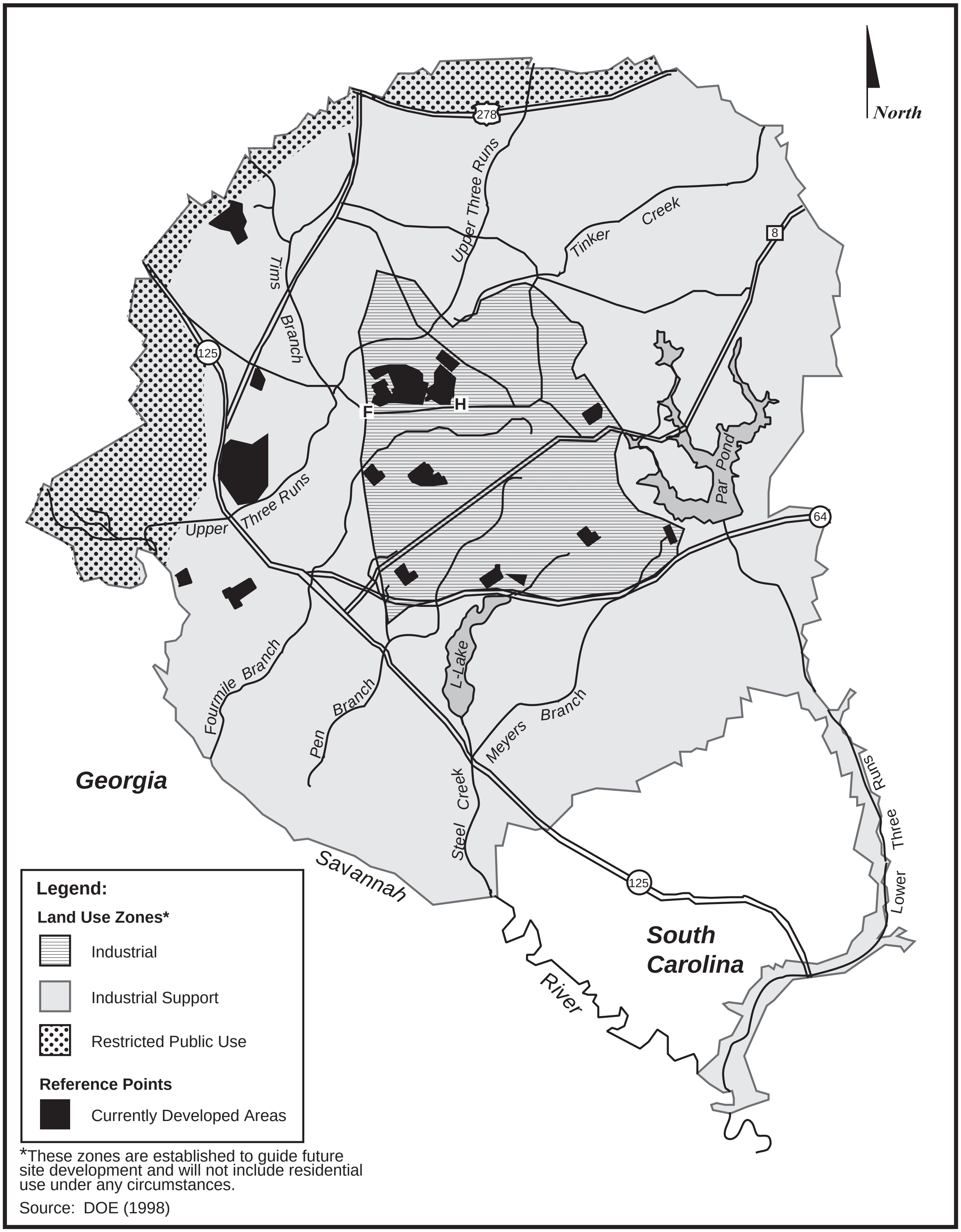

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Figure 4.2.4-1. Savannah River Site land use zones.

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- Use of the land around the tank farms
- Arrangement of the tanks within the stratigraphy
- Actions to be completed under each of the alternatives

In its evaluation, DOE has reviewed the human populations that could be exposed to contaminants from the tank farms and has identified the following hypothetical individuals:

- *Worker*: an adult who has authorized access to, and works at, the tank farm and surrounding areas. This analysis assumes that the worker remains on the shores of Fourmile Branch or Upper Three Runs during working hours. This assumption maximizes the hypothetical worker's exposure to contaminants that might emerge at the seepline.
- *Intruder*: a person who gains unauthorized access to the tank farm and is potentially exposed to contaminants.
- *Nearby adult resident*: an adult who lives in a dwelling across either Fourmile Branch or Upper Three Runs downgradient of the tank farms, near the stream.
- *Nearby child resident*: a child who lives in a dwelling across either Fourmile Branch or Upper Three Runs downgradient of the tank farms, near the stream.
- *Downstream resident*: a person who lives in a downstream community where residents get their household water from the Savannah River. Effects are estimated for an average individual in the downstream communities and for the entire population in these communities.

DOE has based the assessment of population health effects on present-day populations because estimation of future populations is very speculative. The analysis based on present-day populations is useful for the purpose of understanding the potential impacts of the proposed action on future residents of the region.

DOE evaluated the impacts over a 10,000-year period, which is consistent with the time period used previously in the *Industrial Wastewater Closure Plan for F- and H-Area High Level Waste Tank System* (DOE 1996). Because the tanks are located below the grade of the surrounding topography, DOE does not expect any long-term air-borne releases to occur from the tanks. Therefore, DOE based its calculations on postulated release scenarios whereby contaminants in the tanks would be leached from the tank structures and transported to the groundwater. However, the holes formed by the collapsed tanks under the No Action Alternative would pose a long-term safety hazard.

As discussed in Section 4.2.2, the aquifers in the vicinity of F-Area Tank Farm and H-Area Tank Farm outcrop along both Fourmile Branch and Upper Three Runs. Because the locations where these aquifers outcrop from the tank farms do not overlap, DOE has chosen to calculate and present the impacts for these hypothetical individuals separately for F-Area Tank Farm and H-Area Tank Farm.

In addition to the hypothetical individuals and populations listed above, DOE also calculated the concentration of contaminants in groundwater at the location where the groundwater outcrops into the environment (i.e., the seepline) and at 1 meter and 100 meters downgradient from each of the tank farms. Discussion of these results is provided in Section 4.2.2, along with an estimate of the impacts from pathways at these locations.

For nonradiological constituents, DOE compared the water concentrations directly to the concentrations listed as MCLs in 40 CFR 141. Appendix C lists concentrations for all the nonradiological constituents. As discussed in Section 4.2.2, DOE has chosen to present the fractions of MCL for nonradiological constituents to enable quantitative comparison among the alternatives.

As discussed in Appendix C, DOE performed its calculations for the three uppermost aquifers underneath the General Separations Area;

however, in this section, DOE presents only the maximum results for the two tank farms. In addition, the maximum results for H-Area Tank Farm are reported independent of which seepline (Upper Three Runs or Fourmile Branch) receives the highest level of contaminants. Downstream Savannah River users are assumed to be exposed to contemporaneous releases from all aquifers and seeplines. Further details on aquifer-specific results can be found in Appendix C.

Tables 4.2.5-1, 4.2.5-2, and 4.2.5-3 show the radiological results for the F- and H-Area Tank Farms. The maximum annual dose to the adult resident for either tank farm is 6.2 millirem per year for the No Action Alternative. This dose is less than the annual 100 millirem public dose limit and represents only a marginal increase in the annual average exposure of individuals in the United States of approximately 360 mrem due to natural sources of radiation exposure, as discussed in Section 3.8. Based on this low dose, DOE would not expect any health effects if an individual were to receive the dose calculated for the hypothetical adult.

DOE considered, but did not model, the potential exposures to people who live in a home built over the tanks at some time in the future when they are unaware that the residence was built over closed waste tanks. DOE previously modeled this type of exposure for the saltstone disposal vaults in the Z Area. That analysis found that external radiation exposure was the only potentially significant pathway of potential radiological exposure other than groundwater use (WSRC 1992). Tables 4.2.2-4 and 4.2.2-5 present estimates of the radiological doses from drinking water from the close-in wells where on-site residents might obtain their water. DOE also projected the contribution of other water-related environmental pathways to one set of model output and concluded that the dose to a future resident from these other pathways would not exceed the drinking water dose by more than TC 20 percent. For the Fill with Grout and Fill with Sand Options of the Stabilize Tanks Alternative, external radiation doses to onsite residents would be negligible because the thick layers of nonradioactive material between the waste (near the bottom of the tanks) and the ground surface would shield residents from any direct radiation emanating from the waste. External radiation exposures could occur under the Fill with TC Saltstone Option which would place radioactive saltstone near the ground surface. If it is conservatively assumed that all of the backfill soil is eroded or excavated away and there is no other cap over the saltstone, so that a home is built directly on the saltstone, analysis presented in WSRC (1992) indicates that 1,000 years after tank closure a resident would be exposed to an effective dose equivalent of 390 mrem/year, resulting in an estimated 1 percent increase in risk of latent cancer fatality from a 70-year lifetime of exposure. Backfill soils or caps would eliminate or substantially reduce the potential external exposure. For example, with a 30-inch-thick intact concrete cap, the dose would be reduced to 0.1 mrem/year. For the No Action Alternative, external exposures to onsite residents would be expected to be unacceptably high, due to the potential for contact with the residual waste.

At the 1-meter well, the highest calculated peak EC drinking water dose under the No Action Alternative is 9,300,000 millirem per year (9,300 rem per year), which would lead to acute radiation health effects, including death. Peak doses at this well for the Stabilize Tanks TC Alternative are calculated to be in the range of 100,000 to 130,000 millirem per year (100 to 130 rem per year), which substantially exceeds all criteria for acceptable exposure, could result in acute health effects, and would give a significantly increased probability of a latent cancer fatality. Peak doses calculated at the 100-meter well range from 300 millirem (0.3 rem per year) per year for the Fill with TC Grout Option to 90,000 millirem per year (90 rem per year) for the No Action Alternative. Individuals exposed to 300 millirem per year would experience a lifetime increased risk of latent cancer fatality of less that 0.02 percent per year of exposure. The estimated doses at the 1- and 100-meter wells are extremely conservative (high) estimates because the analysis treated all of the tanks in a given group as being at the same physical location. Realistic doses at these

Table 4.2.5-1. Radiological results from contaminant transport from F-Area Tank Farm.[a]

	Stabilize Tanks Alternative			
	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Adult resident maximum annual dose (millirem per year)	0.027	0.051	0.37	6.2
Child resident maximum annual dose (millirem per year)	0.024	0.047	0.34	5.7
Seepline worker maximum annual dose (millirem per year)	(c)	(c)	0.001	0.018
Intruder maximum annual dose (millirem per year)	(c)	(c)	(c)	9.0×10^{-3}
Adult resident maximum lifetime dose (millirem)[b]	1.9	3.6	26	430
Child resident maximum lifetime dose (millirem)[b]	1.7	3.3	24	400
Seepline worker maximum lifetime dose (millirem)[d]	0.002	0.004	0.03	0.54
Intruder maximum lifetime dose (millirem)[d]	0.001	0.002	0.02	0.27
Adult resident latent cancer fatality risk	9.5×10^{-7}	1.8×10^{-6}	1.3×10^{-5}	2.2×10^{-4}
Child resident latent cancer fatality risk	8.5×10^{-7}	1.7×10^{-6}	1.2×10^{-5}	2.0×10^{-4}
Seepline worker latent cancer fatality risk	8.0×10^{-10}	1.6×10^{-9}	1.2×10^{-8}	2.2×10^{-7}
Intruder latent cancer fatality risk	4.0×10^{-10}	8.0×10^{-10}	8.0×10^{-9}	1.1×10^{-7}
1-meter well drinking water dose (millirem per year)	130	420	790	3.6×10^{5}
1-meter well alpha concentration (picocuries per liter)	13	13	13	1,700
100-meter well drinking water dose (millirem per year)	51	190	510	1.4×10^{4}
100-meter well alpha concentration (picocuries per liter)	4.8	4.7	4.8	530
Seepline drinking water dose (millirem per year)	1.9	3.5	25	430
Seepline alpha concentration (picocuries per liter)	0.04	0.039	0.04	9.2
Surface water drinking water dose (millirem per year)	9.8×10^{-3}	0.019	0.13	2.3

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a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the tank farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the *SRS Waste Management EIS* (DOE 1995), Section 4.2.3.
b. Lifetime of 70 years assumed for this individual.
c. The radiation dose for this alternative is less than 1×10^{-3} millirem.
d. Lifetime of 30 years assumed for this individual.

Table 4.2.5-2. Radiological results from contaminant transport from H-Area Tank Farm.[a]

TC

	Stabilize Tanks Alternative			
	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Adult resident maximum annual dose (millirem per year)	0.010	0.016	0.19	2.4
Child resident maximum annual dose (millirem per year)	9.3×10^{-3}	0.015	0.18	2.2
Seepline worker maximum annual dose (millirem per year)	(c)	(c)	(c)	7×10^{-3}
Intruder maximum annual dose (millirem per year)	(c)	(c)	(c)	3.5×10^{-3}
Adult resident maximum lifetime dose (millirem)[b]	0.7	1.1	13	170
Child resident maximum lifetime dose (millirem)[b]	0.65	1.1	1.3	150
Seepline worker maximum lifetime dose (millirem)[d]	(c)	0.001	0.017	0.21
Intruder maximum lifetime dose (millirem)[d]	(c)	(c)	0.008	0.11
Adult resident latent cancer fatality risk	3.5×10^{-7}	5.5×10^{-7}	6.5×10^{-6}	8.5×10^{-5}
Child resident latent cancer fatality risk	3.3×10^{-7}	5.5×10^{-7}	6.5×10^{-7}	7.5×10^{-5}
Seepline worker latent cancer fatality risk	(e)	4.0×10^{-10}	6.8×10^{-9}	8.4×10^{-8}
Intruder latent cancer fatality risk	(e)	(e)	3.2×10^{-9}	4.4×10^{-8}
1-meter well drinking water dose (millirem per year)	1×10^{5}	1.3×10^{5}	1.0×10^{5}	9.3×10^{6}
1-meter well alpha concentration (picocuries per liter)	24	290	24	13,000
100-meter well drinking water dose (millirem per year)	300	920	870	9.0×10^{4}
100-meter well alpha concentration (picocuries per liter)	7.0	38	7.0	3,800
Seepline drinking water dose (millirem per year)	2.5	25	46	2.5×10^{3}
Seepline alpha concentration (picocuries per liter)	0.15	0.33	0.15	34
Surface water drinking water dose (millirem per year)	3.7×10^{-3}	6.0×10^{-3}	0.071	0.90

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a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the tank farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the *SRS Waste Management EIS* (DOE 1995), Section 4.2.3.
b. Lifetime of 70 years assumed for this individual.
c. The radiation dose for this alternative is less than 1×10^{-3} millirem.
d. Lifetime of 30 years assumed for this individual.

Table 4.2.5-3. Radiological results to downstream resident from contaminant transport from F- and H-Area Tank Farms.[a]

	Stabilize Tanks Alternative			
	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Downstream maximum individual annual dose (millirem per year)	(b)	(b)	(b)	(b)
Downstream maximum individual lifetime dose (millirem)	(b)	(b)	3.4×10^{-3}	4.1×10^{-2}
Downstream maximum individual latent cancer fatality risk	(c)	(c)	1.8×10^{-9}	2.1×10^{-8}
Population dose (person-rem per year)	8.6×10^{-5}	3.3×10^{-4}	3.4×10^{-3}	4.1×10^{-2}
Population latent cancer fatality risk (incidents per year)	4.3×10^{-8}	1.7×10^{-7}	1.8×10^{-6}	2.1×10^{-5}

TC

a. The Clean and Remove Tanks Alternative is not presented in this table because the residual waste (and tank components) would be removed from the tank farm areas and transported to SRS radioactive waste disposal facilities. The environmental impacts of these disposal facilities were analyzed in the *SRS Waste Management EIS* (DOE 1995), Section 4.2.3.
b. The radiation dose for this alternative is less than 1×10^{-3} millirem.
c. The risk for this alternative is very low, less than 10^{-9}.

close-in locations would be substantially smaller. As noted above, land-use controls and other institutional control measures would be employed to prevent exposure at these locations.

