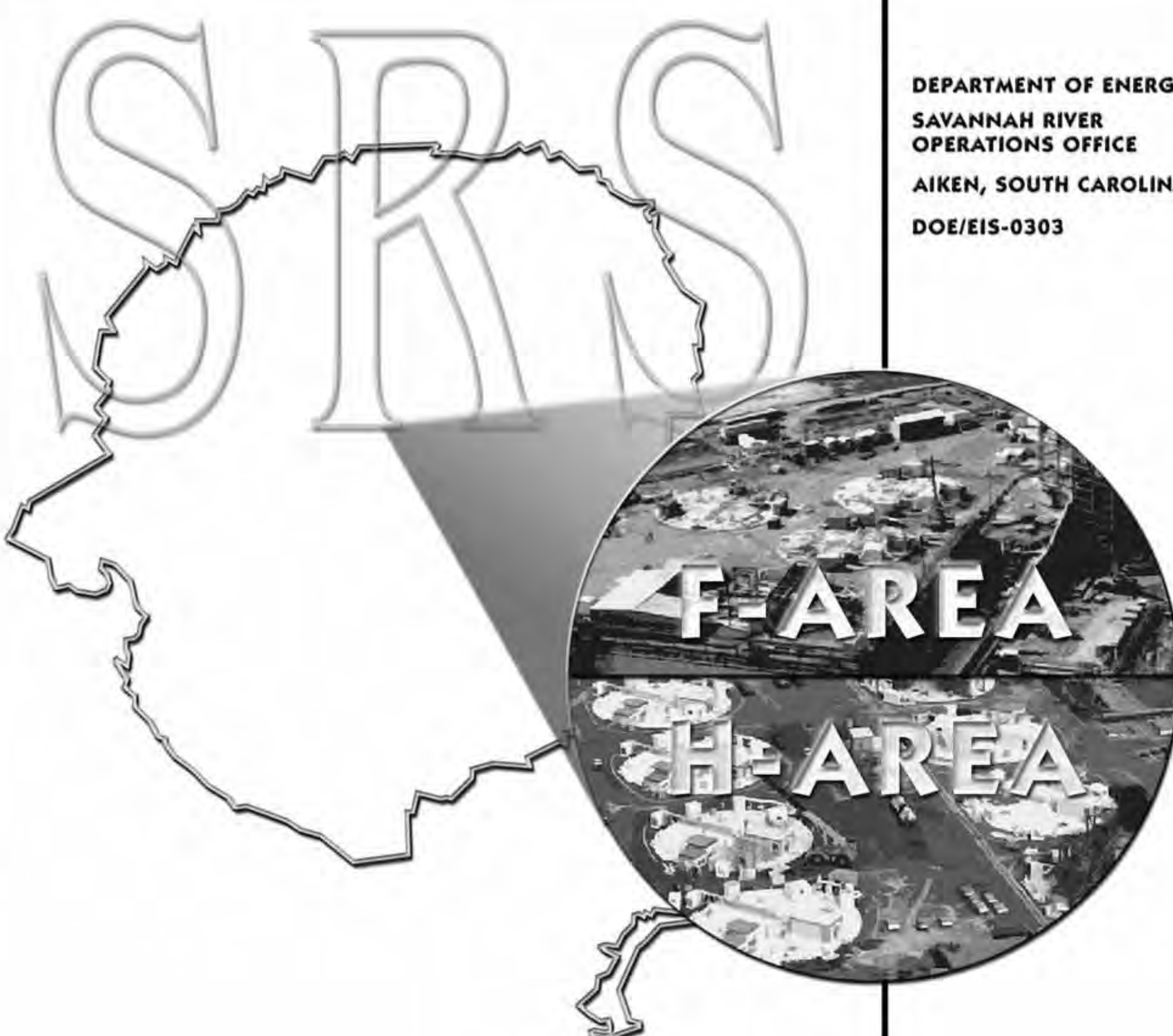
Savannah River Site

HIGH- LEVEL WASTE TANK CLOSURE

Final Environmental Impact Statement



DEPARTMENT OF ENERGY

SAVANNAH RIVER OPERATIONS OFFICE

AIKEN, SOUTH CAROLINA

DOE/EIS-0303

May 2002

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.

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.

EC

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

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Gregg-Graniteville Library
Aiken, SC

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U.S. Department of Energy
Washington, D.C.

Battelle-Pacific Northwest Laboratories
Attn: Technical Library
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GLOSSARY

Terms in this glossary are defined based on the context in which they are to be used in this EIS.

accident
An unplanned sequence of events that results in undesirable consequences.

alpha-emitter
A radioactive substance that decays by releasing an alpha particle.

alpha particle
A positively charged particle consisting of two protons and two neutrons, that is emitted during radioactive decay from the nucleus of certain nuclides. It is the least penetrating of the three common types of radiation (alpha, beta, and gamma).

alpha waste
Waste containing alpha-emitting transuranic radionuclides with activities between 10 and 100 nanocuries per gram.

alternative
A major choice or strategy to address the EIS “Purpose and Need” statement, as opposed to the engineering options available to achieve the goal of an alternative.

annulus
The space between the two walls of a double-wall tank.

applicable or relevant and appropriate requirements (ARARs)
Requirements, including cleanup standards, standards of control, and other substantive environmental protection requirements and criteria for hazardous substances as specified under Federal and State law and regulations, that must be met when complying with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

aquifer
A body of permeable rock, rock fragments, or soil through which groundwater moves.

as low as reasonably achievable (ALARA)
A process by which a graded approach is applied to maintaining dose levels to workers and the public, and releases of radioactive materials to the environment at a rate that is as far below applicable limits as reasonably achievable.

atomic number
The number of positively charged protons in the nucleus of an atom and the number of electrons on an electrically neutral atom.

background radiation
Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices.

backfill
Material such as soil or sand used in refilling an excavation.

basemat
The concrete and steel portion of the tank below the residual material and above the vadose zone.

beta-emitter
A radioactive substance that decays by releasing a beta particle.

beta particle
A charged particle emitted from a nucleus during radioactive decay, with a mass equal to 1/1837 that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron.

beyond design basis accident (BDBA)
An accident with an annual frequency of occurring between 1 in 1,000,000 and 1 in 10,000,000 ($1.0\times^{-6}$ and 1.0×10^{-7}).

biodiversity
Pertains to the variety of life (e.g., plants, animals and other organisms) that inhabits a particular area or region.

blackwater stream
Water in coastal plains, creeks, swamp, and/or rivers that has been imparted a dark or black coloration due to dissolution of naturally occurring organic matter from soils and decaying vegetation.

borosilicate
A form of glass with silica sand, boric oxide, and soda ash.

borrow material
Material such as soil or sand that is removed from one location and used as fill material in another location.

bounding accident
A postulated accident that is defines to encompass the range of anticipated accidents and used to evaluate the consequences of accidents at facilities. The most conservative parameters (e.g., source terms, and meteorology) applied to a conservative accident resulting in a bounding accident analysis.

cancer
The name given to a group of diseases characterized by uncontrolled cellular growth.

canister
A container (generally stainless steel) into which immobilized radioactive waste is placed and sealed.

capable fault
In part, a capable fault is one that may have had movement at or near the ground surface at least once within the past 35,000 years, or has had recurring movement within the past 500,000 years. Further definition can be found in 10 CFR 100, Appendix A.

carcinogen
A radionuclide or nonradiological chemical that has been proven or suspected to be either a promoter or initiator of cancer in humans or animals.

characterization
The determination of waste composition and properties, whether by review of process knowledge, nondestructive examination or assay, or sampling and analysis, generally done for the purpose of determining appropriate storage, treatment, handling, transport, and disposal requirements.

chronic exposure
The absorption of hazardous material (or intake of hazardous materials) over a long period of time (for example, over a lifetime).