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CHAPTER 5. CUMULATIVE IMPACTS

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In its regulations for implementing the procedural provisions of the National Environmental Policy Act (NEPA), the Council on Environmental Quality (CEQ) defines cumulative impacts as follows: the impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions (40 CFR 1508.7). The cumulative impacts analysis presented in this chapter is based on the incremental actions associated with the highest potential impact for each resource area considered for all alternatives for high-level waste (HLW) tank closure at the SRS, other actions associated with onsite activities, and offsite activities with the potential for related environmental impacts. The highest impact alternative varied, based on the resource area being evaluated, as shown in the data tables within this chapter.

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> The U.S. Department of Energy (DOE) has examined impacts of the construction and operation of the Savannah River Site (SRS) over its 50-year history. It has analyzed trends in the environmental characteristics of the Site and nearby resources to establish a baseline for measurement of the incremental impact of tank closure activities and other reasonably foreseeable onsite and offsite activities with the potential for related environmental impact.

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SRS History

In 1950, the U.S. Government selected a large rural area of nearly 400 square miles in southwest South Carolina for construction and operation of facilities required to produce nuclear fuels (primarily defense-grade plutonium and tritium) for the nation's defense. Then called the Savannah River Plant, the facility would have full production capability, including fuel and target fabrication, irradiation of the fuel in five production reactors, product recovery in two chemical separations plants, and waste management facilities, including the HLW tank farms (DOE 1980).

Construction impacts included land clearing, excavation, air emissions from construction vehicles, relocation of about 6,000 persons, and the formation of mobile home communities to house workers and families during construction; peak construction employment totaled 38,500 in 1952 (DOE 1980).

Socioeconomic effects stabilized quickly. The largest community on the Site, Ellenton, was relocated immediately north of the Site boundary and was renamed New Ellenton.

The Site, later reduced to approximately 300 square miles, is predominately (73 percent) open fields and pine and hardwood forests. Twenty-two percent is wetlands, streams, and reservoirs, and only five percent is dedicated to production and support areas, roads, and utility corridors (DOE 1997). The Savannah River Natural Resource Management and Research Institute (SRI) (formerly the Savannah River Forest Station) manages the natural resources at SRS. The SRI supports forest research, erosion control projects, and native plants and animals (through maintenance and improvements to their habitats). SRI sells timber, manages controlled-burns, plants new seedlings, and maintains secondary roads and exterior boundaries (Arnett and Mamatey 1997a). EC

Normal operations included non-radioactive and radioactive emissions of pollutants to the surrounding air and discharges of pollutants to onsite streams. Impacts of these releases to the environment were minimal. In addition, large withdrawals of cooling water from the Savannah River caused minimal entrainment and impingement of aquatic biota and severe thermal impacts due to the subsequent discharge of the cooling water to onsite streams. The thermal discharges stripped vegetation along stream channels and adjacent banks and destroyed cypress-tupelo forests in the Savannah River Swamp. Thermal effects did not extend beyond

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the Site boundary. In 1991, DOE committed to reforest the Pen Branch delta in the Savannah River Swamp, using appropriate wetland species, and to manage it until successful reforestation had been achieved (56 FR 5584-5587, February 11, 1991).

Groundwater contamination also occurred in areas of hazardous, radioactive, and mixed waste sites and seepage basins. Due to the large buffer area from the center of operations to the Site boundary (approximately five miles), offsite effects were minimal. Groundwater contamination plumes did not move offsite, and onsite EC surface water contamination had minimal effects offsite because they are discharged to the Savannah River and diluted to concentrations that are well below concentrations of concern.

SRS has had a beneficial socioeconomic effect on employment in the region. The operations workforce varied from 7,500 (DOE 1980) to EC almost 26,000 (HNUS 1992), and presently numbers approximately 14,000 as of February 2000 (DOE 2000a).

Over the years of operation, mitigation measures have substantially reduced onsite environmental EC stresses. DOE installed a Liquid Effluent Treatment Facility that minimized liquid releases of pollutants (except tritium) before discharge through a National Pollutant EC Discharge Elimination System (NPDES) outfall. Direct discharge of highly tritiated disassembly basin purge water to surface streams was replaced by discharge to seepage basins that enabled substantial decay during transport in the groundwater before their eventual outcrop to onsite streams. In addition, DOE eliminated thermal discharges with construction of a cooling lake for L-Reactor operation and a cooling tower intended to support K-Reactor operation.

Other agencies contributed to this trend by improving the quality and regulation of flows in the Savannah River. Five large reservoirs upriver of SRS were constructed in the 1950s through early 1980s. They have reduced peak flows in the Savannah River, moderated flood cycles in the Savannah River Swamp and, with the exception of a severe drought from 1985 EC through 1988, maintained flows sufficient for water quality and managing fish and wildlife resources downstream (DOE 1990). In 1975, the City of Augusta, Georgia, installed a EC secondary sewage treatment plant to eliminate the discharge of untreated or inadequately treated domestic and industrial waste into the Savannah River and its tributaries. Similarly, treatment facilities for Aiken County, South EC Carolina, began operation in 1979 (DOE 1987).

In 1988, DOE placed the active site reactors on standby, and the end of the Cold War resulted in permanent shutdown. DOE planted wetland hardwood species in 300-400 acres of the Pen Branch delta. Successful reforestation has begun and is ongoing.

Once operations ceased, key indicators of environmental impacts decreased rapidly. For EC example, one discriminator for measuring impacts to human health is the dose to the maximally exposed offsite individual (MEI). The impact measured is the estimated EC probability of a latent cancer fatality, which is assumed to be directly proportional to dose. The estimate of latent cancers is, at best, an order of magnitude approximation. Thus an estimate of 10^{-5} latent cancer fatalities is likely between 10^{-6} and 10^{-4}. By 1996, the dose to the MEI (and the associated probability of a latent cancer fatality) decreased to about 1/8th of its 1987 value (Arnett and Mamatey 1997b). Further detail on the MEI is discussed later under public and worker health.

In general, the combination of mitigation measures and post-Cold War cleanup efforts demonstrates an environmental trend of protecting and improving the quality of the SRS environment with minimal impact on the offsite environment. Although groundwater modeling indicates that most contaminants in the groundwater have reached their peak concentrations, several slow-moving constituents would peak in this millennium at the 100-meter well (DOE 1987). Long-term cumulative impacts are discussed further in Section 5.7 of this chapter.

CEQ Cumulative Effects Guidance

A handbook prepared by CEQ (1997) guides this chapter. In accordance with the handbook, DOE identified the resource areas in which tank closure could add to the impacts of past, present, and reasonably foreseeable actions within the project impact zones, as defined by CEQ (1997).

Based on an examination of the environmental impacts of actions resulting from tank closure (coupled with DOE and other agency actions) and some private actions, it was determined that cumulative impacts for the following areas need to be presented: (1) air resources, (2) water resources, (3) public and worker health, (4) waste generation, (5) utilities and energy consumption, and (6) land use (long-term only). Discussion of cumulative impacts for the following resources is omitted because impacts from the proposed tank closure activities would be so small that their potential contribution to cumulative impacts would be very small: geologic resources, ecological resources, aesthetic and scenic resources, cultural resources, traffic, socioeconomics, and environmental justice.

In accordance with the CEQ guidance, DOE defined the geographic (spatial) and time (temporal) boundaries to encompass cumulative
L-4-9 impacts on the six identified resources of concern.

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Spatial and Temporal Boundaries

L-7-52 The purpose of this section is to identify the boundaries (both in space and time) of DOE's cumulative impacts analysis. For determining the human health impact from airborne emissions, the population within the 50-mile radius surrounding SRS was selected as the project impact zone. Although the doses are almost undetectable at the 50-mile boundary, this is the customary definition of the offsite public. For aqueous releases, onsite streams and the downstream population that uses the Savannah River as its source of drinking water was selected. Analyses revealed that other potential incremental impacts from tank closure, including air quality, waste management, and utilities and energy diminish within or quite near the Site boundaries. The effective project impact zone for each of these is identified in the discussions that follow.

Nuclear facilities in the vicinity of SRS include: Georgia Power's Plant Vogtle Electric Generating Plant across the river from SRS; Chem-Nuclear Inc., a commercial low-level waste burial site just east of SRS; and Starmet CMI, Inc. (formerly Carolina Metals), located southeast of SRS, which processes uranium-contaminated metals. Plant Vogtle, Chem-Nuclear, and Starmet CMI are approximately 11, EC
8, and 15 miles, respectively, from the SRS HLW tank farms. Other nuclear facilities are clearly too far (greater than 50 miles) to have a cumulative effect. Therefore, the project impact zone for cumulative impacts on air quality from radioactive emissions is 15 miles. Radiological impacts from the operation of the Vogtle Electric Generating Plant, a two-unit commercial nuclear power plant, are minimal, but DOE has factored them into the analysis. The *South Carolina Nuclear Facility Monitoring* EC
Annual Report (SCDHEC 1995) indicates that operation of the Chem-Nuclear Services facility and the Starmet CMI facility does not noticeably impact radiation levels in air or water in the vicinity of SRS. Therefore, they are not included in this assessment.

The counties surrounding SRS have numerous existing (e.g., textile mills, paper product mills, L-7-53
and manufacturing facilities) and planned industrial facilities with permitted air emissions and discharges to surface waters. Because of the distances between SRS and the private industrial facilities, there is little opportunity for interactions of plant emissions and no major cumulative impact on air or water quality. As indicated in results from the SRS Environmental Surveillance Program Report, ambient levels of pollutants in air and water have remained below regulatory levels in and around the SRS region (Arnett and Mamatey 1999). EC

An additional offsite facility with the potential to affect the nonradiological environment is South Carolina Electric and Gas Company's Urquhart Station. Urquhart Station is a three-unit, 250-

megawatt, coal- and natural-gas-fired steam electric plant in Beech Island, South Carolina, located about 20 river miles and about 18 aerial miles north of SRS. Because of the distance between SRS and the Urquhart Station and the regional wind direction frequencies, there is little opportunity for any interaction of plant emissions, and no significant cumulative impact on air quality. Thus, the project impact zone for nonradiological atmospheric releases is less than 18 miles.

Finally, utility and energy capacity is available onsite and is too small to affect the offsite region. Similarly, onsite waste disposal capacity can satisfy the quantities generated by tank closure. Thus the extent of the project impact zone (from utilities, energy, and waste generation) is best described as the SRS boundary.

Temporal limits were defined by examining the period of influence from both the proposed action and other Federal and non-Federal actions that have the potential for cumulative impacts. Actions for tank closure are expected to begin in 2001.

With the exception of the long-term cumulative impacts described in Section 5.7, the period of interest for the cumulative impacts analysis for this EIS includes 2000 to 2030.

Reasonably Foreseeable DOE Actions

DOE also evaluated the impacts from its own proposed future actions by examining impacts to resources and the human environment, as shown in NEPA documentation related to SRS (see Section 1.6). Additional NEPA documents related to SRS that are considered in the cumulative impacts section include the following:

- *Final Environmental Impact Statement - Interim Management of Nuclear Materials* (DOE/EIS-0220) (DOE 1995a). DOE is in the process of implementing the preferred alternatives for the nuclear materials discussed in the *Interim Management of Nuclear Materials EIS*. SRS baseline data in this chapter reflect projected impacts from implementation.

- *Final Environmental Impact Statement for the Accelerator Production of Tritium at the Savannah River Site* (DOE/EIS-0270) (DOE 1999a). DOE has proposed an accelerator design (using helium-3 target blanket material) and an alternate accelerator design (using lithium-6 target blanket material). If an accelerator had been built, it would have been located at SRS. However, since the Record of Decision (64 FR 26369; May 14, 1999) states the preferred alternative as use of an existing commercial light-water reactor, data from this environmental impact statement (EIS) are not used. EC EC

- *Environmental Assessment for the Tritium Facility Modernization and Consolidation Project at the Savannah River Site* (DOE/EA-1222) (DOE 1997). This environmental assessment addresses the impacts of consolidating tritium activities. Tritium extraction functions will be transferred to the Tritium Extraction Facility. The overall impact will be to reduce the tritium facility complex net tritium emissions by up to 50 percent. Another positive effect of this planned action will be to reduce the amount of low-level radioactive job-control waste. Effects on other resources will be negligible. Therefore, impacts from the environmental assessment have not been included in this cumulative impacts analysis. EC

- *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE/EIS-0240) (DOE 1996). This cumulative impacts analysis incorporates blending highly enriched uranium at SRS to 4 percent low-enriched uranium as uranyl nitrate hexahydrate, as decided in the Record of Decision (61 FR 40619, August 5, 1996).

- *Final Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site* (DOE/EIS-

0277F) (DOE 1998a). As stated in the Record of Decision (64 FR 8068, February 18, 1999), DOE will process certain plutonium-bearing materials being stored at the Rocky Flats Environmental Technology Site. These materials are plutonium residues and scrub alloy remaining from nuclear weapons manufacturing operations formerly conducted by DOE at Rocky Flats. DOE has decided to ship certain residues from the Rocky Flats Environmental Technology Site to SRS for plutonium separation and stabilization. The separated plutonium will be stored at SRS, pending disposition decisions. Environmental impacts from using SRS Canyons to chemically separate the plutonium from the remaining materials at SRS are included in this section. EC

- *Draft and Final Environmental Impact Statement for the Construction and Operation of a Tritium Extraction Facility at the Savannah River Site* DOE/EIS-0271) (DOE 1998b, 1999b). As stated in the Record of Decision (64 FR 26369, May 14, 1999), DOE will construct and operate a Tritium Extraction Facility on SRS to provide the capability to extract tritium from commercial light-water reactor targets and targets of similar design. The purpose of the proposed action and alternatives evaluated in the EIS is to provide tritium extraction capability to support either accelerator or reactor tritium production. Environmental impacts from the maximum processing option in both the Draft and Final EISs are included in this section. The final EIS presents responses to public comments and a record of changes to the Draft EIS.

- *Surplus Plutonium Disposition Final Environmental Impact Statement* (DOE/EIS-0283) (DOE 1999d). This EIS analyzed the activities necessary to implement DOE's disposition strategy for surplus plutonium. As announced in the Record of Decision (65 FR 1608, January 11, 2000), SRS was selected for three disposition facilities, pit (a nuclear weapon component) disassembly and conversion, plutonium conversion and immobilization, and mixed oxide fuel fabrication. The DOE decision allows the immobilization of approximately 17 metric tons of surplus plutonium and the use of up to 33 metric tons of surplus plutonium as mixed oxide fuel. Both methods in this hybrid approach ensure that surplus plutonium produced for nuclear weapons is never again used for nuclear weapons. DOE has subsequently decided (67 FR 19432, April 19, 2002) to cancel the immobilization program due to budgetary constraints. Impacts from construction and operation of all three facilities in that EIS are included in this section. TC

- *Defense Waste Processing Facility Supplemental Environmental Impact Statement* (DOE/EIS-0082-S) (DOE 1994). The selected alternative in the Record of Decision (60 FR 18589, April 12, 1995) was the completion and operation of the Defense Waste Processing Facility (DWPF) to immobilize HLW at the SRS. The facility is currently processing sludge from SRS HLW tanks. However, SRS baseline data are not representative of full DWPF operational impacts, including processing of salt and supernate from these tanks. Therefore, the DWPF data are listed separately. EC

- *Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE/EIS-0306) (DOE 2000b). DOE has prepared a *Final Treatment and Management of Sodium-Bonded Spent Nuclear Fuel Environmental Impact Statement* (65 FR 47987, August 4, 2000). One of the alternatives evaluated in the EIS would involve processing Idaho National Engineering and Environmental Laboratory (INEEL's) sodium-bonded fuel inventory at SRS using the Plutonium-Uranium Extraction process. Because processing at SRS is a reasonable alternative to processing at INEEL, it has been included in this cumulative impact analysis. This method of stabilization of spent nuclear fuel could be used for the sodium-bonded spent nuclear fuel, most of which is currently in storage at INEEL. There are approximately EC EC EC

22.4 metric tons of heavy metal (MTHM) of Experimental Breeder Reactor-II (EBR-II) fuel and 34.2 MTHM of Fermi-1 fuel to be processed. This fuel would be declad before shipment to SRS. Because the decladding activities would occur at INEEL, the impacts of these decladding activities are not included in this chapter.

In the Record of Decision (65 FR 56565, September 19, 2000), DOE decided to electrometallurgically treat the EBR-II fuel at Argonne National Laboratory-West. However, due to the different characteristics of the Fermi-1 fuel, DOE decided to continue to store this material while alternative treatments are evaluated.

- *Savannah River Site Spent Nuclear Fuel Management Final Environmental Impact Statement (DOE/EIS-0279)* (DOE 2000c). The proposed DOE action described in this EIS is to implement appropriate processes for the safe and efficient management of spent nuclear fuel (SNF) and targets at SRS, including placing these materials in forms suitable for ultimate disposition. Options to treat, package, and store this material are discussed. The material included in this EIS consists of approximately 68 MTHM of spent nuclear fuel (20 MTHM of aluminum-based spent nuclear fuel at SRS, as much as 28 MTHM of aluminum-clad spent nuclear fuel from foreign and domestic research reactors to be shipped to SRS through 2035, and 20 MTHM of stainless-steel or zirconium-clad spent nuclear fuel and some programmatic material stored at SRS for repackaging and dry storage pending shipment offsite).

  In the Record of Decision (65 FR 48224, August 7, 2000), DOE decided to implement the Preferred Alternative. As part of the Preferred Alternative, DOE will develop and demonstrate the Melt and Dilute technology. Following development and demonstration of the technology, DOE will begin detailed design, construction, testing, and startup of a Treatment and Storage Facility (TSF). The SNF will remain in wet storage until treated and placed in dry storage in the Treatment and Storage Facility.

  DOE also decided to use conventional processing to stabilize about 3 percent by volume and 40 percent by mass of the aluminum-based SNF. DOE also decided to continue to store small quantities of higher actinide materials until DOE determines their final disposition. Finally, DOE decided to ship non-aluminum-based SNF from the SRS to the INEEL.

Other materials under consideration for processing at SRS Canyons include various components currently located at other DOE sites, including Oak Ridge, Rocky Flats, Los Alamos, and Hanford. These materials, which were identified during the processing needs assessment, consist of various plutonium and uranium components. In this chapter, estimates of the impacts of processing these materials (DOE 2000b) have been included in the cumulative analysis. These estimates are qualitative because DOE has not yet proposed to process the materials. When considering cumulative impacts, the reader should be aware of the indeterminate nature of some of the actions for which impacts have been estimated.

In addition, the cumulative impacts analysis includes the impacts from actions proposed in this EIS. Risks to members of the public and Site workers from radiological and nonradiological releases are based on operational impacts from the alternatives described in Chapter 4.

The cumulative impacts analysis also accounts for other SRS operations. Most of the SRS baseline data are based on 1998 environmental report information (Arnett and Mamatey 1999), which are the most recent published data available.

5.1 Air Resources

Table 5-1 compares the cumulative concentrations of nonradiological air pollutants from the SRS, including the tank closure alternative with the largest impact (the Fill with

Table 5-1. Estimated maximum cumulative ground-level concentrations of nonradiological pollutants (micrograms per cubic meter) at SRS boundary.[a]

Pollutant[b]	Averaging time	SCDHEC ambient standard (μg/m³)[c]	SRS baseline[d] (μg/m³)	Tank closure[e] (μg/m³)	Other foreseeable planned SRS activities[f] (μg/m³)	Maximum cumulative concentration[g] (μg/m³)	Percent of standard
Carbon monoxide	1 hour	40,000	10,000	3.4	46.4	10,050	25
	8 hours	10,000	6,900	0.8	6.5	6,907	69
Oxides of nitrogen	Annual	100	26	0.07	7.7	33.8	34
Sulfur dioxide	3 hours	1,300	1,200	0.6	9.7	1,210	93
	24 hours	365	350	0.12	2.6	352.7	97
	Annual	80	34	0.006	0.19	34.2	43
Ozone[h]	1 hour	235	NA[i]	2.0	1.51	3.5	1.5
Lead	Max. quarter	1.5	0.03	4.1×10^{-6}	<0.00001	0.03	2
Particulate matter (≤10 microns aerodynamic diameter)[h]	24 hours	150	130	0.06	3.37	133.43	89
	Annual	50	25	0.03	0.15	25.2	50
Total suspended particulates (μg/m³)	Annual	75	67	0.005	0.08	67.1	90

a. DOE (1994, 1996, 1997, 1998a,b; 1999c,d; 2000b,c).
b. Hydrochloric acid, formaldehyde, hexane, and nickel are not listed in Table 5-1 because tank closure or other foreseeable, planned SRS activities would not result in any change to the SRS baseline concentrations of these toxic pollutants.
c. SCDHEC (1976). EC
d. Source: Table 3.3-3.
e. Data based on the Fill with Saltstone Option under the Stabilize Tanks Alternative (Table 4.1.3-2). TC
f. Includes Spent Nuclear Fuel, Highly Enriched Uranium, Tritium Extraction Facility, Management of Certain Plutonium Residues and Scrub Alloy Concentrations, Defense Waste Processing Facility, and Disposition of Surplus Plutonium, Sodium-Bonded Spent Nuclear Fuel, and components from throughout the DOE complex.
g. Includes tank closure concentrations.
h. New National Air Quality Standards Ambient (NAAQS) for ozone (1 hr replaced by 8 hr standard = 0.08 ppm) and particulate matter ≤ 2.5 microns (24 hr standard = 65 μg/m³ and annual standard of 15 μg/m³) may become enforceable during the stated temporal range of the cumulative impacts analyses. TC
i. NA = Not available. EC
μg/m³ = micrograms per cubic meter.

TC Saltstone Option under the Stabilize Tanks Alternative) to Federal and State regulatory standards. The listed values are the maximum modeled concentrations that could occur at ground level at the Site boundary. The data demonstrate that total estimated concentrations of nonradiological air pollutants from SRS would in all cases be below the regulatory standards at the Site boundary. The highest percentages of the regulatory standards are for sulfur dioxide concentrations for the shorter time interval (approximately 97 percent of standard for the 24-hour averaging time and 93 percent of the standard for the 3-hour average time), for particulate matter of less than 10 microns (approximately 89 percent of standard for the 24-hour averaging time), and total suspended particulates (approximately 90 percent of standard). EC The remaining pollutant concentrations would range from under 2 to 69 percent of the applicable standards. The majority of the concentration comes from estimated SRS baseline concentrations and not from tank closure and other foreseeable actions. The incremental impact from tank closure would not be noticeable. Also, it is unlikely that actual concentrations at ambient monitoring stations would be as high as that shown for the SRS baseline values. The SRS baseline values are based on the maximum potential emissions from the 1998 air emissions inventory and for all SRS sources, and observed concentrations from nearby ambient air monitoring stations.

DOE also evaluated the cumulative impacts of airborne radioactive releases in terms of dose to a maximally exposed individual at the SRS boundary and dose to the 50-mile population (see Table 5-2). Although comparable results for Plant Vogtle were not available for the nonradiological analysis (Table 5-1), DOE included the impacts of Plant Vogtle (NRC 1996) in this cumulative radioactive release total. The *South Carolina Nuclear Facility Monitoring Annual Report* (SCDHEC 1995) indicates that operation of the Chem-Nuclear low-level waste disposal facility just east of SRS does not noticeably impact radiation levels in air or water in the vicinity of SRS and thus are not included.

Table 5-2 lists the results of this analysis using 1998 emissions (1992 for Plant Vogtle), which are the latest available data for the SRS baseline. The cumulative dose to the maximally exposed member of the public would be 0.0001 rem (or 0.10 millirem) per year, well below the regulatory standard of 10 millirem per year (40 CFR 61). Summing the doses to the maximally exposed individual for the actions and baseline SRS operations listed in Table 5-2 is an extremely conservative approach because, in order to get the calculated dose, the maximally exposed individual would have to occupy different physical locations at the same time, which is impossible.

Adding the population doses from current and projected activities at SRS, Plant Vogtle, and tank closure activities could yield a total annual cumulative dose of 6.9 person-rem from airborne sources. The total annual cumulative dose translates into 0.0035 excess latent cancer fatality for each year of exposure for the population living within a 50-mile radius of the SRS.

5.2 Water Resources

At present, a number of SRS facilities discharge treated wastewater to Upper Three Runs and its tributaries and Fourmile Branch via NPDES-permitted outfalls. These include the F- and H-Area Effluent Treatment Facility and the M-Area Liquid Effluent Treatment Facility. As stated in Section 4.1.2, the SRS storm drainage system is designed to enable operators to secure specific storm sewer zones and divert potentially contaminated water to lined retention basins. Therefore, during the short term, tank closure activities are not expected to result in any radiological or nonradiological discharges to groundwater. Discharges to surface water would be treated to remove contaminants prior to release into SRS streams. Other potential sources of contaminants into Upper Three Runs

Table 5-2. Estimated average annual cumulative radiological doses and resulting health effects to the maximally exposed offsite individual and population in the 50-mile radius from airborne releases.

	Offsite Population			
	Maximally exposed individual		50-mile population	
Activity	Dose (rem)	Probability of fatal cancer risk	Collective dose (person-rem)	Excess latent cancer fatalities
SRS Baseline[a]	7.0×10^{-5}	3.5×10^{-8}	3.5	1.8×10^{-3}
Tank Closure[b]	5.2×10^{-8}	2.6×10^{-11}	3.0×10^{-3}	1.5×10^{-6}
Other foreseeable SRS activities[c]	5.1×10^{-5}	2.5×10^{-8}	3.4	1.7×10^{-3}
Plant Vogtle[d]	5.4×10^{-7}	2.7×10^{-10}	0.042	2.1×10^{-5}
Total	1.2×10^{-4}	6.1×10^{-8}	6.9	3.5×10^{-3}

a. Arnett and Mamatey (1999) for 1998 data for maximally exposed individual and population.
b. Data is based on the Fill with Saltstone Option under the Stabilize Tanks Alternative (Table 4.1.8-1).
c. Includes Spent Nuclear Fuel, Highly Enriched Uranium, Tritium Extraction Facility Management of Certain Plutonium Residues and Scrub Alloy Concentrations, Defense Waste Processing Facility, and Disposition of Surplus Plutonium, Sodium-Bonded Spent Nuclear Fuel, and components from throughout the DOE complex.
d. NRC (1996).

during the tank closure activities period include the accelerator production of tritium, the tritium extraction facility, environmental restoration, and decontamination and decommissioning activities, as well as modifications to existing SRS facilities. Discharges associated with the accelerator production of tritium and tritium extraction facility activities would not add significant amounts of nonradiological contaminants to Upper Three Runs. The amount of discharge associated with environmental restoration and decontamination and decommissioning activities would vary based on the level of activity. All the potential activities that could result in wastewater discharges would be required to comply with the NPDES permit limits that ensure protection of the water quality needed to support state-designated uses for the receiving stream. Studies of water quality and biota in Upper Three Runs suggest that discharges from facilities outfalls have not degraded the stream (Halverson et al. 1997).

5.3 Public and Worker Health

Table 5-3 summarizes the cumulative radiological health effects of routine SRS operations, proposed DOE actions, and non-Federal nuclear facility operations (Plant Vogtle Electric Generating Facility). In addition to estimated radiological doses to the hypothetical MEI, the offsite population, and the involved workers population, Table 5-3 also lists the potential number of excess latent cancer fatalities for the public and workers, due to exposure to radiation, and the involved workers population and the risk of a latent cancer fatality to the MEI. The radiation dose to the MEI from air and liquid pathways would be 0.00035 rem (0.35 mrem) per year, which is well below the applicable DOE regulatory limits (10 mrem per year from the air pathway, 4 mrem per year from the liquid pathway, and 100 mrem per year for all pathways). The total annual population dose for current and projected activities of 8.9 person-rem translates into 0.0045 latent cancer fatality for each year of exposure for the population living within a 50-mile radius of the SRS. For comparison, 144,000 deaths from cancer due to all causes would be likely in the same population over their lifetimes.

The annual radiation dose to the involved worker population would be 1,344 person-rem, which could result in 0.54 latent cancer fatalities. Closure actions under the Clean and Remove Tanks Alternative would result in 0.2 latent cancer fatalities per year. In addition, doses to individual workers would be kept below the regulatory limit of 5,000 mrem per year (10 CFR 835). Further, as low as reasonably achievable principles would be exercised to maintain individual worker doses below the SRS Administrative Control Level of 500 mrem per year. Tank closure activities would add minimal amounts to the overall radiological health effects of the workers and general public.

5.4 Waste Generation and Disposal Capacity

As stated in Section 4.1.10, HLW, low-level waste, and hazardous/mixed waste would be generated from tank closure activities.

Table 5-4 lists cumulative volumes of HLW, low-level, transuranic, and hazardous and mixed wastes that SRS would generate. The table includes data from the SRS 30-year expected waste forecast. The 30-year expected waste forecast is based on operations, environmental restoration, and decontamination and decommissioning waste forecasts from existing generators and the following assumptions: secondary waste from the DWPF, a form of HLW salt processing (In-Tank Precipitation), and Extended Sludge Processing operations are addressed in the DWPF EIS; HLW volumes are based on the selected option for the *F-Canyon Plutonium Solutions EIS* and the *Interim Management of Nuclear Materials at SRS EIS*; some investigation-derived wastes are handled as hazardous waste per Resource Conservation and Recovery Act regulations; purge water from well samplings is handled as hazardous waste; and the continued receipt of small amounts of low-level waste from other DOE facilities and nuclear naval operations would occur. The estimated quantity of radioactive/hazardous waste from operations in this forecast during the next 30 years would be approximately 143,000

Table 5-3. Estimated average annual cumulative radiological doses and resulting health effects to offsite population and facility workers.

	Maximally exposed individual				Offsite population[a]				Workers	
Activity	Dose from airborne releases (rem)	Dose from water releases (rem)	Total dose (rem)	Probability of fatal cancer risk	Collective dose from airborne releases (person-rem)	Collective dose from water releases (person-rem)	Total collective dose (person-rem)	Excess latent cancer fatalities	Collective dose (person-rem)	Excess latent cancer fatalities
SRS Baseline[b]	7.0×10^{-5}	1.2×10^{-4}	1.9×10^{-4}	9.5×10^{-8}	3.5	1.8	5.3	2.7×10^{-3}	160	0.066
Tank Closure[c]	2.6×10^{-8}	(f)	2.6×10^{-8}	1.3×10^{-11}	1.5×10^{-3}	(f)	1.5×10^{-3}	7.5×10^{-7}	490	0.20 TC
Other foreseeable SRS activities[d]	5.1×10^{-5}	5.7×10^{-5}	1.1×10^{-4}	5.4×10^{-8}	3.4	0.19	3.6	1.8×10^{-3}	694	0.28
Plant Vogtle[e]	5.4×10^{-7}	5.4×10^{-5}	5.5×10^{-5}	2.7×10^{-8}	0.042	2.5×10^{-3}	0.045	2.1×10^{-5}	NA	NA
Total	1.2×10^{-4}	2.3×10^{-4}	3.5×10^{-4}	1.8×10^{-7}	6.9	2.0	8.9	4.5×10^{-3}	1,344	0.54

N/A = not available

a. A collective dose to the 50-mile population for atmospheric releases and to the downstream users of the Savannah River for aqueous releases.

b. Arnett and Mamatey (1999) for 1998 data for MEI and population. Worker dose is based on 1997 data (WSRC 1998).

c. Collective worker dose of 490 person-rem is based on closure of two tanks per year for the Clean and Remove Tanks Alternative (Table 4.1.8-2).

d. Includes Spent Nuclear Fuel, Highly Enriched Uranium, Tritium Extraction Facility, Management of Certain Plutonium Residues and Scrub Alloy Concentrations, Defense Waste Processing Facility, and Disposition of Surplus Plutonium, Sodium-Bonded Spent Nuclear Fuel, and components from throughout the DOE complex.

e. NRC (1996).

f. Less than minimum reportable levels.

Table 5-4. Estimated cumulative waste generation from SRS concurrent activities (cubic meters).