Code of Federal Regulations (CFR)
A document containing the regulations of Federal executive departments and agencies.

collective effective dose equivalent
Sum of the effective dose equivalents for individuals composing a defined population. The units for this are person-rem or person-sievert.

committed dose equivalent
Total dose equivalent accumulated in an organ or tissue in the 50 years following a single intake of radioactive materials into the body.

committed effective dose equivalent
The sum of committed radiological dose equivalents to various tissues in the body, each multiplied by the appropriate weighing factor and expressed units of rem.

condensate
Liquid that results from condensing a gas by cooling below its saturation temperature.

confining (unit)
A rock layer (or stratum) having very low hydraulic conductivity (or permeability) that restricts the movement of groundwater either into or out of adjacent aquifers.

contaminant
Any gaseous, chemical or organic material that contaminates (pollutes) air, soil, or water. This term also refers to any hazardous substance that does not occur naturally or that occurs at levels greater than those naturally occurring in the surrounding environment (background).

contamination
The deposition of unwanted radioactive material on the surfaces of structures, areas, objects, or personnel.

critical
A condition where in uranium, plutonium or tritium is capable of sustaining a nuclear chain reaction.

criticality
State of being critical. Refers to a self-sustaining nuclear chain reaction in which there is an exact balance between the production of neutrons and the losses on neutrons in the absence of extraneous neutron sources.

curie (CI)
: The basic unit used to describe the intensity of radioactivity in a sample of material. he curie is equal to 37 billion disintegrations per second, which is approximately the rate of decay of 1 gram of radium. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second.

decay, radioactive
: The decrease in the amount of any radioactive material with the passage of time, due to the spontaneous emission from the atomic nuclei of either alpha or beta particles, often accompanied by gamma radiation (see half-life, radioactive).

decommissioning
: The process of removing a facility from operation followed by decontamination, entombment, dismantlement, or conversion to another use.

decontamination
: The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment, such as radioactive contamination from facilities, soil, or equipment by washing, chemical action, mechanical cleaning, or other techniques.

design basis accident (DBA)
: For nuclear facilities, a postulated abnormal event that is used to establish the performance requirements of structures, systems, and components that are necessary to maintain them in a safe shutdown condition indefinitely or to prevent or mitigate the consequences so that the general public and operating staff are not exposed to radiation in excess of appropriate guideline values.

design basis earthquake
: The maximum intensity earthquake that might occur along the nearest fault to a structure. Structures are built to withstand a design basis earthquake.

DOE Orders
: Requirements internal to the U.S. Department of Energy (DOE) that establish DOE policy and procedures, including those for compliance with applicable laws.

dosage
: The concentration-time profile for exposure to toxicological hazards.

dose (or radiation dose)
: A generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined elsewhere in this glossary.

dose equivalent
: Product of the absorbed dose, the quality factor, and any other modifying factors. The dose equivalent is a quantity for comparing the biological effectiveness of different kinds of radiation on a common scale. The unit of dose equivalent is the rem. A millirem is one one-thousandth of a rem.

effective dose equivalent (EDE)

The sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated. It includes the dose from radiation sources internal and/or external to the body and is expressed in units of rem. The International Commission on Radiation Protection defines this as the effective dose.

effluent

Liquid or gaseous waste streams released from a facility.

effluent monitoring

Sampling or measuring specific liquid or gaseous effluent streams for the presence of pollutants.

endemic

Native to a particular area or region.

environmental restoration

Cleanup and restoration of sites and decontamination and decommissioning of facilities contaminated with radioactive and/or hazardous substances during past production, accidental releases, or disposal activities.

environmental restoration program

A DOE subprogram concerned with all aspects of assessment and cleanup of both contaminated facilities in use and of sites that are no longer a part of active operations. Remedial actions, most often concerned with contaminated soil and groundwater, and decontamination and decommissioning are responsibilities of this program.

evaporator

A facility that mechanically reduces the water contents in tank waste to concentrate the waste and reduce storage space needs.

exposure pathways

The course a chemical or physical agent takes from the source to the exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a release site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium such as air or water is also included.

external accident (or initiator)

An accident that is initiated by manmade energy sources not associated with operation of a given facility. Examples include airplane crashes, induced fires, transportation accidents adjacent to a facility, and so forth.

facility basemat

For this purposes of this EIS, basemat is defined as the concrete pad beneath the HLW tank.

fissile material

Any material fissionable by thermal (slow) neutrons. The three primary fissile materials are uranium-233, uranium-235, and plutonium-239.

floodplain

The level area adjoining a river or stream that is sometimes covered by flood water.

gamma-emitter

A radioactive substance that decays by releasing gamma radiation.

gamma ray (gamma radiation)

High-energy, short wavelength electromagnetic radiation (a packet of energy) emitted from the nucleus. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded against by dense materials, such as lead or uranium. Gamma rays are similar to x-rays, but are usually more energetic.

geologic repository

A deep (on the order of 600 meter [1,928 feet] or more) underground mined array of tunnels used for permanent disposal of radioactive waste.

groundwater

Water occurring beneath the earth's surface in the intervals between soil grains, in fractures, and in porous formations.

grout

A fluid mixture of cement-like materials and liquid waste that sets up as a solid mass and is used for waste fixation, immobilization, and stabilization purposes.

habitat

The sum of environmental conditions in a specific place occupied by animals, plants, and other organisms.

half-life

The time in which half the atoms of a particular radioactive substance disintegrate to another nuclear form. Measured half-lives vary from millionths of a second to billions of years. Also called physical half-life.

hazard index

The sum of several hazard quotients for multiple chemicals and/or multiple exposure pathways. A hazard index of greater than 1.0 is indicative of potential adverse health effects. Health effect could be minor temporary effects or fatal, depending on the chemical and amount of exposure.

hazard quotient

The ratio of an exposure level to a substance to a toxicity reference value selected for risk assessment purposes.

hazardous chemical

A term defined under the Occupational Safety and Health Act and the Emergency Planning and Community Right-to-Know Act as any chemical that is a physical hazard or a health hazard.

hazardous material

A substance or material, including a hazardous substance, which has been determined by the U.S. Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce.

hazardous substance

Any substance that when released to the environment in an uncontrolled or unpermitted fashion becomes subject to the reporting and possible response provisions of the Clean Water Act and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

hazardous waste

Under the Resource Conservation and Recovery Act, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Source, special nuclear material, and by-product material, as defined by the Atomic Energy Act, are specifically excluded from the definition of solid waste.

heavy metals

Metallic elements with high atomic weights (for example, mercury, chromium, cadmium, arsenic, and lead) that can damage living things at low concentrations and tend to accumulate in the food chain.

high-efficiency particulate air (HEPA) Filter

A filter with an efficiency of at least 99.95 percent used to separate particles from air exhaust streams prior to releasing that air into the atmosphere.

high-level waste

As defined by the Nuclear Waste Policy Act [42 U.S. C. 10101], High Level Waste means (a) the 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 that contains [a combination of transuranic and] fission products [nuclides] in sufficient concentrations; and (b) other highly radioactive material that the [U.S. Nuclear Regulatory] Commission, consistent with existing law, determines by rule requires permanent isolation.

hydrology

The study of water, including groundwater, surface water, and rainfall.

immobilization

A process (e.g., grouting or vitrification) used to stabilized waste. Stabilizing the waste inhibits the release of waste to the environment.

inadvertent intrusion

The inadvertent disturbance of a disposal facility or its immediate environment by a potential future occupant that could result in loss of containment of the waste or exposure of personnel. Inadvertent intrusion is a significant consideration that shall be included either in the design requirements or waste acceptance criteria of a waste disposal facility.

incidental waste

Wastes that are not defined as high-level waste (i.e., originating from nuclear fuel processing).

inhibited water

Water to which sodium hydroxide has been added to inhibit corrosion.

in situ
A Latin term meaning "in place."

institutional control
The control of waste disposal sites or other contaminated sites by human institutions in order to prevent or limit exposures to hazardous materials. Institutional control may be accomplished by (1) active control measures, such as employing security guards and maintaining security fences to restrict site access, and (2) passive control measures, such as using physical markers, deed restrictions, government regulations, and public records and archives to preserve knowledge of the site and prevent inappropriate uses.

internal accidents
Accidents that are initiated by man-made energy sources associated with the operation of a given facility. Examples include process explosions, fires, spills, criticalities, and so forth.

involved worker
Workers that would be involved in a proposed action as opposed to workers that would be on the site of a proposed action but not involved in the action.

isotope
One of two or more atoms with the same number of protons, but different numbers of neutrons, in their nuclei. Thus, carbon-12, carbon-13, and carbon-14 are isotopes of the element carbon, the numbers denoting the approximate atomic weights. Isotopes have very nearly the same chemical properties, but often different physical properties (for example, carbon-12 and -13 are stable, carbon-14 is radioactive).