Waste type	SRS baseline[a,b]	Tank closure[c]	ER/D&D[b,d]	Other waste volume[e]	Total
HLW	14,000	97,000	0	80,000	191,000
Low-level	119,000	19,260	61,600	251,000	450,000
Hazardous/mixed	3,900	470	6,200	4,700	15,200
Transuranic	6,000	0	0	12,500	18,500
Total[f]	143,000	117,000	67,800	348,000	675,000

a. Source: Halverson 1999.
b. Based on a total 30-year expected waste generation forecast, which includes previously generated waste.
c. Waste volume estimates based on the Clean and Remove Tanks Alternative (Table 4.1.10-2).
d. ER/D&D = environmental restoration/decontamination & decommissioning; based on a total 30-year expected waste forecast.
e. Sources: DOE (1996, 1997, 1998a,b; 1999b,c; 2000b,c). Life-cycle waste associated with reasonably foreseeable future activities such as spent nuclear fuel management, tritium extraction facility, plutonium residues, surplus plutonium disposition, highly-enriched uranium, commercial light water reactor waste, sodium-bonded spent nuclear fuel, and weapons components that could be processed in SRS Canyons. Impacts for the last two groups are based on conventional processing impacts of spent nuclear fuel "Group A"; DOE (2000c).
f. Totals have been rounded.

cubic meters. In addition, radioactive/hazardous waste associated with environmental restoration EC | and decontamination and decommissioning activities would have a 30-year expected forecast of approximately 68,000 cubic meters. Waste generated from the Clean and Remove Tanks Alternative would add a total of 117,000 cubic meters. During this same time period, other reasonably foreseeable activities that were not included in the 30-year forecast would add an additional 348,000 cubic meters. The major contributor to the other waste volumes would be from weapons components from various DOE sites that could be processed in SRS Canyons and from SNF management activities. Therefore, the potential cumulative amount of waste generated from SRS activities during the period of interest would be 675,000 cubic meters.

This large quantity of radioactive and hazardous waste must be managed safely and effectively to avoid severe impacts to human health and the environment. Such management is a major component of new missions for DOE. DOE has facilities in place and is developing new ways to better contain radioactive and hazardous substances. It is important to note that the quantities of waste generated are not equivalent to the amounts that will require disposal. For example, HLW is evaporated and concentrated to a smaller volume for final disposal.

The Three Rivers Solid Waste Authority Regional Waste Management Center at SRS accepts non-hazardous and non-radioactive solid wastes from SRS and eight surrounding South Carolina counties. This municipal solid waste landfill provides state-of-the-art Subtitle D (non-hazardous) facilities for landfilling solid wastes, while reducing the environmental consequences associated with construction and operation of multiple county-level facilities (DOE 1995b). It was designed to accommodate combined SRS and county solid waste disposal needs for at least 20 years, with a projected maximum operational life of 45 to 60 years (DOE 1995b). The landfill is designed to handle an average of 1,000 tons per day and a maximum of 2,000 tons per day of municipal solid wastes. SRS and eight cooperating counties had a combined generation rate of 900 tons per day in 1995. The Three Rivers Solid Waste Authority Regional Waste Management Center opened in mid-1998.

Tank closure activities and other planned SRS activities would not generate larger volumes of radioactive, hazardous, or solid wastes beyond current and projected capacities of SRS waste storage and/or management facilities.

5.5 Utilities and Energy

Table 5-5 lists the cumulative total of water consumption from activities at SRS. The values are based on annual consumption estimates. DOE has also evaluated the SRS water needs during tank closure. At present, the SRS rate of groundwater withdrawal is estimated to be a maximum of 1.7×10^{10} liters per year. The maximum estimated amount of water needed annually for the Fill with Grout Option under the Stabilize Tanks Alternative would increase this demand by less than 0.1 percent (Table 5-5), when added to present groundwater withdrawals and that for other foreseeable SRS activities. This level of water withdrawal is not expected to exceed SRS capacities.

Overall SRS electricity consumption would not be impacted by tank closure activities. Electricity usage for tank closure would be similar to current consumption levels in F- and H-Area Farms.

5.6 Closure – Near-Term Cumulative Impacts

The above analysis demonstrates minimal cumulative impacts due to the increment of near-term (2000-2030) tank closure activities for the five resource areas that required evaluation. Table 5-6 summarizes the near-term cumulative impact of past, present, proposed, and other reasonably foreseeable actions for the resource areas presented in this chapter.

5.7 Long-Term Cumulative Impacts

SRS personnel prepared a report, referred to as the *Composite Analysis* (WSRC 1997), that calculated the potential cumulative impact to a hypothetical member of the public over a period of 1,000 years from releases to the environment from all sources of residual radioactive material expected to remain in the SRS General Separations Area, which contains all of the SRS waste disposal facilities, chemical separations facilities, HLW tank farms, and numerous other sources of radioactive material. The impact of primary concern was the increased probability of fatal cancers. The *Composite Analysis* also included contamination in the soil in and around the HLW tank farms resulting from previous surface spills, pipeline leaks, and Tank 16 leaks as sources of residual radioactive material. The *Composite Analysis* considered 114 potential sources of radioactive material containing 115 radionuclides.

The *Composite Analysis* calculated maximum radiation doses to hypothetical members of the public at the mouth of Fourmile Branch, at the mouth of Upper Three Runs, and on the Savannah River at the Highway 301 bridge. The estimated peak all-pathway dose (excluding the drinking water pathway) from all radionuclides was 14 mrem/year (7×10^{-7} fatal cancer risk to a hypothetical member of the public at the mouth of Fourmile Branch), 1.8 mrem/year (mouth of Upper Three Runs), and 0.1 mrem/year

Table 5-5. Estimated average annual cumulative water consumption.

Activity	Water usage[a] (liters)
SRS Baseline	1.70×10^{10}
SRS HLW Tank Closure[b]	8.65×10^{6}
Other foreseeable SRS activities[c]	8.84×10^{8}
Total	1.79×10^{10}

a. Includes groundwater and surface-water usage.
b. Based on the Fill with Grout Option under the Stabilize Tanks Alternative (Table 4.1.11-1).
c. Includes Spent Nuclear Fuel, Highly Enriched Uranium, Tritium Extraction Facility, Management of Certain Plutonium Residues and Scrub Alloy Concentrations, Defense Waste Processing Facility, and Disposition of Surplus Plutonium, Sodium-Bonded Spent Nuclear Fuel, and components from throughout the DOE complex.

Table 5-6. Summary of short-term cumulative effects on resources from HLW tank closure alternatives.

Resource	Key Indicator of Environmental Impacts	Past Actions	Present Actions	HLW Tank Closure Alternatives	Other Future Actions	Cumulative Effect	
Air	24-hour sulfur dioxide concentration	No residual impacts remain from past emissions.	Conservatively estimated to be 96 percent of applicable standard	Incremental increase from the Fill with Saltstone Option under the Stabilize Tanks Alternative is about 0.03 percent of present condition.	Increment of about 0.33 percent of present condition.	Unchanged by proposed and other future actions.	EC TC TC
Water	Tritium to onsite streams	No residual impacts of past direct discharges. Tritium in the Savannah River was a small fraction of Federally mandated limit.	Largest contributor to dose from drinking water dramatically reduced from past operations.	No addition of tritium to Upper Three Runs under any tank closure alternative.	Very small addition of tritium to Upper Three Runs.	No meaningful increment from present, satisfactory conditions.	
Health	Annual radiological dose to offsite maximally exposed individual	All-pathway dose of 1.6 mrem is small fraction of 100-mrem limit	All-pathway dose of 0.07 mrem is very small fraction of 100-mrem limit.	All-pathway dose from the Fill with Saltstone Option under the Stabilize Tanks Alternative is less than 0.1 percent of current dose of 0.07 mrem (which is a small fraction of the 100-mrem limit).	Approximately 60 percent of current dose of 0.07 mrem (which is a small fraction of the 100-mrem limit).	All-pathway dose of 0.12 mrem is small fraction of 100-mrem limit.	TC TC
Waste Management	High-level waste (HLW) generation	Large, continual quantities of HLW generated.	Less annual generation, minimal additional tank space needed, 34 million gallons in storage.	About 50 percent of cumulative total from the Clean and Remove Tanks Alternative.	Highly radioactive fraction immobilized in DWPF. Separated, low activity waste disposed in onsite vaults.	Actions initiated to handle this substantial quantity of HLW with minimal impact to human health and the environment.	EC
Utility and Energy	Annual withdrawal of groundwater	No cumulative impact to aquifer from past high withdrawals.	Aquifer is not stressed by annual withdrawals of 1.7×10^{10} liters.	Very small fraction (0.05 percent) of current withdrawals from the Fill with Grout Option under the Stabilize Tanks Alternative.	Moderate increase (13 percent) in groundwater withdrawals.	Potential cumulative impacts are not added to by the proposed action.	TC TC

(Savannah River). The major contributors to dose were tritium, carbon-14, neptunium-237, and isotopes of uranium (WSRC 1997). These impacts are small because they are substantially below the U.S. Nuclear Regulatory Commission (and DOE) exposure limit of 100 mrem/yr for offsite individuals.

The analysis also calculated radiation doses from drinking water in Fourmile Branch and Upper Three Runs. The estimated peak drinking water doses from all radionuclides for these creeks were 23 mrem/year (1.2×10^{-5} fatal cancer risk to a hypothetical member of the public at Fourmile Branch) and 3 mrem/year for Upper Three Runs (WSRC 1997).

In this EIS, DOE estimated peak doses over a 10,000-year period of analysis. The highest estimated radiation dose in these creeks from the No Action Alternative, the first location where it could interact with contaminants from these other facilities, is 2.3 mrem/year. The location for which this value is calculated is upstream of the location presented in the *Composite Analysis*. DOE expects additional dilution to occur as the contaminants from HLW tank closure activities move downstream. Therefore, the dose and the associated impact (1.2×10^{-6} fatal cancer risk to a hypothetical member of the public) from HLW tank closure activities would be a small fraction of the doses, due to the other activities analyzed in the *Composite Analysis*.

In addition, the peak radiation doses from HLW tank closure activities would occur substantially later in time than the impacts of the other activities evaluated in the *Composite Analysis*. For example, because the radioactive contamination in the soil in and around the HLW tank farms does not have the benefit of a concrete layer below or above it (as would the residual activity remaining in the closed HLW tanks under the Fill with Grout Option), these contaminants would reach the groundwater (and thus the seepline and the surface water) long before the contaminants in the in the closed HLW tanks. Therefore, there would be no overlap in time of these contaminants.

As described in Section 4.2.4, DOE has developed a future use policy for the SRS which is further defined in the *Land Use Control Assurance Plan*, which is approved by SCDHEC and EPA. A key component of this policy is that residential uses of all SRS land would be prohibited in any area of the Site. This policy also states that SRS boundaries would remain unchanged, and the land would remain under the ownership of the Federal government. The area around the General Separations Area would remain an industrial use zone. Residential uses of the General Separations Area would be prohibited under any circumstances.

The future condition of the F- and H-Area Tank Farms would vary among the alternatives. Under the No Action Alternative, structural collapse of the tanks would create unstable ground conditions and form holes into which workers or other Site users could fall. Neither the Stabilize Tanks Alternative nor the Clean and Remove Tanks Alternative would have this safety hazard, although there could be some moderate ground instability with the Fill with Sand Option. For the Stabilize Tanks Alternative, four tanks in F Area and four tanks in H Area would require backfill soil to be placed over the tops of the tanks. The backfill soil would bring the ground surface at these tanks up to the surrounding surface elevations to prevent water from collecting in the surface depressions. This action would prevent ponding conditions over these tanks that could facilitate the degradation of the tank structure. For the Clean and Remove Tanks Alternative, the tank voids remaining after excavation would be filled in. The backfill material would consist of a soil type similar to the soils currently surrounding the tanks.

From a land use perspective, the F- and H-Area Tank Farms are zoned Heavy Industrial and are within existing heavily industrialized areas. The alternatives evaluated in this EIS are limited to closure of the tanks and associated equipment. They do not address other potential sources of contamination co-located with the tank systems, such as soil or groundwater contamination from past releases or other facilities. Consequently, future land use of the tank farm areas is not solely determined by the alternatives for closure of the tank systems. For example, the

Environmental Restoration program may determine that the tank farm areas should be capped to control the spread of contaminants through the groundwater. Such decisions would constrain future use of the tank farm areas. The Stabilize Tanks Alternative would render the tank farm areas least suitable for other uses, as the closed grout-filled tanks would remain in the ground. The Clean and Remove Tanks Alternative would have somewhat less impact on future land use because the tank systems would be removed. However, DOE does not expect the General Separations Area, which surrounds the F- and H-Area Tank Farms, to be available for other uses, making future uses of the tank farm areas a moot point.

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CHAPTER 6. RESOURCE COMMITMENTS

This chapter describes the unavoidable adverse impacts, short-term uses of environmental resources versus long-term productivity, and irreversible and irretrievable commitments of resources associated with cleaning, isolating, and stabilizing the high-level waste (HLW) tanks and related systems at the Savannah River Site (SRS). This chapter also includes discussions about U.S. Department of Energy (DOE) waste minimization, pollution prevention, and energy conservation programs in relation to implementation of the proposed action.

6.1 Unavoidable Adverse Impacts

Implementing any of the alternatives considered in this environmental impact statement (EIS) for closure of the HLW tanks at SRS would result in unavoidable adverse impacts to the human environment. The construction and operation of a saltstone mixing facility in F and H Areas (combined with continued operation of the current Saltstone Manufacturing and Disposal Facility in Z Area) under the Fill with Saltstone Option, or the construction and operation of temporary batch plants for grout production in F and H Areas under the Fill with Grout Option, would result in minimal short-term adverse impacts to geologic resources and traffic, as described in Chapter 4. These actions are not expected to impact cultural resources. Short-term impacts span from the year 2000 through final closure of the existing HLW tanks in approximately 2030. Generally, all construction activities would occur within the boundary of the tank farms (67 acres total) in an already developed industrial complex. An additional 1 to 3 acres would be required outside the fenced areas as a lay-down area to support construction activities under the Stabilize Tanks Alternative and the Clean and Remove Tanks Alternative.

Excavation of backfill material from an onsite borrow area could result in potential adverse impacts to geologic and surface water resources. Under the Stabilize Tanks Alternative, the soil elevation configurations surrounding four tanks in F Area and four tanks in H Area would require backfill soil to bring the ground surface at these tanks up to the surrounding surface elevations, to prevent surface water from collecting in the surface depressions. An estimated 170,000 cubic meters of soil would be required to fill the depressions to grade. Under the Clean and Remove Tanks Alternative, 356,000 cubic meters of soil would be required to backfill the voids left by removal of the tanks. As part of the required sediment and erosion control plan (using Best Management Practices), storm water management and sediment control measures (i.e., retention basins) would minimize runoff from these areas and any potential discharges of silts, solids, and other contaminants to surface water streams. Any storm water collected in the lined retention basins would be sent to Fourmile Branch (if uncontaminated rainwater), to the Effluent Treatment Facility for removal of contaminants, or rerouted to the tank farms for temporary storage prior to treatment. In addition, use of Best Management Practices would minimize any short-term adverse impacts to geologic resources.

Impacts from the borrow site development would include the physical alteration of 7 to 14 acres of land (and attendant loss of potential wildlife habitat) and noise disturbances to wildlife in nearby woodlands, assuming woodlands are present. Any site selected for the borrow area would be within the central developed core of the SRS, which is dedicated to industrial facilities. There would be no change in overall land use patterns on the SRS.

Adverse impacts to ecological resources would be minimal and short-term because most activities would occur within the previously disturbed and fenced areas. Although noise levels would be relatively low outside the immediate areas of construction, the combination of construction noise and human activity probably would displace small numbers of animals associated with an approximate 20-acre area surrounding the F and H Areas.

6.2 Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

The proposed locations for any new facilities would all be within developed industrial landscapes. Each of the options for the Stabilize Tanks Alternative would require approximately 1 to 3 additional acres for lay-down areas. The existing infrastructure (roads and utilities, etc.) within the F and H Areas is sufficient to support the proposed facilities.

For both F- and H-Area saltstone mixing facilities, after the operational life (i.e., all tanks are filled and closed), DOE could decontaminate and decommission the facilities in accordance with applicable regulatory requirements and restore the area to a brown-field site that would be available for other industrial use. Appropriate National Environmental Policy Act (NEPA) review would be conducted prior to the initiation of any decontamination and decommissioning action. In all likelihood, none of the sites would be restored to a natural terrestrial habitat (DOE 1998).