latent cancer fatality
A fatality resulting from cancer caused by an exposure to a known or suspected radionuclide or carcinogenic chemical.

low-level waste (LLW)
Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel, or byproduct tailings containing uranium or thorium from processed ore (as defined in Section II e(2) of the Atomic Energy Act).

low-level mixed waste (LLMW)
Waste that contains both hazardous waste under the Resource Conservation and Recovery Act and source, special nuclear, or by-product material subject to the Atomic energy Act of 1954 2 USC 2011, *et seq.*).

macroinvertebrate
Small animal, such as a larval aquatic insect, that is visible to the naked eye and has no vertebral column.

maximally exposed individual (MEI)
A hypothetical individual defined to allow dose or dosage comparison with numerical criteria for the public. This individual is located at the point on the DOE site boundary nearest to the facility in question.

millirad
One thousandth of a rad (see rad).

millirem
One thousandth of a rem (see rem).

mixed waste
Waste that contains both hazardous wastes under the Resource Conservation and Recovery Act and source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954.

nanocurie
One billionth of a curie (see curie).

natural phenomena accidents
Accidents that are initiated by phenomena such as earthquakes, tornadoes, floods, and so forth.

noninvolved workers
Workers in a fixed population outside the day-to-day process safety management controls of a given facility area. In practice, this fixed population is normally the workers at an independent facility area located a specific distance (often 100 meters) from the reference facility area.

nuclear criticality
A self-sustaining nuclear chain reaction.

nuclide
A general term referring to all known isotopes, both stable (279) and unstable (about 5,000), of the chemical elements.

offsite
Away from the SRS site.

offsite population
For facility accident analyses, the collective sum of individuals located within an 80-kilometer (50-mile) radius of a facility and within the path of the plume with the wind blowing in the most populous direction.

oxalic acid
A water soluble organic acid, $H_2C_2O_4$, being considered as a cleaning agent to use in spray-washing tanks because it dissolves sludge and is only moderately aggressive against carbon steel, the material used in the construction of the waste tanks.

particulate
Pertains to minute, separate particles. An example of dry particulate is dust.

performance objectives
Parameters within which a facility must perform to be considered acceptable.

permanent disposal
For high level waste the term means emplacement in a repository for high-level radioactive waste, spent nuclear fuel, or other highly radioactive material with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste.

permeability
The degree of ease with which water can pass through a rock or soil.

person-rem

A unit used to measure the radiation exposure to an entire group and to compare the effects of different amounts of radiation on groups of people. It is obtained by multiplying the average dose equivalent (measured in rems) to a given organ or tissue by the number of persons in the population of interest.

pH

A measure of the relative acidity or alkalinity of a solution. A neutral solution has a pH of 7, acids have a pH of less than 7, and bases have a pH of greater than 7.

picocurie

One trillionth of a curie (see curie).

pollutant migration

The movement of a contaminant away from its initial source.

population

For risk assessment purposes, population consists of the total potential members of the public or workforce who could be exposed to a possible radiation or chemical dose from an exposure to radionuclides or carcinogenic chemicals.

population dose

The overall dose to the offsite population.

rad

The special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram.

radiation (ionizing radiation)

Alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as it is used here, does not include nonionizing radiation such as radio- or microwaves, or visible, infrared, or ultraviolet light.

radiation worker

A worker who is occupationally exposed to ionizing radiation and receives specialized training and radiation monitoring devices to work in such circumstances.

radioactive waste

Waste that is managed for its radioactive content.

radioactivity

The property or characteristic of material to spontaneously "disintegrate" with the emission of energy in the form of radiation. The unit of radioactivity is the curie (or becquerel).

radioisotope

An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation. approximately 5,000 natural and artificial radioisotopes have been identified.

radionuclide
The radioisotopes that together comprise 95 percent of the total curie content of a waste package by volume and have a half-life of at least 1 week. Radionuclides that are important to a facility's radiological performance assessment and/or a safety analysis and are listed in the facility's waste acceptance criteria are considered major radionuclides.

Record of Decision (ROD)
A public document that records the final decision(s) concerning a proposed action.

reducing grout
A grout formulated to behave as a chemical reducing agent. A chemical reducing agent is a substance that reduces other substances (i.e., decreases their positive charge or valence) by supplying electrons. The purpose of a reducing grout in closure of the high-level waste tanks would be to provide long-term chemical durability against leaching of the residual waste by water. Reducing grout would be com

posed primarily of cement, blast furnace slag, masonry sand, and silica fume.

rem
A unit of radiation dose that reflects the ability of different types of radiation to damage human tissues and the susceptibility of different tissues to the damage. Rems are a measure of effective dose equivalent.

risk
Quantitative expression of possible loss that considers both the probability that a hazard causes harm and the consequences of that event.

Safety Analysis Report (SAR)
A report, prepared in accordance with DOE Orders 5481.1B and 5480.23, that summarize the hazards associated with the operation of a particular facility and defines minimum safety requirements.

saltcake
Salt compounds that have crystallized as a result of concentrating the liquid.

saltstone
Concrete-like substance formed when the low-activity fraction of high-level waste is mixed with cement, flyash, and slag.

seepline
An area where subsurface water or groundwater emerges from the earth and slowly flows overland.

segregation
The process of separating (or keeping separate) individual waste types and/or forms in order to facilitate their cost-effective treatment and storage or disposal.

seismicity
The phenomenon of earth movements; seismic activity. Seismicity is related to the location, size, and rate of occurrence of earthquakes.

sludge
Solid material that precipitates or settles to the bottom of a tank.

solvent
: Substance (usually liquid) capable of dissolving one or more other substances.

source material
: (a) Uranium, thorium, or any other material that is determined by the U.S. Nuclear Regulatory Commission pursuant to the provisions of the Atomic Energy Act of 1954, Section 61, to be source material; or (b) ores containing one or more of the foregoing materials, in such concentration as the U.S. Nuclear Regulatory Commission may by regulation determine from time-to-time [Atomic Energy Act 11(z)]. Source material is exempt from regulation under to Resource Conservation and Recovery Act.

source term (Q)
: the quantity of radioactive material released by an accident or operation that causes exposure after transmission or deposition. Specifically, it is that fraction of respirable material at risk (MAR) that is released to the atmosphere from a specific location. The source term defines the initial condition for subsequent dispersion and consequence evaluations. Q = material at risk (MAR) damage ration (DR) x airborne release fraction (ARF) x respirable fraction (RF) x leak path factor (LPF). The units of Q are quantity at risk averaged over the specified time duration.

spent nuclear fuel
: Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated.

stabilization
: Treatment of waste to protect the environment from contamination. This includes rendering a waste immobile or safe for handling and disposal.

subsurface
: The area below the land surface (including the vadose zone and aquifers).

tank farm
: An installation of multiple adjacent tanks, usually interconnected for storage of liquid radioactive waste.

total effective dose equivalent
: The sum of the external dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

transuranic waste
: Waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, with half-lives greater than 20 years, per gram of waste, except for (a) high-level radioactive waste; (b) waste that the U.S. Department of Energy has determined, with the concurrence of the Administrator of the U.S. Environmental Protection Agency, does not need the degree of isolation required by 40 CFR 191; or (c) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.

treatment
: Any activity that alters the chemical or physical nature of a hazardous waste to reduce its toxicity, volume, mobility or to render it amenable for transport, storage or disposal.

vadose zone

The zone between the land surface and the water table. Saturated bodies, such as perched groundwater, may exist in the vadose zone. Also called the zone of aeration and the unsaturated zone.

vitrification

A method of immobilizing waste (e.g., radioactive, hazardous, and mixed). This involves adding frit and waste to a joule-heated vessel and melting the mixture into a glass. The purpose of this process is to permanently immobilize the waste and to isolate it from the environment.

volatile organic compound (VOC)

Compounds that readily evaporate and vaporize at normal temperatures and pressures.

waste minimization

An action that economically avoids or reduces the generation of waste by source reduction, reducing the toxicity of hazardous waste, improving energy usage, or recycling. These actions will be consistent with the general goal of minimizing present and future threats to human health, safety, and the environment.

waste stream

A waste or group of wastes with similar physical form, radiological properties, U. S. Environmental Protection Agency waste codes, or associated land disposal restriction treatment standards. It may be the result of one or more processes or operations.

wetlands

Area that are inundated or saturated by surface water or groundwater and that typically support vegetation adapted for life in saturated soils. Wetlands generally include swamps, marshes, bogs, and similar areas.

wind rose

A star-shaped diagram showing how often winds of various speeds blow from different directions. This is usually based on yearly average.