The project-related uses of environmental resources for the implementation of any of the proposed alternatives are characterized in the following paragraphs:

- Groundwater would be used in tank washing and cleaning and to meet process and sanitary water needs over the short-term impact period (i.e., 2002 to 2030). Long-term groundwater use would be limited to amounts necessary to support sanitary and drinking water needs during monitoring of the institutional area. After use and treatment (in the F- and H-Area Effluent Treatment Facility), this water would be released through permitted discharges into surface water streams. Therefore, the withdrawal, use, and treatment of groundwater would not affect the long-term productivity of this resource.

- Air emissions associated with implementation of any of the alternatives would add small amounts of radiological and nonradiological constituents to the air of the region. During the short-term impacts period (i.e., 2002 to 2030), these emissions would result in additional loading and exposure, but would not impact SRS compliance with air quality or radiation exposure standards. During the long-term impacts period, air emissions associated with the proposed action would be negligible. Therefore, there would be no significant residual environmental affects to long-term environmental productivity.

- Radiological contamination of the groundwater below and adjacent to the F and H Areas would occur over time. Because the bottoms of some tank groups in the H Area lie beneath the water table, the contaminants from these tanks could be released directly into the groundwater. In addition, some contaminants from each tank farm could be transported by groundwater through the Water Table and Barnwell-McBean Aquifers to the seepline along Fourmile Branch. For tanks situated north of the groundwater divide in the H-Area Tank Farm, contaminants released to the Water Table or Barnwell-McBean Aquifers may discharge to unnamed tributaries to Upper Three Runs or migrate downward to underlying aquifers. Beta-gamma dose and alpha concentrations would be below Maximum Contaminant Levels (MCL) at the seepline in both F and H Areas for two of the three options (i.e., Fill with Grout, Fill with Sand) under the Stabilize Tanks Alternative. In addition, the No Action Alternative would exceed the MCL at the seepline. DOE calculated peak radiation dose to aquatic and terrestrial receptors at the seepline and receiving surface water and compared the dose to the limit of 1.0 rad per day. Results indicated that all calculated absorbed doses to the referenced organisms are below regulatory limits and would, therefore, have no impact on the long-term productivity of the ecosystem at the seepline.

- Residual contaminants remaining in the HLW tanks after closure and following the period of institutional control could result in long-term impacts to public health. DOE evaluated the impacts over a 10,000-year period, in which the contaminants would be leached from the tank structures to the groundwater. The seepline was determined to be the area of greatest concern (i.e., area of maximum dose). Results indicated that the maximum dose to an adult receptor at the seepline for either tank farm is 6.2 EC millirem (mrem) for the No Action Alternative. This dose is less than the 100-mrem public dose limit. Based on this low dose, DOE would not expect any long-term productivity health effects to an adult receptor.

- The management and disposal of waste (low-level, hazardous, mixed, industrial, and sanitary) and non-recyclable radiological waste over the project's life would require energy and space at SRS treatment, storage, or disposal facilities (e.g., Z-Area Saltstone EC Facility, E-Area Vaults, Consolidated Incineration Facility, and Three Rivers Sanitary Landfill). The land required to meet the solid waste needs would require a long-term commitment of terrestrial resources. DOE established a future use policy for the SRS for the next 50 years in the 1998 *Savannah River Site Future Use* TC *Plan* (DOE 1998) and the *Land Use Control Assurance Plan*. This report sets forth guidance that would exclude the tank farms and associated waste disposal areas from non-conforming land uses. Therefore, this policy ensures that the areas would be removed from long-term productivity.

6.3 Irreversible and Irretrievable Resource Commitments

Resources that would be irreversibly and irretrievably committed during the implementation of HLW tank closure alternatives include those that cannot be recovered or recycled and those that are consumed or reduced to unrecoverable forms. The commitment of capital, energy, labor, and material during the implementation of HLW tank closure alternatives would generally be irreversible.

Energy expended would be in the form of fuel for equipment and vehicles, electricity for facility operations (e.g., bulk waste removal and production of grout at batch plant[s]), production of steam (i.e., for operation of ventilation systems on the waste tanks and heating of the cleaning solutions), and human labor. Construction (e.g., new saltstone mixing facilities) would generate nonrecyclable materials such as sanitary solid waste and construction debris. Implementation of any of the options for the Stabilize Tanks Alternative TC would generate nonrecyclable waste streams such as radiological and nonradiological wastes including liquid, low-level, hazardous, mixed low-level, and industrial. For example, oxalic acid cleaning would require between 225,000 and 500,000 gallons of oxalic acid for washing of each Type III tank (see Section 4.1.10 for greater detail). However, certain materials (e.g., copper and stainless steel) used during construction and operation of any proposed facility or facilities could be recycled when the facility is decontaminated and decommissioned. Some construction materials, particularly those associated with existing F- and H-Area Tank Farm facilities would not be salvageable, due to radioactive contamination. Table 6-1 lists estimated requirements for materials consumed during the closure of a single Type III tank.

The implementation of the any of the HLW tank closure alternatives considered in this EIS, including the No Action Alternative, would

Table 6-1. Estimated maximum quantities of materials consumed for each Type III tank closed.[a]

Materials	Stabilize Tanks Alternative: Fill with Grout Option	Stabilize Tanks Alternative: Fill with Sand Option	Stabilize Tanks Alternative: Fill with Saltstone Option	Clean and Remove Tanks Alternative	No Action Alternative
Oxalic acid[b] (4 percent) (gallons)	225,000	225,000	225,000	500,000	-
Sand (gallons)	-	2,640,000	-	-	-
Cement (gallons)	2,640,000	-	52,800	-	-
Fly ash	-	-	Included in	-	-
Boiler slag	-	-	saltstone	-	-
Additives (grout) (gallons)	500	-	-	-	-
Saltstone (gallons)	-	-	2,640,000	-	-

a. The SRS HLW tank systems includes four tank designs (Types I, II, III, and IV). Estimates were developed for closure of a single Type III tank system. Closure of a Type III tank system represents the maximum material consumption, relative to the other tank designs. Waste generation estimates for closure of the other tank designs are assumed to be: Type I – 60 percent of Type III estimate, Type II – 80 percent of Type III estimates, and Type IV – 90 percent of Type III estimate (Johnson 1999a).

b. At the present time, potential safety considerations restrict the use of oxalic acid in the HLW tanks (see Section 2.1). TC

require water, electricity, and diesel fuel. Table 6-2 lists the utilities and energy that would be consumed as a result of implementing each of the proposed alternatives.

Water would be obtained from onsite groundwater sources. Electricity, oxalic acid, sand, and diesel fuel would be purchased from commercial sources. These commodities are readily available, and the amounts required would not have an appreciable impact on available supplies or capacities.

6.4 Waste Minimization, Pollution Prevention, and Energy Conservation

6.4.1 WASTE MINIMIZATION AND POLLUTION PREVENTION

DOE has implemented an aggressive waste minimization and pollution prevention program at SRS at the site-wide level and for individual organizations and projects. As a result, significant reductions have been achieved in the amounts of wastes discharged into the environment and sent to landfills, resulting in significant cost savings.

To implement a waste minimization and pollution prevention program for the closure of the HLW tanks, DOE would characterize waste streams and identify opportunities for reducing or eliminating them. Emphasis would be placed on minimizing the largest waste stream, radioactive liquid waste, through source reductions, efficiencies, and recycling (if possible). Selected waste minimization practices could include:

- Process design changes to eliminate the potential for spills and to minimize contamination areas
- Decontamination of equipment to facilitate reuse
- Recycling metals and other usable materials, especially during the construction phase of the project
- Preventive maintenance to extend process equipment life

Table 6-2. Total estimated utility and energy usage for the HLW tank closure alternatives.[a]

	Stabilize Tanks Alternative					TC
	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	Clean and Remove Tanks Alternative	No Action Alternative	
Water (gallons)	48,930,000	12,840,000	12,840,000	25,680,000	7,120,000	TC
Electricity	NA	NA	NA	NA	NA	
Steam (pounds)	8,560,000	8,560,000	8,560,000	17,120,000	NA	
Fossil fuel (gallons)	214,000	214,000	214,000	428,000	NA	
Total utility cost	$4,280,000	$4,280,000	$4,280,000	$12,840,000	NA	

a. Source: Johnson (1999a,b,c,d).
b. NA = Not applicable to this alternative. Utility and energy usage for these alternatives would not differ significantly from baseline consumption.

- EC Modular equipment designs to isolate potential failure elements, so as to avoid changing out entire units
- Use of non-toxic or less toxic materials to prevent pollution and minimize hazardous and mixed waste streams
- Gloveboxes to eliminate the need for plastic suits and air hoses during maintenance activities and line breaks
- Incineration at the Consolidated Incineration Facility and other volume reduction techniques (i.e., compaction, cutting) to reduce waste volumes.

During construction, DOE would implement actions to control surface water runoff and construction debris and to prevent infiltration of contaminants into groundwater. The construction contractor would be selected, in part, based on prior pollution prevention practices.

6.4.2 ENERGY CONSERVATION

SRS has an active energy conservation and management program. Since the mid-1990s, more than 40 onsite administrative buildings have undergone energy-efficiency upgrades. Representative actions include the installation of energy-efficient light fixtures, the use of occupancy sensors in rooms, use of diode light sticks in exit signs, and the installation of insulating blankets around hot water heaters. Regardless of location, the incorporation of these types of energy-efficient technologies into facility design, along with the implementation of process efficiencies and waste minimization concepts, would facilitate energy conservation by any of the tank closure alternatives.

References

DOE (U.S. Department of Energy), 1998, *Savannah River Site Future Use Plan*, Savannah River Operations Office, Savannah River Site, Aiken, South Carolina, January.

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Johnson G., 1999a, Westinghouse Savannah River Company, "Draft Input to Tank Closure EIS," e-mail to P. Young, Tetra Tech NUS, Aiken, South Carolina, April 8.

Johnson G., 1999b, Westinghouse Savannah River Company, "Re: FW: Draft Input to Tank Closure EIS," e-mail to P. Young, Tetra Tech NUS, Aiken, South Carolina, April 13.

Johnson G., 1999c, Westinghouse Savannah River Company, "Responses to 4/20/99 Questions for Tank Closure EIS," e-mail to P. Young, Tetra Tech NUS, Aiken, South Carolina, April 21.

Johnson G., 1999d, Westinghouse Savannah River Company, "Re: Tank Closure EIS," e-mail to L. Matis, Tetra Tech NUS, Aiken, South Carolina, May 20.

CHAPTER 7. APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

This chapter identifies and summarizes the major laws, regulations, Executive Orders, and U.S. Department of Energy (DOE) Orders that could apply to the closure of the high-level waste (HLW) tank systems at the Savannah River Site (SRS). Permits or licenses could be required under some of these laws and regulations. EC

Section 7.1 describes the process DOE used to develop the methodology and performance standards for closure of the SRS HLW tank systems. Section 7.2 discusses the major Federal and State of South Carolina statutes and regulations that impose environmental protection requirements on DOE and that require DOE to obtain approval prior to closing the HLW tank systems. Each of the applicable regulations establishes how potential releases of pollutants and radioactive materials are to be controlled or monitored and include requirements for the issuance of permits for new operations or new emission sources. In addition to environmental permit requirements, the statutes may require consultations with various authorities to determine if an action requires a permit or the implementation of protective or mitigative measures. Sections 7.2.1 and 7.2.2 discuss the environmental permitting process and list the environmental permits and consultations (see Table 7-1) applicable to closure of the SRS HLW tank systems.

Sections 7.3 and 7.4 address the major Federal statutes, regulations, and Executive Orders, respectively, which address issues such as protection of public health and the environment, worker safety, and emergency planning. The Executive Orders clarify issues of national policy and set guidelines under which Federal agencies must act.

DOE implements its responsibilities for protection of public health, safety, and the environment through a series of departmental regulations and orders (see Section 7.5) that are typically mandatory for operating contractors of DOE-owned facilities.

7.1 Closure Methodology

7.1.1 CLOSURE STANDARDS

The SRS HLW tank systems are permitted by the South Carolina Department of Health and Environmental Control (SCDHEC) under authority of the South Carolina Pollution Control Act (SC Code Ann., Section 48-1-10, et seq.) (see Section 7.2.1) as industrial wastewater treatment facilities. DOE is required to close the HLW tank systems in accordance with Atomic Energy Act requirements (e.g., DOE Orders) and SC Regulation R.61-82 "Proper Closeout of Wastewater Treatment Facilities." This regulation requires the performance of such closures to be carried out in accordance with site-specific guidelines established by SCDHEC to prevent health hazards and to promote safety in and around the tank systems. To facilitate compliance with this requirement and to recognize the need for consistency with overall remediation of SRS under the Federal Facility Agreement (see Section 7.3.2), DOE has adopted a general strategy for HLW tank system closure that includes evaluation of an appropriate range of closure alternatives with respect to pertinent, substantive environmental requirements and guidance and other appropriate criteria (e.g., technical feasibility, cost). The general strategy for HLW tank system closure is set forth in the *Industrial Wastewater Closure Plan for the F- and H-Area High-Level Waste Tank Systems* (DOE 1996a). The general strategy is consistent with comparative analyses performed as part of a corrective measures study/feasibility study under the Federal Facility Agreement. EC

DOE will close all of the HLW tank systems in the F- and H-Area Tank Farms in accordance with the general strategy, including Tank 16,

Table 7-1. Environmental permits and consultations required by law (if needed).

Activity/Topic	Law	Requirements	Agency
Site Preparation	Federal Clean Water Act (Section 404)	Stormwater Pollution Prevention Plan for Industrial Activity	SCDHEC[a]
Wastewater Discharges	Federal Clean Water Act S.C. Pollution Control Act	Stormwater Pollution Prevention/Erosion Control Plan for Construction Activity	SCDHEC
		NPDES[b] Permit(s) for Process Wastewater Discharges	SCDHEC
		Process Wastewater Treatment Systems Construction and Operation Permits (if applicable)	SCDHEC
		Sanitary Waste Water Pumping Station Tie-in Construction Permit; Permit to Operate	SCDHEC
Air	Clean Air Act – NESHAP[c]	Rad Emissions - Approval to construct new emission source (if needed)	EPA[d]
		Air Construction and Operation permits - as required (e.g., Fire Water Pumps; Diesel Generators)	SCDHEC
		General source - stacks, vents, concrete batch plant	SCDHEC
		Air Permit - Prevention of Significant Deterioration (PSD)	SCDHEC
Domestic Water	Safe Drinking Water Act	Construction and operation permits for line to domestic water system	SCDHEC
Endangered Species	Endangered Species Act	Consultation	U.S. Fish and Wildlife Service, National Marine Fisheries Service
Migratory Birds	Migratory Bird Treaty Act	Consultation	U.S. Fish and Wildlife Service
Historical/Cultural Resources	National Historic Preservation Act	Consultation	State Historic Preservation Officer

a. South Carolina Department of Health and Environmental Control.
b. National Pollutant Discharge Elimination System.
c. National Emissions Standards for Hazardous Air Pollutants.
d. U.S. Environmental Protection Agency.

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which is no longer operational and hence was not permitted as part of the industrial wastewater treatment facility. With respect to closure, Tank 16 is subject to the same considerations that determine acceptable closure alternatives for the other 50 HLW tank systems. The past release from Tank 16 that resulted in its removal from service will be addressed along with the releases from the Tank 37 condensate transfer system as part of the H-Area Tank Farm Groundwater Operable Unit in accordance with the Federal Facility Agreement.

The General Closure Plan identifies the resources potentially affected by contaminants remaining in the tanks after waste removal and closure, describes how the tanks would be cleaned and how the tank systems and residual wastes would be stabilized, and identifies Federal and State environmental regulations and guidance that apply to the tank closures. It also describes the methodology using fate and transport models to calculate potential environmental exposure concentrations or radiological dose rates from the residual waste left in the tank systems and provides a methodology to account for closure impacts of individual tank systems, such that all closures would comply with environmental standards. This Closure Plan specifies the management of residual waste as waste incidental to reprocessing.

In developing its general closure strategy that includes extensive consultation with environmental regulators, DOE identified the substantive environmental requirements and guidance documents most pertinent to the selection and implementation of HLW tank system closure options. These requirements and guidance are comparable to those established as applicable or relevant and appropriate requirements (known as “ARARs”) and to-be-considered materials (known as “TBCs”) in the context of a corrective measures study/feasibility study under the Federal Facility Agreement. A compilation of the ARARs and TBCs can be found in Appendix C of DOE (1996a).

DOE reviewed the requirements and guidance to identify (1) standards for environmental protection that are invoked by more than one regulatory program or authority, and (2) conflicting requirements. This process resulted in a list of requirements and guidance, including DOE Orders (435.1, 5400.1, 5400.5) and State and Federal regulations, that DOE used to identify specific regulatory standards for protection of human health and the environment. Overlapping requirements and guidance were reduced to a single list representing only the most stringent or most specific standards. This listing became the closure performance standards. The performance standards are generally numerical, such as concentrations or dose limits for specific radiological or chemical constituents in releases to the environment, which are set forth in the requirements and standards guidance. The numerical standards apply at different points of compliance and at varying times during or after closure. The performance standards apply to the entire tank farm area. Performance standards are established for environmental media. For example, the performance standard for groundwater will be the groundwater protection standard applied at the point where groundwater discharges to the surface (known as the seepline). For surface water, the performance standard will be the surface water quality standard applied in the receiving stream. Tables 7-2 and 7-3 present the radiological and nonradiological water quality criteria identified as performance standards for the SRS HLW tank closures.

7.1.2 PERFORMANCE OBJECTIVE

DOE will establish performance objectives for closure of each HLW tank. Each performance objective will correspond to a performance standard in the Closure Plan. Performance objectives will normally be more stringent than the performance standard. For example, if the performance standard for drinking water at the seepline is 4 millirem per year, the contribution of contaminants from all tanks (and other facilities) will not exceed the 4 millirem per year limit. DOE will evaluate closure options

Table 7-2. Nonradiological groundwater and surface water performance standards applicable to SRS HLW tank closure.

Constituents of concern[a]	Maximum contaminant level (40 CFR §141.62) (mg/l)	Maximum contaminant level goal (40 CFR §141.51) (mg/l)	Maximum contaminant levels (SC R.61-58.5.B(2)) (mg/l)	Water quality criteria for protection of human health (SC R.61-68, Appendix 2) (mg/l)	Criteria to protect aquatic life (SC R.61-68, Appendix 1) (mg/l)	
					Average	Maximum
Aluminum					0.087	0.750
Chromium III				637.077	0.120	0.980
Chromium VI				0.050	0.011	0.016
Total chromium	0.1	0.1	0.1		0.011	0.016
Copper		1.3			0.0065	0.0092
Fluoride	4.0	4.0	4.0			
Iron					1.000	2.000
Lead		zero[b]		0.050	0.0013	0.034
Mercury	0.002	0.002	0.002	1.53×10^{-4}	1.2×10^{-5}	0.0024
Nickel			0.1	4.584	0.088	0.790
Nitrate	10 (as N)	10 (as N)	10 (as N)			
Nitrite	1 (as N)	1 (as N)	1 (as N)			
Total nitrate and nitrite	10 (as N)	10 (as N)	10 (as N)			
Selenium	0.05	0.05	0.05	0.010	0.0050	0.020
Silver				0.050		0.0012

Source: DOE (1996a).
a. Includes SRS HLW constituents for which water quality performance standards were identified.
b. Action level for lead is 0.015 mg/l.

Table 7-3. Radiological groundwater and surface water performance standards applicable to SRS HLW tank closure.

Constituent of concern	Standard
Beta particle and photon radioactivity	4 mrem/yr
Combined radium-226 and radium-228	5 pCi/l
Gross alpha	15 pCi/l (including radium-226 but excluding radon and uranium)
Tritium	20,000 pCi/l
Strontium	8 pCi/l
Radiation dose to native aquatic organisms	1 rad/day from liquid discharges to natural waterways

Source: DOE (1996a).

for specific tank systems to determine if use of a specific closure option will allow DOE to meet the performance objectives. Based on this analysis, DOE will develop a closure module for each HLW tank system such that the performance objectives for the tank system can be met.

The performance evaluation will focus on the exposure pathways and contaminants of most concern for a specific HLW tank system. DOE anticipates that the exposure pathway of most concern will be the contaminant release to groundwater and migration to onsite streams. The contaminants of most concern will be those subject to the most stringent performance standards for points of compliance within the exposure pathway. The lowest concentration limit for a specific constituent would become the performance objective for that constituent.

L-7-55 An example of comparison to performance objectives (conformance to drinking water standard at the F-Area Tank Farm seepline) is provided in Table 7-4.

7.1.3 INCIDENTAL WASTE

The terms "incidental waste" or "waste incidental to reprocessing" refer to a process for identifying wastes that might otherwise be considered HLW due to their origin, but are actually managed as low-level or transuranic waste, as appropriate, if the waste incidental to reprocessing requirements contained in DOE Radioactive Waste Management Manual (DOE M 435.1-1) are met. This is a process by which DOE can make a determination that, for example, waste residues remaining in HLW tanks, equipment, or transfer lines are managed as low-level or transuranic waste, if the requirements in Section II.B of DOE M 435.1-1 have been or will be met.

The requirements contained in DOE M 435.1-1 are divided into two processes: the "citation" process and the "evaluation" process. When determining whether spent nuclear fuel reprocessing plant wastes are another waste type or HLW, either the citation or evaluation process described in DOE M 435.1-1 shall be used.

- Citation – Waste incidental to reprocessing by "citation" includes spent nuclear fuel processing plant wastes that meet the "incidental waste" description included in the Notice of Proposed Rulemaking (34 FR 8712, June 3, 1969) for promulgation of proposed Appendix D, 10 CFR Part 50, Paragraphs 6 and 7. These radioactive wastes are the result of processing plant operations, such as, but not limited to, contaminated job wastes, such as laboratory items (clothing, tools, and equipment).

- Evaluation – Waste incidental to reprocessing by "evaluation" includes spent nuclear fuel processing plant wastes that:

  (a) Will be managed as low-level waste and meet the following criteria: (1) have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical; and (2) will be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR Part 61; and (3) are to be managed, pursuant to DOE's authority under the *Atomic Energy Act of 1954*, as amended, and in accordance with the provisions of Chapter IV of this Manual [DOE M 435.1-1], provided the waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10 CFR 61.55, Waste Classification; or will meet alternative requirements for waste classification and characterization as DOE may authorize. TC

  (b) Will be managed as transuranic waste and meet the following criteria: (1) have been processed, or will be processed, to re-move key radionuclides to the maximum extent that is technically and economically practical; and (2) will be incorporated in a

Table 7-4. Comparison of modeling results to performance objectives at the seepline.[a]

	Units	Adjusted PO	F-Area GTS impact	Previous closures impact[b]	Tank 17 impact	Remaining PO
Radiological						
Beta-gamma dose	mrem/yr	4.0	1.9	0.0055	0.022	3.99
Alpha concentration	pCi/L	15	3.9×10^{-2}	(c)	(c)	15
Nonradiological						
Nickel	mg/L	0.1	(d)	0	(d)	0.1
Chromium[e]	mg/L	0.1	4.6×10^{-5}	5.0×10^{-6}	1.1×10^{-5}	0.1
Mercury	mg/L	0.002	(d)	0	(d)	0.002
Silver	mg/L	0.05	1.7×10^{-3}	1.9×10^{-4}	4.1×10^{-4}	0.049
Copper	mg/L	1.3	(d)	0	(d)	1.3
Nitrate	mg/L	10 (as N)	1.2×10^{-2}	1.3×10^{-3}	7.5×10^{-3}	10 (as N)
Lead	mg/L	0.015	(d)	0	(d)	0.015
Fluoride	mg/L	4.0	1.1×10^{-3}	1.3×10^{-4}	2.7×10^{-4}	4
Barium	mg/L	2.0	(d)	0	(d)	2

EC

a. Source: DOE (1997a).
b. Tank 20.
c. Concentration is less than 1.0×10^{-13} pCi/L.
d. Concentration is less than 1.0×10^{-6} mg/L
e. Total chromium (chromium III and VI).
PO = Performance Objective; GTS = Groundwater Transport Segment.

TC

solid physical form and meet alternative requirements for waste classification and characteristics, as DOE may authorize; and (3) are managed pursuant to DOE's authority under the *Atomic Energy Act of 1954*, as amended, in accordance with the provisions of Chapter III of this Manual [DOE M 435.1-1], as appropriate."

Those waste streams that meet the requirements, either by citation or evaluation, would be excluded from the scope of HLW. In the absence of an "incidental waste" or "waste incidental to reprocessing" determination, DOE would continue management of HLW due to its origin as HLW, regardless of its radionuclide content.

Per DOE guidance in DOE G 435.1, the DOE Field Element Manager is responsible for ensuring that waste incidental to reprocessing determinations are made consistent with either the citation or the evaluation process. A determination made using the evaluation process will include consultation and coordination with the DOE Office of Environmental Management.

The U.S. Nuclear Regulatory Commission (NRC) has participated in regulatory reviews using these evaluation criteria in the past and has expertise that is expected to complement DOE's internal review. Hence, consultation with NRC staff regarding the requirements for the evaluation process is strongly encouraged under the guidance for DOE O 435.1.

DOE has consulted with NRC regarding the incidental waste determination for the SRS tank system residuals. To facilitate the consultations, DOE prepared a demonstration that the material remaining in the SRS tank systems at closure satisfies criteria for classification as "incidental waste" (DOE 1997b). NRC has completed its review of the Savannah River Operations Office's HLW tank closure methodology and concluded that DOE's methodology reasonably analyzes the relevant considerations for an incidental waste determination (65 FR 62377, October 18, 2000).

7.1.4 ENVIRONMENTAL RESTORATION PROGRAM

Upon completion of closure activities for a group of tanks (and their related equipment) in a particular section of a tank farm, responsibility for the tanks and associated equipment in the group would be transferred to the SRS environmental restoration program. The environmental restoration program would conduct soil assessments and remedial actions to address any contamination in the environment (including previous known leaks) and develop a post-closure strategy. Consideration of alternative remedial actions under the remediation program is outside the scope of this environmental impact statement (EIS), and would be conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process. However, DOE has established a formal process to ensure that tank closure activities are coordinated with the environmental restoration program. This process is described in the *High-Level Waste Tank Closure Program Plan* (DOE 1996b). This process requires that, once a group of tanks in a particular section of a tank farm is closed, the HLW operations organization and the environmental restoration organization would establish a Co-Occupancy Plan to ensure safe and efficient soils assessment and remediation.

The HLW organization would be responsible for operational control and the environmental restoration organization would be responsible for environmental restoration activities. The primary purpose of the Co-Occupancy Plan is to provide the two organizations with a formal process to plan, control, and coordinate the environmental restoration activities in the tank farm areas. The activities of the environmental restoration program would be governed by the CERCLA, Resource Conservation and Recovery Act (RCRA) corrective action, and the Federal Facility Agreement between DOE, SCDHEC, and the U.S. Environmental Protection Agency (EPA). As such, it is beyond the scope of this EIS.

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DOE's HLW tank closure strategy was designed to be consistent with the requirements of RCRA and CERCLA under which the tank farms will eventually be remediated. The details of the proposed closure configuration for individual tank systems will be detailed in modules that are submitted to SCDHEC for approval. The modules are also provided to the SCDHEC and EPA Region IV Federal Facility Agreement project managers for review to ensure consistency with the Agreement's requirements for overall remediation of the tank farms. DOE's intention is that HLW tank closure actions would not interfere with or foreclose remedial alternatives for past releases.

7.2 Statutes and Regulations Requiring Permits or Consultations

Environmental regulations require that the owner or operator of a facility obtain permits for the construction and operation of new (water and air) emissions sources and for new domestic drinking water systems. To obtain these permits, the facility operator must apply to the appropriate government agency for a discharge permit for discharges of wastewater to the waters of the state and submit construction plans and specifications for the new emission sources, including new air sources. The environmental permits contain specific conditions with which the permittee must comply during construction and operation of a new emission source, describe pollution abatement and prevention methods to be utilized for reduction of pollutants, and contain emissions limits for pollutants which will be emitted from the facility. Section 7.2.1 discusses the environmental statutes and regulations under which DOE will be required to obtain permits. Table 7-5 identifies the major State of South Carolina statutes and their implementing regulations applicable to HLW tank system closures. The table also provides the underlying Federal statutes and implementing regulations. Table 7-1 lists the permits.

Table 7-5. Major state and federal laws and regulations applicable to high-level waste tank system closures.

South Carolina laws and regulations	Federal laws and regulations
South Carolina Pollution Control Act (SC Code Section 48-1-10)	Clean Air Act (42 USC 7401) Clean Water Act (33 USC 1251)
Safe Drinking Water Act (SC Code Section 44-55-10)	Safe Drinking Water Act (42 USC 300(f))
Hazardous Waste Management Act (SC Code Section 44-56-10)	Resource Conservation and Recovery Act (42 USC 6901 et seq.)
R.61-9 Water Pollution Control Permits	40 CFR Part 122 *EPA Administered Permit Programs: The National Pollutant Discharge Elimination System*
R.61-58 *State Primary Drinking Water Regulations*	40 CFR Part 141 *National Primary Drinking Water Regulations*
R. 61-62 *Air Pollution Control Regulations and Standards*	40 CFR Part 50 *National Primary and Secondary Ambient Air Quality Standards*
	40 CFR §51.166 *Prevention of Significant Deterioration of Air Quality*
	40 CFR Part 60 *Standards of Performance for New Stationary Sources*
	40 CFR Part 61 *National Emission Standards for Hazardous Air Pollutants*
R.61-68 *Water Classification and Standards* R.61-69 *Classified Waters*	40 CFR 131 *Water Quality Standards*
R.61-79 *Hazardous Waste Management Regulations*	40 CFR Parts 260-266, 268, 270 (RCRA Subtitle C implementing regulations)
R.61-82 *Proper Closeout of Wastewater Treatment Facilities*	No federal equivalent

7.2.1 ENVIRONMENTAL PROTECTION PERMITS

Clean Air Act, as amended, (42 USC 7401 et seq.), (40 CFR Parts 50-99); South Carolina Pollution Control Act [Section 48-1-10 et seq., SCDHEC Regulation 61-62]

The Clean Air Act, as amended, is intended to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population." Section 118 of the Act requires Federal agencies, such as DOE, with jurisdiction over any property or facility that might result in the discharge of air pollutants, to comply with "all Federal, State, interstate, and local requirements" related to the control and abatement of air pollution.

The Act requires EPA to establish National Ambient Air Quality Standards to protect public health, with an adequate margin of safety, from any known or anticipated adverse effects of a regulated pollutant (42 USC 7409). It also requires the establishment of national standards of performance for new or modified stationary sources of atmospheric pollutants (42 USC 7411) and the evaluation of specific emission increases to prevent a significant deterioration in air quality (42 USC 7470). In addition, the Clean Air Act regulates emissions of hazardous air pollutants, including radionuclides, through the National Emission Standards for Hazardous Air Pollutants (NESHAP) program (42 USC 7412). Air emission standards are established at 40 CFR Parts 50 through 99. The following describes four key aspects of the Clean Air Act.

- ***Prevention of Significant Deterioration*** – Prevention of Significant Deterioration, as defined by the Clean Air Act, applies to major stationary sources and is designed to permanently limit the degradation of air quality from specific pollutants in areas that meet attainment standards. The Prevention of Significant Deterioration regulations apply to new construction and to major modifications made to stationary sources. A major modification is defined as a net increase in emissions beyond thresholds listed at 40 CFR 51.166(b)(23). Construction or modifications of facilities that fall under this classification are subject to a preconstruction review and permitting under the program that is outlined in the Clean Air Act. In order to receive approval, DOE must show that the source (1) will comply with ambient air quality levels designed to prevent deterioration of air quality, (2) will employ "best available control technology" for each pollutant regulated under the Clean Air Act that will emit significant amounts, and (3) will not adversely affect visibility.