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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.

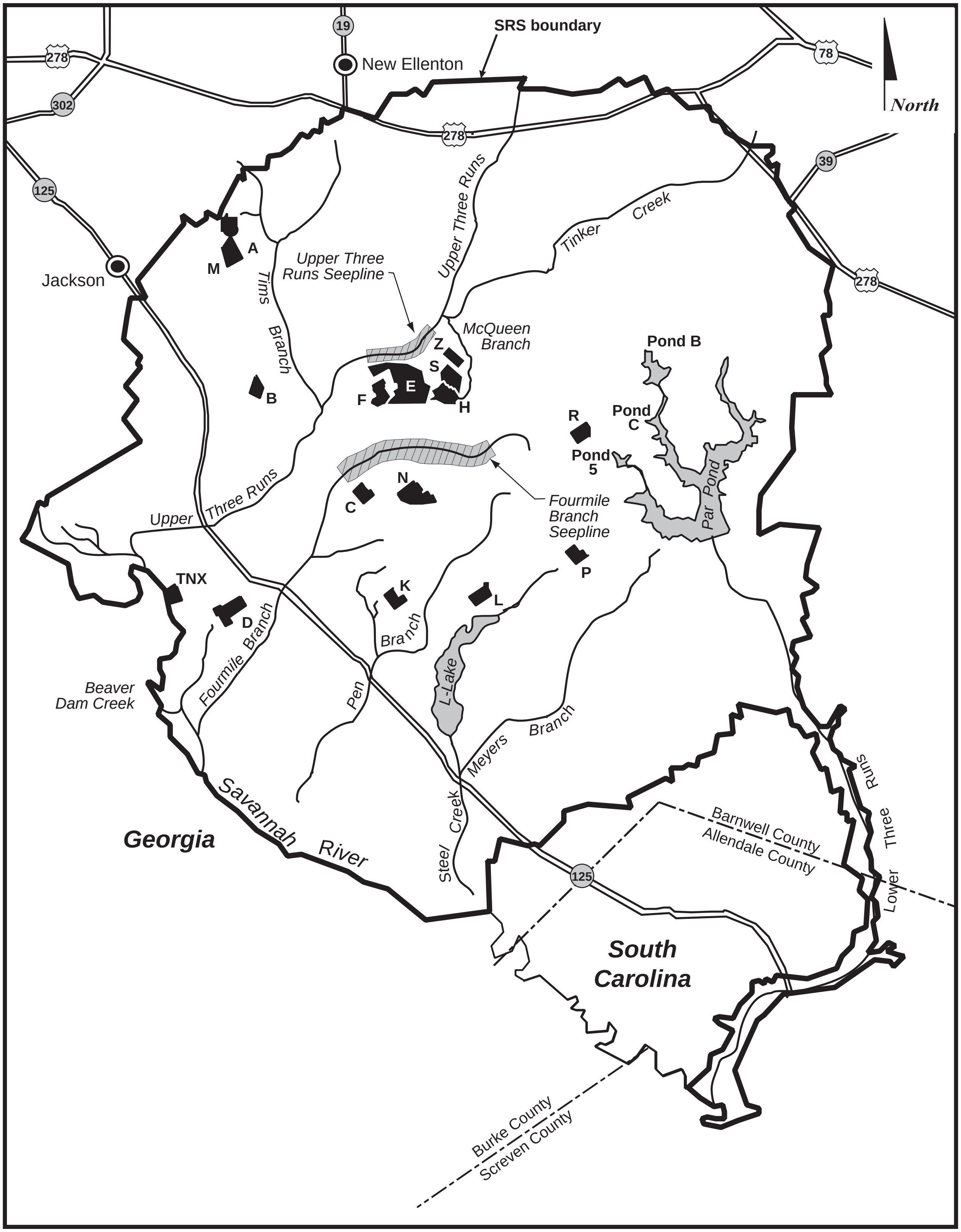

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Figure 1-1. Savannah River Site map. F and H Areas are in the upper center.

TC

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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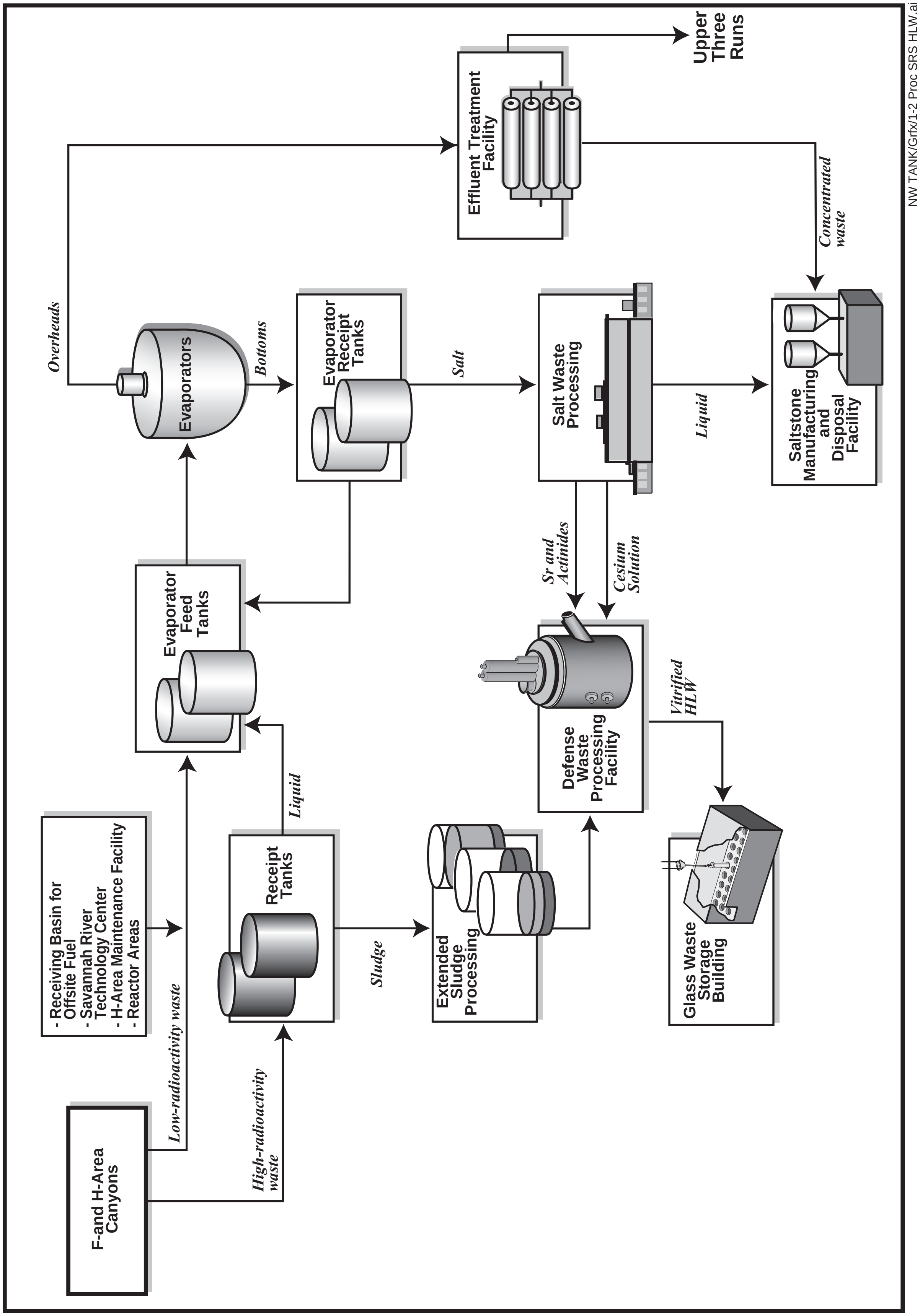

Figure 1-2. Process flows for Savannah River Site high-level waste management system.

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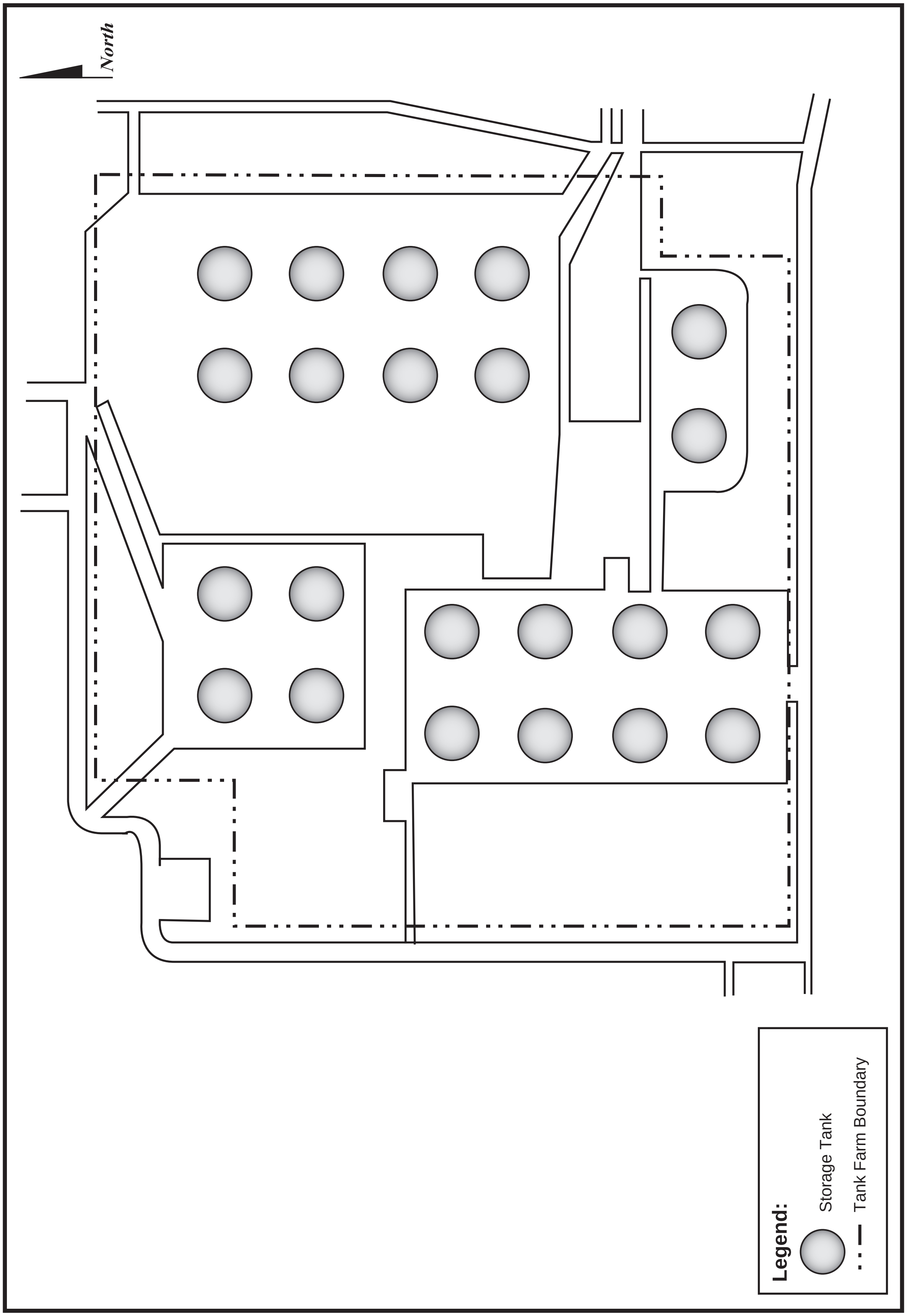

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Figure 1-3. General layout of F-Area Tank Farm.

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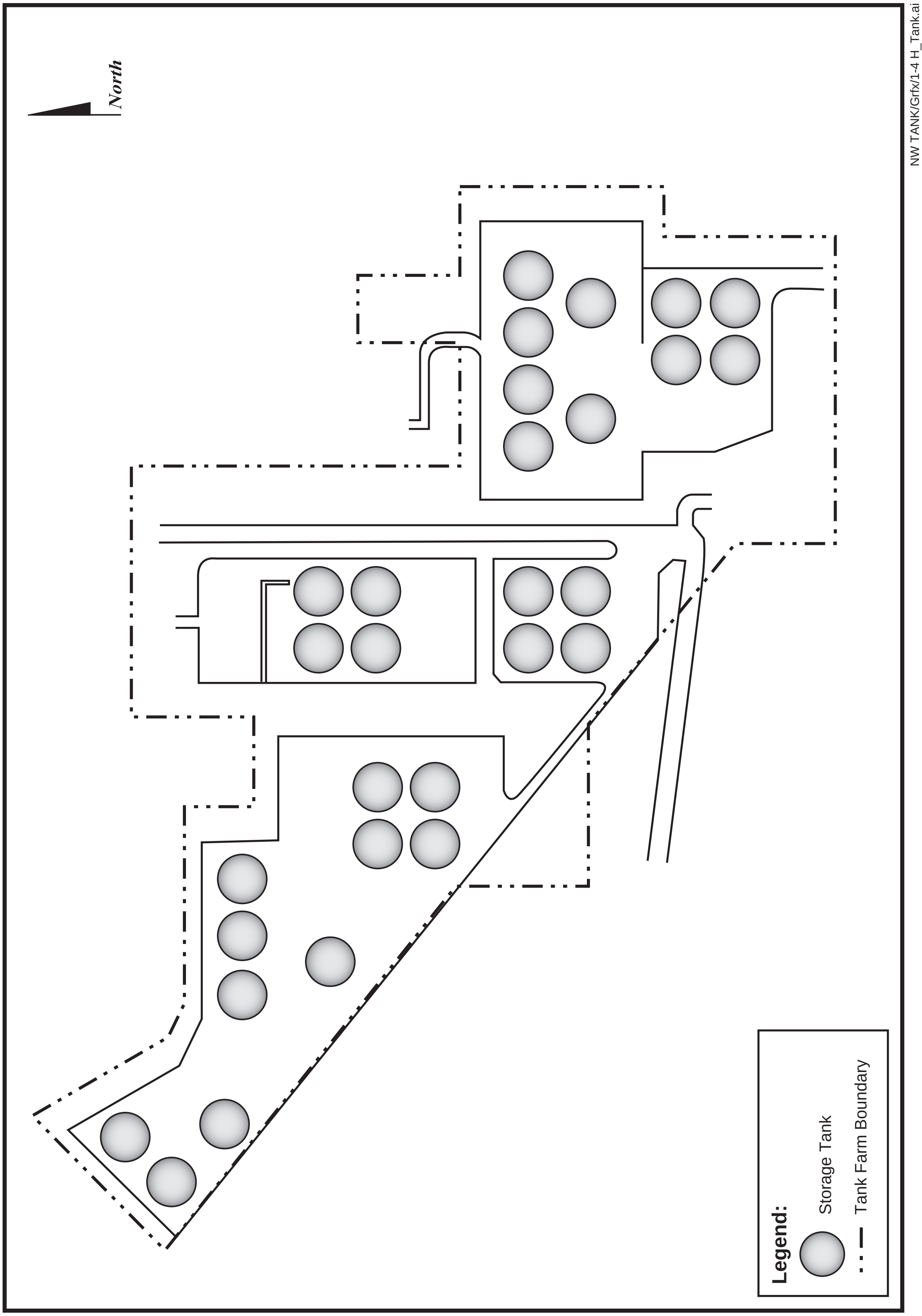

Figure 1-4. General layout of H-Area Tank Farm.