- ***Title V Operating Permit*** – Congress amended the Clean Air Act in 1990 to include requirements for a comprehensive operating permit program. Title V of the 1990 amendments requires EPA to develop a Federally enforceable operating permit program for air pollution sources to be administered by the state and/or local air pollution agencies. The purpose of this permit program is to consolidate in a single document all of the Federal and state regulations applicable to a source, in order to facilitate source compliance and enforcement. The EPA promulgated regulations at Section 107 and 110 of the Clean Air Act that define the requirements for state programs.

- ***Hazardous Air Pollutants*** – Hazardous air pollutants are substances that may cause health and environmental effects at low concentrations. Currently, 189 compounds have been identified as hazardous air pollutants. A major source is defined as any stationary source, or a group of stationary sources, located within a contiguous area under common control that emits or has the potential to emit at least 10 tons per year of any single hazardous air pollutant or 25 tons per year of a combination of pollutants.

  The 1990 amendments to the Clean Air Act substantially revised the program to regulate potential emissions of hazardous air pollutants. The aim of the new control program is to require state-of-the-art pollution control technology on most existing and all new emission sources. These provisions regulate emissions by promulgating emissions limits reflecting use of the maximum achievable control technology. These emission limits are then incorporated into a facility's operating permit.

- ***National Emission Standards for Hazardous Air Pollutants for Radionuclides*** – Radionuclide emissions other than radon from DOE facilities are also covered under the NESHAP program (40 CFR Part 61, Subpart H). To determine compliance with the standard, an effective dose equivalent value for the maximally exposed members of the public is calculated by using EPA-approved sampling procedures, computer models, or other EPA-approved procedures. EC

  Any fabrication, erection, or installation of a new building or structure within a facility whose emissions would result in an effective dose equivalent to a member of the public that would exceed 0.1 millirem per year would require that an application be submitted to EPA. This application must include the name of the applicant, the location or proposed location of the source, and technical information describing the source. If the application is for a modification of an existing facility, information provided to EPA must include the precise nature of the proposed changes, the productive capacity of the source before and after the changes are completed, and calculations of estimates of emissions before and after the changes are completed.

EPA has overall authority for the Clean Air Act; however, it delegates primary authority to states that have established an air pollution control program approved by EPA. In South Carolina, EPA has retained authority over radionuclide emissions (40 CFR Part 61) and has delegated to SCDHEC the responsibility for the rest of the regulated pollutants under the authority of the South Carolina Pollution Control Act (48-1-10 et. seq.,) and SCDHEC Air Pollution Control Regulation 61-62.

Construction and operation permits or exemptions will be required for new nonradiological air emission sources (diesel generators, concrete batch plants, etc.) constructed and operated as part of the HLW tank system closure process. The permits will contain operating conditions and effluent limitations for pollutants emitted from the facilities (see Table 7-1).

DOE will determine if a NESHAP permit will be required for radiological emissions from any facilities (stacks, process vents, etc.) used in the HLW tank system closure process. As described in 40 CFR Part 61.96, if all emissions from facility operations would result in an effective dose equivalent to a member of the public that would not exceed 0.1 mllirem per year, an application for approval to construct under 40 CFR Part 61.07 is not required to be filed. 40 CFR Part 61.96 also allows DOE to use, with prior EPA approval, methods other than EPA standard methods for estimating the source term for use in calculating the projected dose. If DOE's calculations indicate that the emissions from the HLW tank system closure operations will exceed 0.1 millirem per year, DOE will, prior to the start of construction, complete an application for approval to construct under 40 CFR 61.07.

Federal Clean Water Act, as amended (33 USC 1251 et seq.); SC Pollution Control Act (SC Code Section 48-1-10 et seq., 1976) (SCDHEC Regulation 61-9.122 et. seq.)

The purpose of the Clean Water Act, which amended the Federal Water Pollution Act, is to "restore and maintain the chemical, physical and biological integrity of the Nation's water." The Clean Water Act prohibits the "discharge of toxic pollutants in toxic amounts" to navigable waters of the United States (Section 101). Section 313 of the Act generally requires all branches of the Federal Government engaged in any activity that might result in a discharge or runoff of pollutants to surface waters to comply with Federal, state, interstate, and local requirements.

Under the Clean Water Act, states generally set water quality standards, and EPA or states regulate and issue permits for point-source discharges as part of the National Pollutant Discharge Elimination System (NPDES) permitting program. EPA regulations for this program are codified at 40 CFR Part 122. If the construction or operation of the selected action would result in point-source discharges, DOE could need to obtain an NPDES permit.

EPA has delegated primary enforcement authority for the Clean Water Act and the NPDES permitting program to SCDHEC for waters in South Carolina. In 1996, SCDHEC, under the authority of the Pollution Control Act (48-1-10 et seq.) and Regulation 61-9.122, issued NPDES Permit SC0000175, which addresses wastewater discharges to SRS streams and NPDES permit SCG250162 which addresses general utility water discharges. Permit SC0000175 contains effluent limitations for physical parameters such as flow and temperature and for chemical pollutants with which DOE must comply. DOE will apply for a discharge permit for HLW tank system closure operations if the process chosen results in discharges to waters of the State (see Table 7-1).

Under the authority of the Pollution Control Act, SCDHEC has issued industrial wastewater treatment "as-built" construction permit numbers 14,338, 14,520, and 17,434-IW covering the SRS HLW tank systems. These permit establish design and operating requirements for the tank systems, based on the standards set forth in Appendix B of the SRS Federal Facility Agreement (see Section 7.3.2).

Sections 401 and 405 of the Water Quality Act of 1987 added Section 402(p) to the Clean Water Act. Section 402(p) requires the EPA to establish regulations for the Agency or individual states to issue permits for stormwater discharges associated with industrial activity, including construction activities that could disturb five or more acres (40 CFR Part 122). SCDHEC has issued a General Permit for Storm Water Discharges Associated with Industrial Activities (Permit No. SCR000000), authorizing stormwater discharges to the waters of the State of South Carolina in accordance with effluent limitations, monitoring requirements, and conditions set forth in the permit. This permit requires preparation and submittal of a Pollution Prevention Plan for all new and existing point source discharges associated with industrial activity. Accordingly, DOE Savannah River Operations Office has developed a Storm Water Pollution Prevention Plan for storm water discharges at SRS. The SRS Storm Water Pollution Prevention Plan would need to be revised to include pollution prevention measures to be implemented for HLW tank system operations (See Table 7-1), if industrial activities are exposed to storm water. SCDHEC has issued a General Permit for storm water discharges from construction activities that are "Associated with Industrial Activity" (Permit No. SCR100000). An approved plan would be needed that includes erosion control and pollution prevention measures to be implemented for construction activities. EC

Section 404 of the Clean Water Act requires that a 404 permit be issued for discharge of dredge or fill material into the waters of the United States. The authority to implement these requirements has been given to the U.S. Army Corps of Engineers. Section 401 of the Clean Water Act requires certification that discharges from construction or operation of facilities, including discharges of dredge and fill material into navigable waters, will comply with applicable water standards. This certification, which is granted by SCDHEC, is a prerequisite for the 404 permit. DOE does not believe that a 404 permit will be required for the HLW tank system closures.

Federal Safe Drinking Water Act, as amended [42 USC 300 (f) et seq., 40 CFR Parts 100-149]; South Carolina Safe Drinking Water Act (Title 44-55-10 et seq.), State Primary Drinking Water Regulations, (SCDHEC R.61-58)

The primary objective of the Safe Drinking Water Act is to protect the quality of water supplies. This law grants EPA the authority to protect quality of public drinking water supplies by establishing national primary drinking water regulations. In accordance with the Safe Drinking Water Act, the EPA has delegated authority for enforcement of drinking water standards to the states. Regulations (40 CFR Part 123, 141, 145, 147, and 149) specify maximum contaminant levels (MCLs), including those for radioactivity, in public water systems, which are generally defined as systems that serve at least 15 service connections or regularly serve at least 25 year-round residents. Construction and operation permits would be required for lines to drinking water supply systems associated with HLW tank closure activities (see Table 7-1). Other programs established by the Safe Drinking Water Act include the Sole Source Aquifer Program, the Wellhead Protection Program, and the Underground Injection Control Program. EC

As a regulatory practice and policy, the Safe Drinking Water Act MCLs are also used as groundwater protection standards. For example, the regulations specify that the average annual concentration of manmade radionuclides in drinking water shall not produce a dose equivalent to the total body or an internal organ dose greater than 4 mrem per year beta-gamma activity. This radionuclide MCL is the primary performance objective for the SRS HLW tank system closures. EC EC

EPA has delegated primary enforcement authority to SCDHEC for public water systems in South Carolina. Under the authority of the South Carolina Safe Drinking Water Act (44-55-10 et seq.), SCDHEC has established a drinking water regulatory program (R.61-58). SCDHEC has also established groundwater and surface water classifications and standards under
EC R. 61-68. Along with the Federal MCLs (40 CFR 141), these South Carolina water quality standards are the groundwater and surface water performance standards applicable to closure of the HLW tank systems.

Resource Conservation and Recovery Act, as amended (Solid Waste Disposal Act) (42 USC 6901 et seq.); South Carolina Hazardous Waste Management Act, Section 44-56-30, South Carolina Hazardous Waste Management Regulations (R.61-79.124 et seq.)

RCRA regulates the treatment, storage, and disposal of hazardous wastes. The EPA regulations implementing RCRA are found in 40 CFR Parts 260-280. These regulations define hazardous wastes and specify hazardous waste transportation, handling, treatment, storage, and disposal requirements. This area of the law deals with two different approaches to regulation. First, RCRA regulates the wastes themselves and sets standards for waste forms that may be disposed. Second, RCRA regulates the design and operation of the waste management facilities and establishes standards for their performance.

EPA defines waste that exhibits the characteristics of ignitability, corrosivity, reactivity, or toxicity as "characteristic" hazardous waste. EPA has also identified certain materials as hazardous waste by listing them in the RCRA regulations. These materials are referred to as "listed" hazardous waste. "Mixed waste" is radioactively contaminated hazardous waste. The definition of "solid waste" in RCRA specifically excludes the radiological component (source, special nuclear, or byproduct material as defined by the Atomic Energy Act). As a result, mixed waste is regulated under multiple authorities: by RCRA, as implemented by EPA or authorized states for the hazardous waste components; and by the Atomic Energy Act for radiological components, as implemented by either DOE or the NRC. EC

RCRA applies mainly to active facilities that generate and manage hazardous waste. This law imposed management requirements on generators and transporters of hazardous waste and upon owners and operators of treatment, storage, and disposal facilities. EPA has established a comprehensive set of regulations governing all aspects of treatment, storage, and disposal facilities, including location, design, operation, and closure. Pursuant to Section 3006 of the Act, any state that seeks to administer and enforce a hazardous waste program pursuant to RCRA may apply for EPA authorization of its program. EPA has delegated primary enforcement authority to SCDHEC, which has established hazardous waste management requirements under SC Regulation R.61-79.

Under Section 3004(u) of RCRA, DOE is required to assess releases from solid waste management units and implement corrective action plans where necessary. The RCRA corrective action requirements for SRS are set forth in the Federal Facility Agreement (Section 7.3.2).

The HLW managed in the F- and H-Area Tank Farms is considered mixed waste because it exhibits characteristics of RCRA hazardous waste (i.e., corrosivity and toxicity for certain metals) and contains source, special nuclear, or by-product material regulated under the Atomic Energy Act. Waste removed from the tank systems will be managed in accordance with applicable RCRA requirements (i.e., treated to meet the land disposal restrictions standards prior to disposal). The HLW tank systems are exempt from the design and operating standards and permitting requirements for hazardous waste management units because they are wastewater treatment units regulated under the Clean Water Act [see 40 CFR 260.10, 264.1(g)(6), and 270.1(c)(2)(v)].

The Federal Facility Compliance Act (42 USC 6921 (et. seq.)

The Federal Facility Compliance Act amended RCRA in 1992 and requires DOE to prepare plans for developing treatment capacity for mixed wastes stored or generated at each facility. After consultation with other affected states, the host-state or EPA must approve each plan. The appropriate regulator must also issue an order requiring compliance with the plan.

On September 20, 1995, SCDHEC approved the *Site Treatment Plan* for SRS. SCDHEC issued a consent order, signed by DOE, requiring compliance with the plan on September 29, 1995. DOE provides SCDHEC with annual updates to the information in the *SRS Site Treatment Plan*. DOE would be required to notify SCDHEC of any new mixed waste streams generated as result of HLW tank system closure activities.

7.2.2 PROTECTION OF BIOLOGICAL, HISTORIC, AND ARCHAEOLOGICAL RESOURCES

Endangered Species Act, as amended (16 USC 1531 et seq.)

The Endangered Species Act provides a program for the conservation of threatened and endangered species and the ecosystems on which those species rely. All Federal agencies must assess whether the potential impacts of a proposed action could adversely affect threatened or endangered species or their habitat. If so, the agency must consult with the U.S. Fish and Wildlife Service (part of the U.S. Department of the Interior) and the National Marine Fisheries Service (part of the U.S. Department of Commerce), as required under EC | Section 7 of the Act. The outcome of this consultation may be a biological opinion by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service that states whether the proposed action would jeopardize the continued existence of the species under consideration. If there is non-jeopardy opinion, but if some individuals might be killed incidentally as a result of the proposed action, the Services can determine that such losses are not prohibited as long as measures outlined by the Services are followed. Regulations implementing the Endangered Species Act are codified at 50 CFR Part 15 and 402.

The HLW tank systems are located within fenced, disturbed industrial areas. Construction associated with closure of the tank systems would not disturb any threatened or endangered species, would not degrade any critical or sensitive habitat, and would not affect any jurisdictional wetland. Therefore DOE concludes that no consultation with the U.S. Fish and Wildlife Service or the National Marine Fisheries Service concerning the alternatives considered in this EIS is required.

The following statutes pertain to protection of animals or plants, historic sites, archaeological resources, and items of significance to Native Americans. DOE does not expect these requirements to apply to the closure of the SRS HLW tank systems because these facilities are located in previously disturbed industrial areas.

- Migratory Bird Treaty Act, as amended (16 USC 703 et seq.)
- Bald and Golden Eagle Protection Act, as amended (16 USC 668-668d)
- National Historic Preservation Act, as amended (16 USC 470 et seq.)
- Archaeological Resource Protection Act, as amended (16 USC 470 et seq.)
- Native American Grave Protection and Repatriation Act of 1990 (25 USC 3001)
- American Indian Religious Freedom Act of 1978 (42 USC l996)

7.3 Statutes and Regulations Related to Emergency Planning, Worker Safety, and Protection of Public Health and the Environment

7.3.1 ENVIRONMENTAL PROTECTION

National Environmental Policy Act of 1969, as amended (42 USC 4321 et seq.)

NEPA requires agencies of the Federal Government to prepare EISs on potential impacts of proposed major Federal actions that may significantly affect the quality of the human environment. DOE has prepared this EIS in accordance with the requirements of NEPA, as implemented by Council on Environmental Quality regulations (40 CFR Parts 1500 through 1508) and DOE NEPA regulations (10 CFR Part 1021).

Pollution Prevention Act of 1990 (42 USC 13101 et seq.)

The Pollution Prevention Act of 1990 establishes a national policy for waste management and pollution control that focuses first on source reduction, then on environmentally safe recycling, treatment, and disposal. DOE requires each of its sites to establish specific goals to reduce the generation of waste. If the Department were to build and operate facilities, it would also implement a pollution prevention plan.

Comprehensive Guideline for Procurement of Products Containing Recovered Materials (40 CFR Part 247)

This regulation is issued under the authority of Section 6002 of RCRA and Executive Order 12783, which set forth requirements for Federal agencies to procure products containing recovered materials for use in their operations, using guidelines established by the EPA. The purpose of these regulations is to promote recycling by using government purchasing to expand markets for recovered materials. RCRA Section 6002 requires that any purchasing agency, when using appropriated funds to procure an item, shall purchase it with the highest percentage of recovered materials practicable. The procurement of materials to be used in HLW tank system closure activities should be conducted in accordance with these regulations.

Toxic Substances Control Act, as amended (USC 2601 et seq.) (40 CFR Part 700 et seq.)