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
- 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, 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 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 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 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 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 waste overflowed the annulus pan (secondary containment) in 1962. 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 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 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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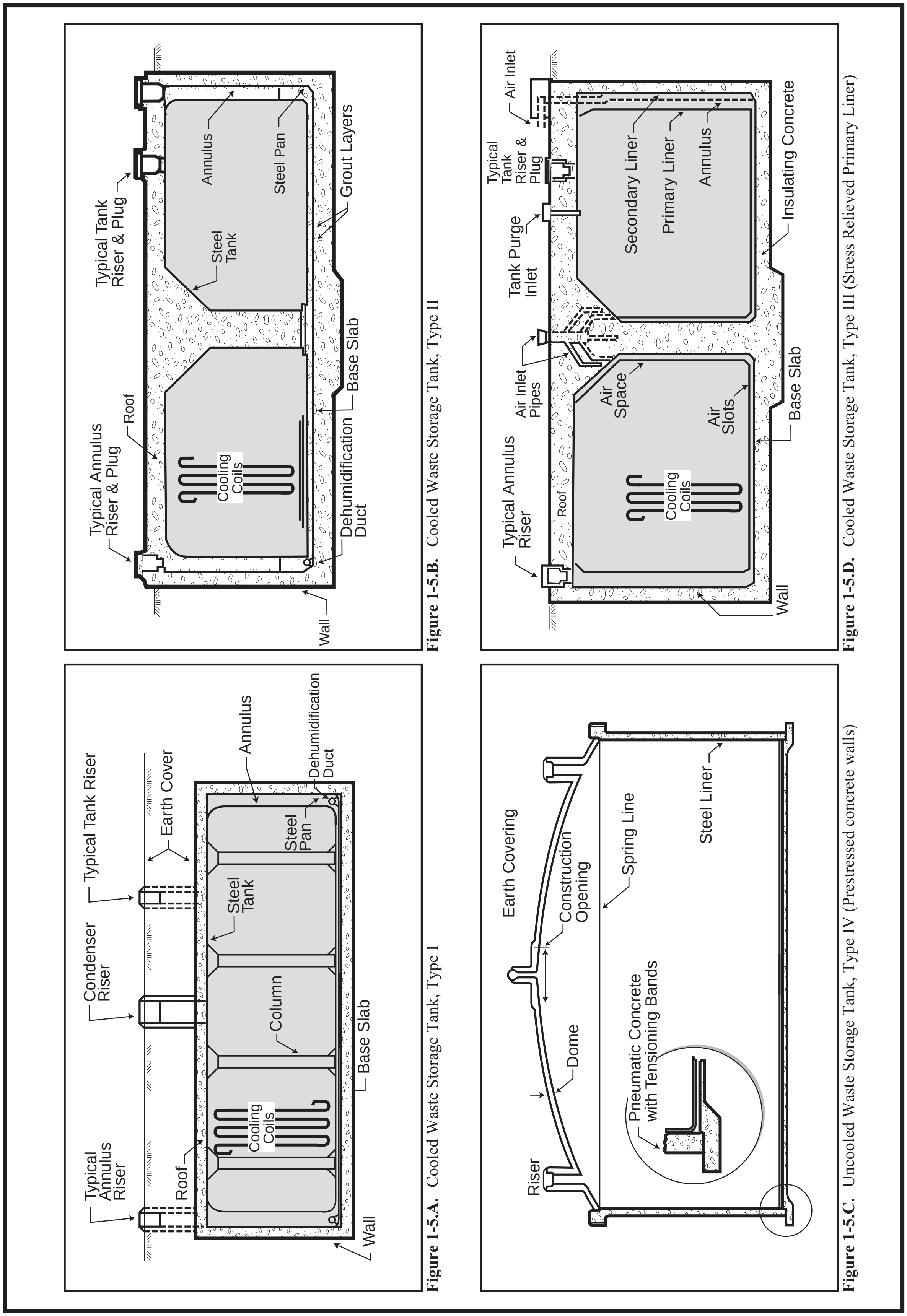

Figure 1-5.A. Cooled Waste Storage Tank, Type I

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.

sampled to determine inhibitor levels, and additional inhibitors are added if concentrations are not sufficient to prevent corrosion. In L-7-11 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. Interior photographic inspections L-7-12 have indicated that small amounts of groundwater have leaked into these tanks; there is no evidence that waste ever leaked out. The TC 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 L-7-25 L-7-68 operational, one in F-Area Tank Farm and two in H-Area Tank Farm. 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. EC

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 EC 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.

Several issues related to the HLW tank closure program will be resolved after DOE selects an L-4-12 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 TC status of the residual waste in the tanks. 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

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). EC

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 TC EC EC

[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). TC EC

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

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 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.

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.

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 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.

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

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

The U.S. Department of Energy (DOE) proposes EC 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>

Following bulk waste removal, DOE would clean the tanks, if necessary, to meet the performance objectives contained in the General TC 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 TC 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.

Tank cleaning by spray water washing involves washing each tank, using hot water in rotary EC spray jets. 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 TC 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 potential cleaning agents for sludge removal were studied. Oxalic acid was chosen as the preferred cleaning agent because it dissolves TC 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-mixed sample at 25°C, EC which was the highest of any of the cleaning agents tested.

Oxalic acid has been demonstrated in Tank 16 only and shown to provide cleaning that is much more effective than spray water washing for removal of radioactivity (see Table 2-1). TC 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 grout provides the same performance and TC 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 pumped into the tank annulus space. M-07

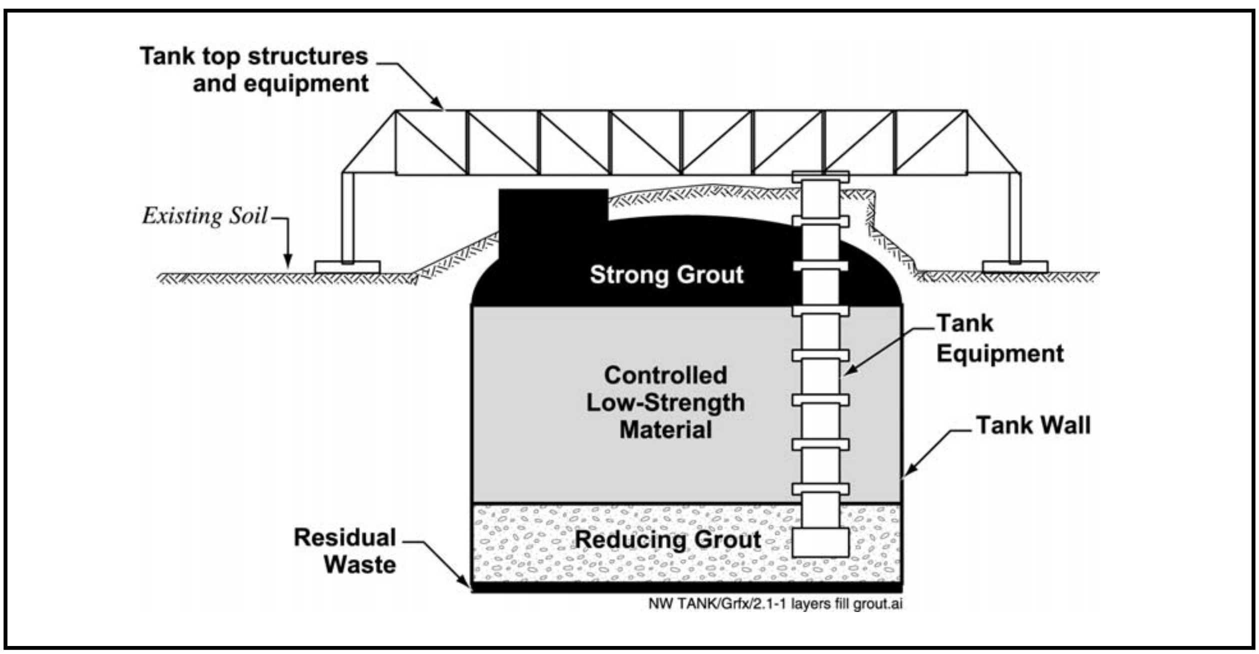

Figure 2.1-1. Typical layers of the Fill with Grout Option.

- 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. L-7-6 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. 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 <u>Management of Tank Residuals as High-Level Waste</u>

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.

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
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

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
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

TC

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

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 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	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

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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.

		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
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	Fill with Sand Option	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	
					TC
Maximum dose from beta-gamma emitting radionuclides in surface water (millirem/year)[c]					
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).

Parameter	No Action Alternative	Stabilize Tanks Alternative: Fill with Grout Option	Fill with Sand Option	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

TC

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
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}
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}

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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]

Fourmile Branch seepline	Maximum concentration (percent of MCL) 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

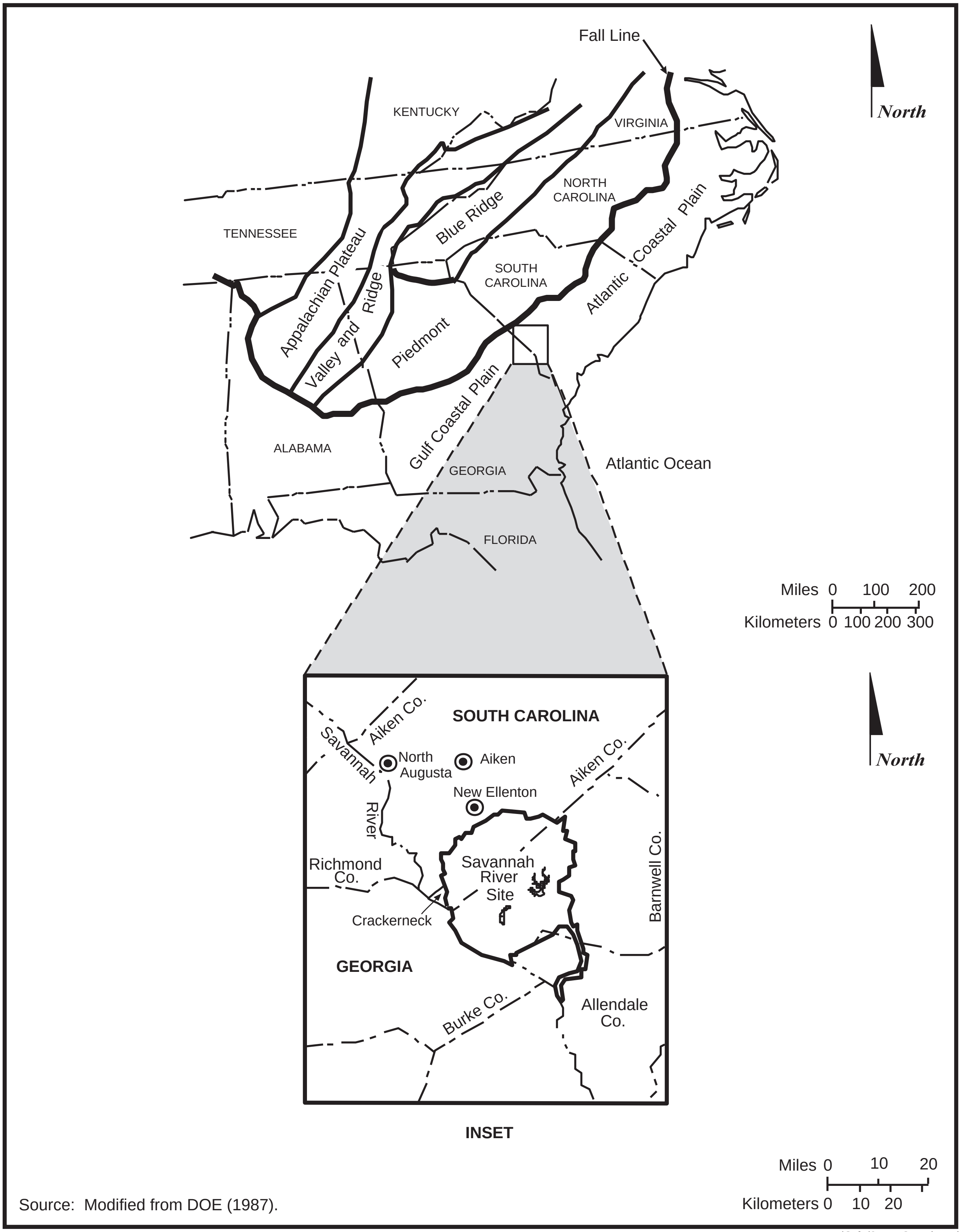
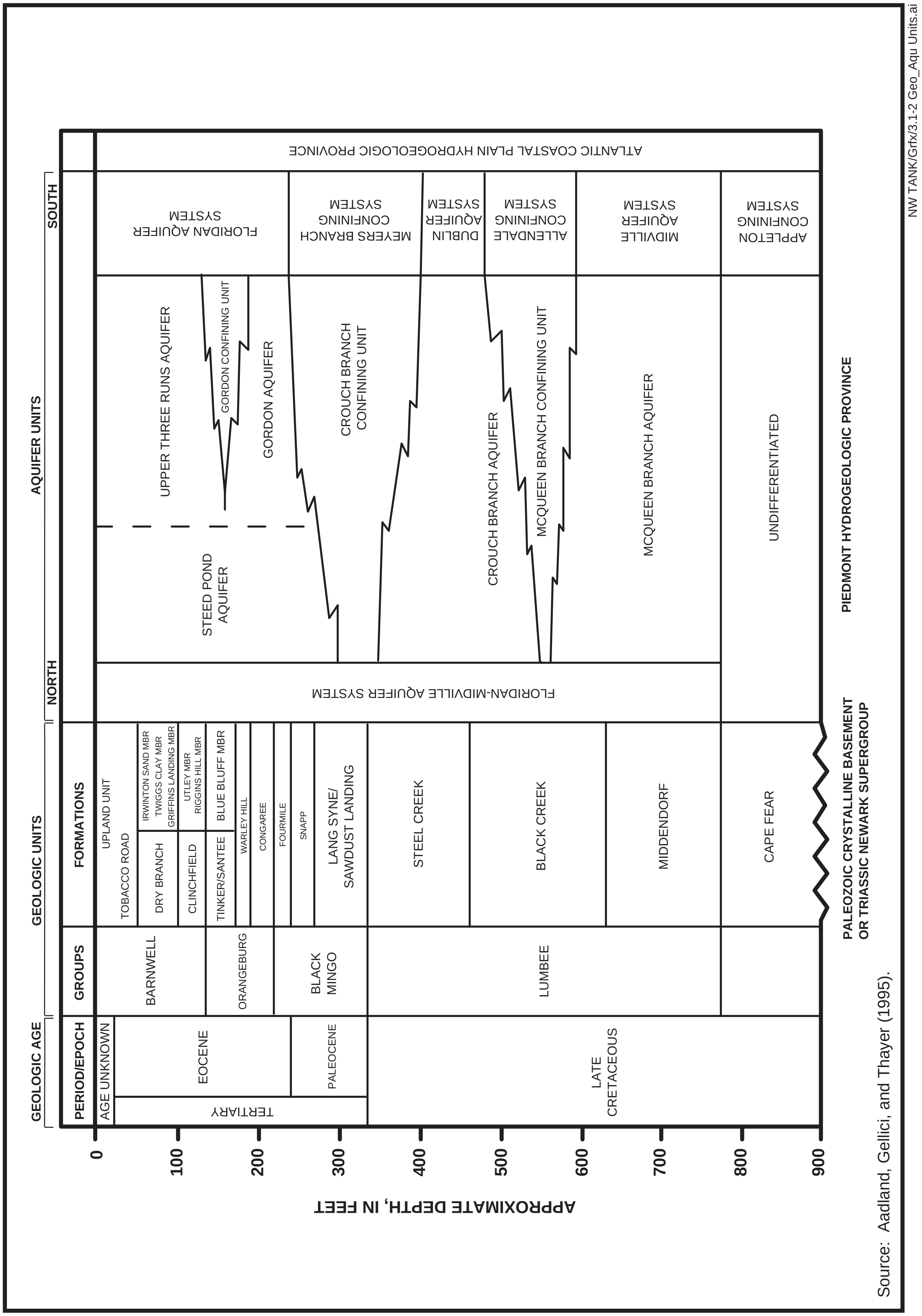


Figure 3.1-1. Generalized location of Savannah River Site and its relationship to physiographic provinces of the southeastern United States.



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

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 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 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. 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, 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.