The Toxic Substances Control Act provides EPA with the authority to require testing of both new and old chemical substances entering the environment and to regulate them where necessary. The Act also regulates the manufacture, use, treatment, storage, and disposal of certain toxic substances not regulated by RCRA or other statutes, specifically polychlorinated biphenyls, chlorofluorocarbons, asbestos, dioxins, certain metal-working fluids, and hexavalent chromium. DOE does not expect to use these materials during closure of the HLW tank systems. Programs and procedures would need to be implemented to address appropriate management and disposal of waste generated as a result of their use, if necessary.

7.3.2 EMERGENCY PLANNING AND RESPONSE AND PUBLIC HEALTH

This section discusses the regulations that address protection of public health and worker safety and require the establishment of emergency plans and coordination with local and Federal agencies related to facility operations. DOE Orders generally set forth the programs and procedures required to implement the requirements of these regulations. See Section 7.5.

Atomic Energy Act of 1954, as amended (42 USC 2011 et seq.)

The Atomic Energy Act, as amended, provides fundamental jurisdictional authority to DOE and the NRC over governmental and commercial use of nuclear materials. The Atomic Energy Act EC ensures proper management, production, possession, and use of radioactive materials. It gives the NRC specific authority to regulate the possession, transfer, storage, and disposal of nuclear materials, as well as aspects of transportation packaging design requirements for radioactive materials, including testing for packaging certification. NRC regulations applicable to the transportation of radioactive materials (10 CFR Part 71 and 73) require that shipping casks meet specified performance criteria under both normal transport and hypothetical accident conditions.

The Atomic Energy Act provides DOE the authority to develop generally applicable standards for protecting the environment from radioactive materials. In accordance with the Atomic Energy Act, DOE has established a system of requirements that it has issued as DOE Orders.

DOE Orders and regulations issued under authority of the Atomic Energy Act include the following:

- ***DOE Order 435.1 (Radioactive Waste Management)*** – This Order and its associated Manual and Guidance (DOE 1999) establish authorities, responsibilities, and requirements for the management of DOE HLW, transuranic waste, low-level waste, and the radioactive component of mixed waste. Those documents provide detailed HLW management requirements including: waste incidental to reprocessing determinations; waste characterizations, certification, storage, treatment, and disposal; and HLW facility design and closure.

- ***DOE Order 5400.1 (General Environmental Protection Program)*** – This Order establishes environmental protection program requirements, authorities, and responsibilities for DOE operations for ensuring compliance with applicable Federal, state, and local environmental protection laws and regulations, as well as internal DOE policies.

- ***DOE Order 5400.5 (Radiation Protection of the Public and the Environment)*** – This Order establishes standards and requirements for DOE and DOE contractors with respect to protection of members of the public and the environment against undue risk from radiation. The requirements of this Order are also codified in the proposed 10 CFR Part 834, Radiation Protection of the Public and the Environment.

- ***DOE Order 440.1A (Worker Protection Management for DOE Federal and Contractor Employees)*** – This Order establishes the framework for an effective worker protection program that will reduce or prevent injuries, illnesses, and accidental losses by providing DOE Federal and contractor workers with a safe and healthful workplace.

Section 202(4) of the Energy Reorganization Act of 1974 (42 USC §5842(4)) gives NRC licensing and related regulatory authority over DOE "facilities authorized for the express purpose of subsequent long-term storage of high-level radioactive waste generated by the Administration [now known as DOE] which are not used for, or are part of, research and development activities." DOE has determined that NRC's licensing authority is limited to DOE facilities that are (1) authorized by Congress for the express purpose of long-term storage of HLW and (2) developed and constructed after the passage of the Energy Reorganization Act (Sullivan 1998). None of the SRS HLW tank systems meets both of these criteria. DOE's Savannah River Operations Office has consulted with NRC concerning criteria regarding incidental waste for the SRS tank residuals.

Atomic Energy Act of 1954, as amended (42 USC 2011 et seq.) Quantities of Radioactive Materials Requiring Consideration of the Need for an Emergency Plan for Responding to a Release (10 CFR Part 30.72 Schedule C)

This list is the basis for both the public and private sectors to determine if the radiological materials they deal with must have an emergency response plan for unscheduled releases. It is one of the threshold criteria documents for DOE Emergency Preparedness Hazard Assessments required by DOE Order 151.1, "Comprehensive Emergency Management System." An emergency response plan addressing HLW tank system closure operations would need to be prepared in accordance with this regulation.

Reorganization Plan No. 3 of 1978, Public Health and Welfare (42 USC 5121 et seq.), Emergency Management and Assistance (44 CFR Part 1-399)

These regulations generally include the policies, procedures, and responsibilities of the Federal Emergency Management Agency, NRC, and DOE for implementing a Federal Emergency Preparedness Program, including radiological planning and preparedness. An emergency response plan, including radiological planning and preparedness for HLW tank system closure operations, would need to be prepared and implemented in accordance with this regulation.

Emergency Planning and Community Right-to-Know Act of 1986 (42 USC 11001 et seq.) (also known as "SARA Title III")

Under Subtitle A of the Emergency Planning and Community Right-to Know Act, Federal facilities, including those owned by DOE, must provide information on hazardous and toxic chemicals to state emergency response commissions, local emergency planning committees, and EPA. The goal of providing this information is to ensure that emergency plans are sufficient to respond to unplanned releases of hazardous substances. The required information includes inventories of specific chemicals used or stored and descriptions of releases that occur from sites. This law, implemented at 40 CFR Parts 302 through 372, requires agencies to provide material safety data sheet reports, emergency and hazardous chemical inventory reports, and toxic chemical release reports to appropriate local, state, and Federal agencies.

DOE submits hazardous chemical inventory reports for SRS to SCDHEC. The chemical inventory could change, depending on the HLW tank system closure alternative(s) DOE implemented; however, subsequent reports would reflect any change to the inventory.

Hazardous Materials Transportation Act, 49 U.S.C. 1801 and Regulations

Federal law provides for uniform regulation of the transportation of hazardous and radioactive materials. Transport of hazardous and radioactive materials, substances, and wastes is governed by U.S. Department of Transportation, NRC, and EPA regulations. These regulations may be found in 49 CFR 100-178, 10 CFR 71, and 40 CFR 262, respectively. | EC

U.S. Department of Transportation hazardous material regulations govern the hazard communication (marking, hazard labeling, vehicle placarding, and emergency response telephone number) and transport requirements, such as required entries on shipping papers or EPA waste manifests. NRC regulations applicable to radioactive materials transportation are found in 10 CFR 71 and detail packaging design requirements, including the testing required for package certification. EPA regulations govern offsite transportation of hazardous wastes. DOE Order 460.1A (Packaging and Transportation Safety) sets forth DOE policy and assigns responsibilities to establish safety requirements for the proper packaging and transportation of DOE offsite shipments and onsite transfers of hazardous materials and for modal transport. (Offsite is any area within or outside a DOE site to which the public has free and uncontrolled access; | EC onsite is any area within the boundaries of a DOE site or facility to which access is controlled.)

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (42 USC 9601 et seq.) National Oil and Hazardous Substance Contingency Plan (40 CFR Part 300 et seq.)

CERCLA, as amended by the Superfund Amendments and Reauthorization Act, authorizes EPA to require responsible site owners, operators, arrangers, and transporters to clean up releases of hazardous substances, including certain radioactive substances. This Act applies to both the Federal government and to private citizens. Executive Order 12580 delegates to heads of executive departments and agencies the responsibility for undertaking remedial actions for releases or threatened releases at sites that are not on the National Priorities List and removal actions, other than emergencies, where the release is from any facility under the jurisdiction or control of executive departments or agencies.

Sites determined to have a certain level of risk to health or the environment are placed upon the National Priorities List so their clean-up can be scheduled and tracked to completion. SRS was placed on the National Priorities List in 1989.

DOE, SCDHEC, and EPA have signed a Federal Facility Agreement to coordinate cleanup at SRS, as required by Section 120 of CERCLA. The Agreement addresses RCRA corrective action and CERCLA requirements applicable to cleanup at SRS. Section IX of the Agreement sets forth requirements for the SRS HLW tank systems. Design and operating standards for the HLW tank systems are found in Appendix B of the Agreement. DOE has submitted a waste EC | removal plan and schedule for the tank systems that do not meet the applicable secondary containment standards to SCDHEC. The approved waste removal schedule appears in Appendix B of the *High-Level Waste Tank Closure Program Plan* (DOE 1996b). DOE must provide SCDHEC with an annual report on the status of the HLW tank systems being removed from service. After waste removal is completed, the tank systems are available for closure in accordance with general closure strategy presented in DOE (1996a).

CERCLA also establishes an emergency response program in the event of a release or a threatened release to the environment. The Act includes requirements for reporting to Federal and state agencies releases of certain hazardous substances in excess of specified amounts. The requirements of the Act could apply to the proposed project in the event of a release of hazardous substances to the environment.

CERCLA also addresses damages for the injury, destruction, or loss of natural resources that are not or cannot be addressed through remedial action. The Federal government, state governments, and Indian tribes are trustees of the natural resources that belong to, are managed by, or are otherwise controlled by those respective governing bodies. As trustees, they may assess damages and recover costs necessary to restore, replace, or acquire equivalent resources when there is injury to natural resources as a result of release of a hazardous substance.

Occupational Safety and Health Act of 1970, as amended (29 USC 651 et seq.); Occupational Safety and Health Administration Emergency Response, Hazardous Waste Operations and Worker Right to Know (29 CFR Part 1910 et seq.)

The Occupational Safety and Health Act (29 USC 651) establishes standards to enhance safe and healthful working conditions in places of employment throughout the United States. The Act is administered and enforced by the Occupational Safety and Health Administration (OSHA), a U.S. Department of Labor agency. While OSHA and EPA both have a mandate to reduce exposures to toxic substances, OSHA's jurisdiction is limited to safety and health conditions that exist in the workplace environment. In general, under the Act, it is the duty of each employer to furnish all employees a place of employment free of recognized hazards likely to cause death or serious physical harm. Employees have a duty to comply with the occupational safety and health standards and all rules, regulations, and orders issued under the Act. The OSHA regulations (29 CFR) establish specific standards telling employers what must be done to achieve a safe and healthful working environment. This regulation sets down the OSHA requirements for employee safety in a variety of working environments. It addresses employee emergency and fire prevention plans (Section 1910.38), hazardous waste operations and emergency response (Section 1910.120), and hazard communication (Section 1910.1200) that enable employees to be aware of the dangers they face from hazardous materials at their workplaces. DOE places emphasis on compliance with these regulations at its facilities and prescribes, through DOE Orders, OSHA standards that contractors shall meet, as applicable to their work at Government-owned, contractor-operated facilities. DOE keeps and makes available the various records of minor illnesses, injuries, and work-related deaths required by OSHA regulations.

Noise Control Act of 1972, as amended (42 USC 4901 et seq.)

Section 4 of the Noise Control Act directs Federal agencies to carry out programs in their jurisdictions "to the fullest extent within their authority" and in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health and welfare. This law provides requirements related to noise that would be generated by activities associated with tank closures.

7.4 Executive Orders

The following Executive Orders would be in effect for the HLW tank system closures. DOE Orders generally set forth the programs and procedures required to implement the requirements of the orders.

Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands)

Executive Order 11988 directs Federal agencies to establish procedures to ensure that any Federal action taken in a floodplain considers the potential effects of flood hazards and floodplain management and avoids floodplain impacts to the extent practicable.

Executive Order 11990 directs Federal agencies to avoid new construction in wetlands unless there is no practicable alternative and unless the proposed action includes all practicable measures to minimize harm to wetlands that might result from such use. DOE requirements for compliance with floodplain and wetlands activity are codified at 10 CFR 1022.

Executive Order 12856 (Right-to-Know Laws and Pollution Prevention Requirements)

This Order directs Federal agencies to: reduce and report toxic chemicals entering any waste stream; improve emergency planning, response, and accident notification; and encourage the use of clean technologies and testing of innovative prevention technologies. In addition, the Order states that Federal agencies are persons for purposes of the Emergency Planning and Community Right-to-Know Act (SARA Title III), which requires agencies to meet the requirements of the Act.

Executive Order 12898 (Environmental Justice)

This Order directs Federal agencies, to the extent practicable, to make the achievement of environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations in the United States and its territories and possessions. The Order provides that the Federal agency responsibilities it establishes are to apply equally to Native American programs.

Executive Order 12902 (Energy Efficiency and Water Conservation at Federal Facilities)

Executive Order 12902 requires Federal agencies to develop and implement a program for conservation of energy and water resources.

Executive Order 13045 (Protection of Children from Environmental Health Risks and Safety Risks)

Because of the growing body of scientific knowledge that demonstrates that children may suffer disproportionately from environmental health and safety risks, Executive Order 13045 directs each Federal agency to make it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children.

Executive Order 13112 (Invasive Species)

Executive Order 13112 requires Federal agencies whose actions may affect the status of invasive species to identify such actions and to use relevant programs and authorities to prevent the introduction of invasive species, detect and respond rapidly to control the populations of such species, monitor invasive species populations, provide for restoration of native species and habitat conditions in ecosystems that have been invaded, conduct research on invasive species and provide for environmentally sound control, and promote public education on invasive species and the means to address them.

7.5 DOE Regulations and Orders

Through the authority of the Atomic Energy Act, DOE is responsible for establishing a comprehensive health, safety, and environmental program for its facilities. The regulatory mechanisms through which DOE manages its facilities are the promulgation of regulations and the issuance of DOE Orders. Table 7-6 lists the major DOE Orders applicable to the closure of the SRS HLW tank systems.

The DOE regulations address such areas as energy conservation, administrative requirements and procedures, nuclear safety, and classified information. For the purposes of this EIS, relevant regulations include 10 CFR Part 820, *Procedural Rules for DOE Nuclear Facilities*; 10 CFR Part 830, *Nuclear Safety Management; Contractor and Subcontractor Activities*; 10 CFR Part 835, *Occupational Radiation Protection*; 10 CFR Part 1021, *Compliance with NEPA*; and 10 CFR Part 1022, *Compliance with Floodplains/Wetlands Environmental Review Requirements*. DOE has enacted occupational radiation protection standards to protect DOE and its contractor employees. These standards are set forth in 10 CFR Part 835, *Occupational Radiation Protection*; the rules in this part establish radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities, including those conducted by DOE contractors. The activity may be, but is not limited to, design, construction, or operation of DOE facilities.

Table 7-6. DOE Orders and Standards relevant to closure of the HLW tank systems.

	DOE Orders
151.1	Comprehensive Emergency Management System
225.1A	Accident Investigations
231.1	Environment, Safety and Health Reporting
232.1A	Occurrence Reporting and Processing of Operations Information
420.1	Facility Safety
425.1A	Startup and Restart of Nuclear Facilities
430.1A	Life Cycle Asset Management
435.1	Radioactive Waste Management
440.1A	Worker Protection Management for DOE Federal and Contractor Employees
451.1A	National Environmental Policy Act Compliance Program
460.1A	Packaging and Transportation Safety
460.2	Departmental Materials Transportation and Packaging Management
470.1	Safeguards and Security Program
471.1	Identification and Protection of Unclassified Controlled Nuclear Information
471.2A	Information Security Program
472.1B	Personnel Security Activities
1270.2B	Safeguards Agreement with the International Atomic Energy Agency
1300.2A	Department of Energy Technical Standards Program
1360.2B	Unclassified Computer Security Program
3790.1B	Federal Employee Occupational Safety and Health Program
4330.4B	Maintenance Management Program
4700.1	Project Management System
5400.1	General Environmental Protection Program
5400.5	Radiation Protection of the Public and the Environment
5480.19	Conduct of Operations Requirements for DOE Facilities
5480.20A	Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities
5480.21	Unreviewed Safety Questions
5480.22	Technical Safety Requirements
5480.23	Nuclear Safety Analysis Report
5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements
5632.1C	Protection and Control of Safeguards and Security Interests
5633.3B	Control and Accountability of Nuclear Materials
5660.1B	Management of Nuclear Materials
6430.1A	General Design Criteria
1020-94	Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities
1021-93	Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components
1024-92	Guidelines for Use of Probabilistic Seismic Hazard Curves at Department of Energy Sites for Department of Energy Facilities
1027-92	Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23 Nuclear Safety Analysis Reports
3009-94	Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports
3011-94	Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans

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