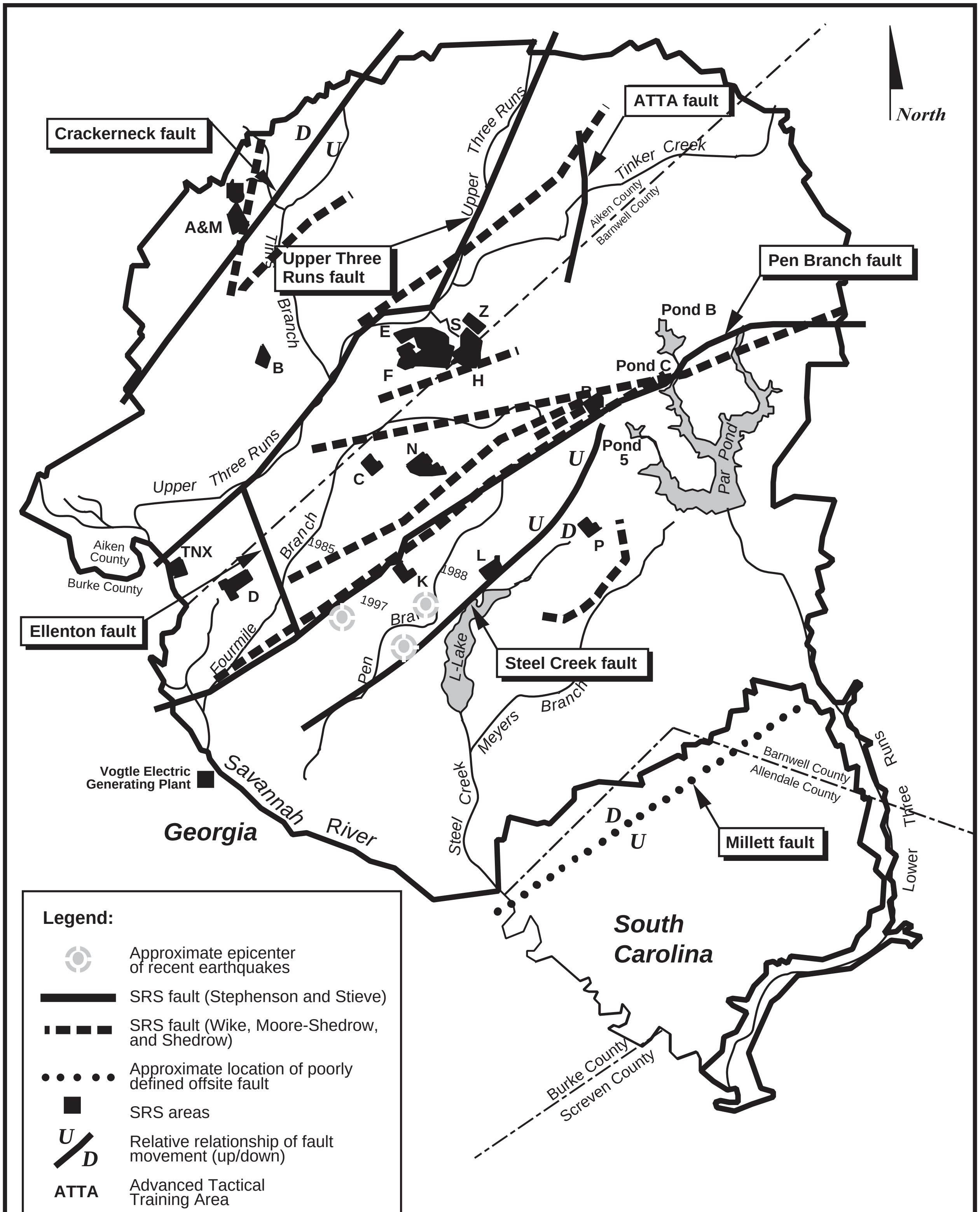
Based on available information, none of the faults discussed in this section is capable, which means that none of the faults has moved at or near the ground surface within the past 35,000 years or is associated with another fault that has moved in the past 35,000 years. Regulation 10 Code of Federal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

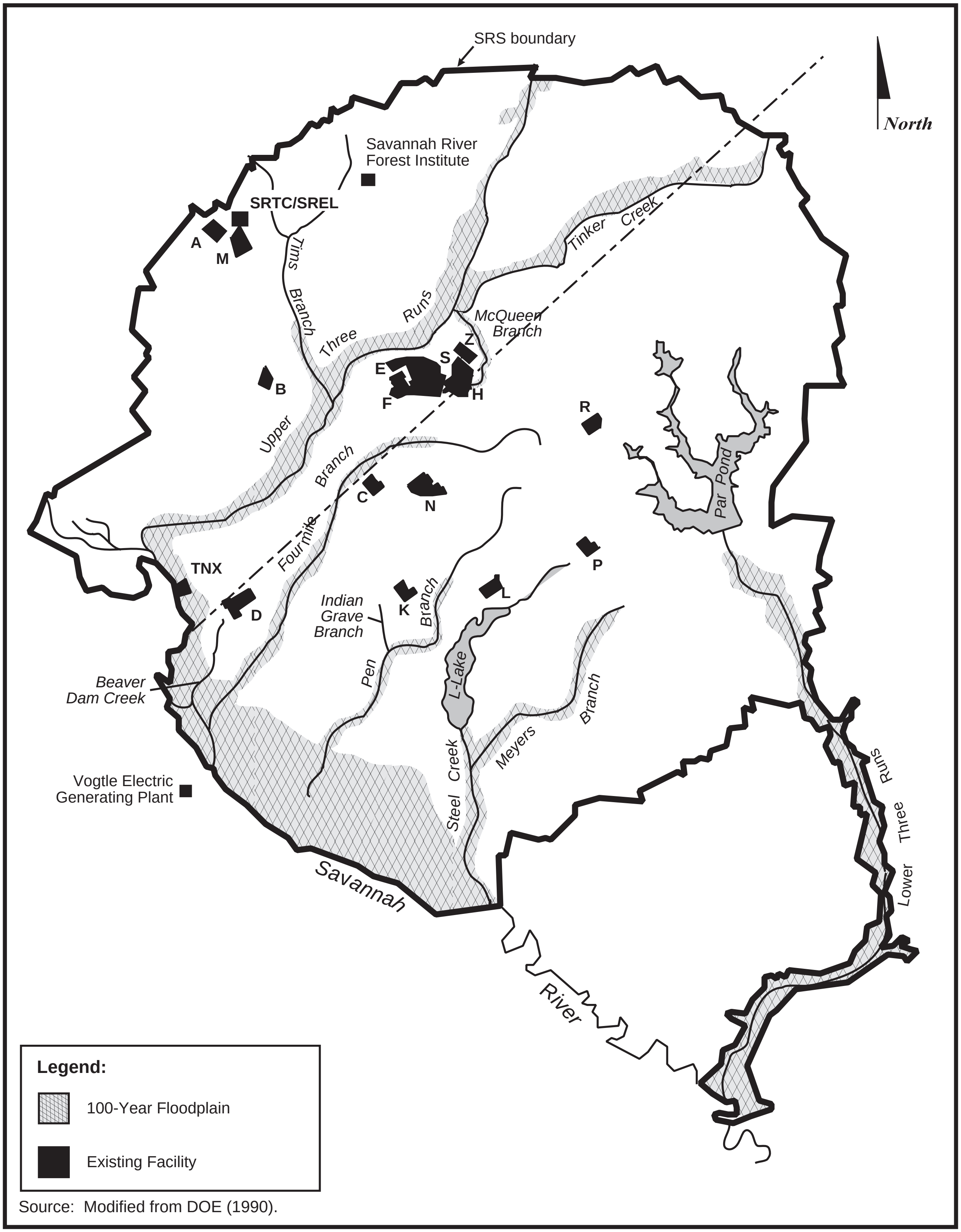

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Figure 3.2-1. Savannah River Site, showing 100-year floodplain and major stream systems.

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* EC *Savannah River Site* (DOE 1997) contain detailed information on flow rates and water quality of the Savannah River and SRS streams.

There are various potential sources of contamination to the Upper Three Runs and EC 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 EC 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.

3.2.2 GROUNDWATER RESOURCES

3.2.2.1 <u>Groundwater Features</u>

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 EC Figure 3.1-2 (Aadland, Gellici, and Thayer 1995). The Meyers Branch Confining System and/or the Allendale Confining System, as

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

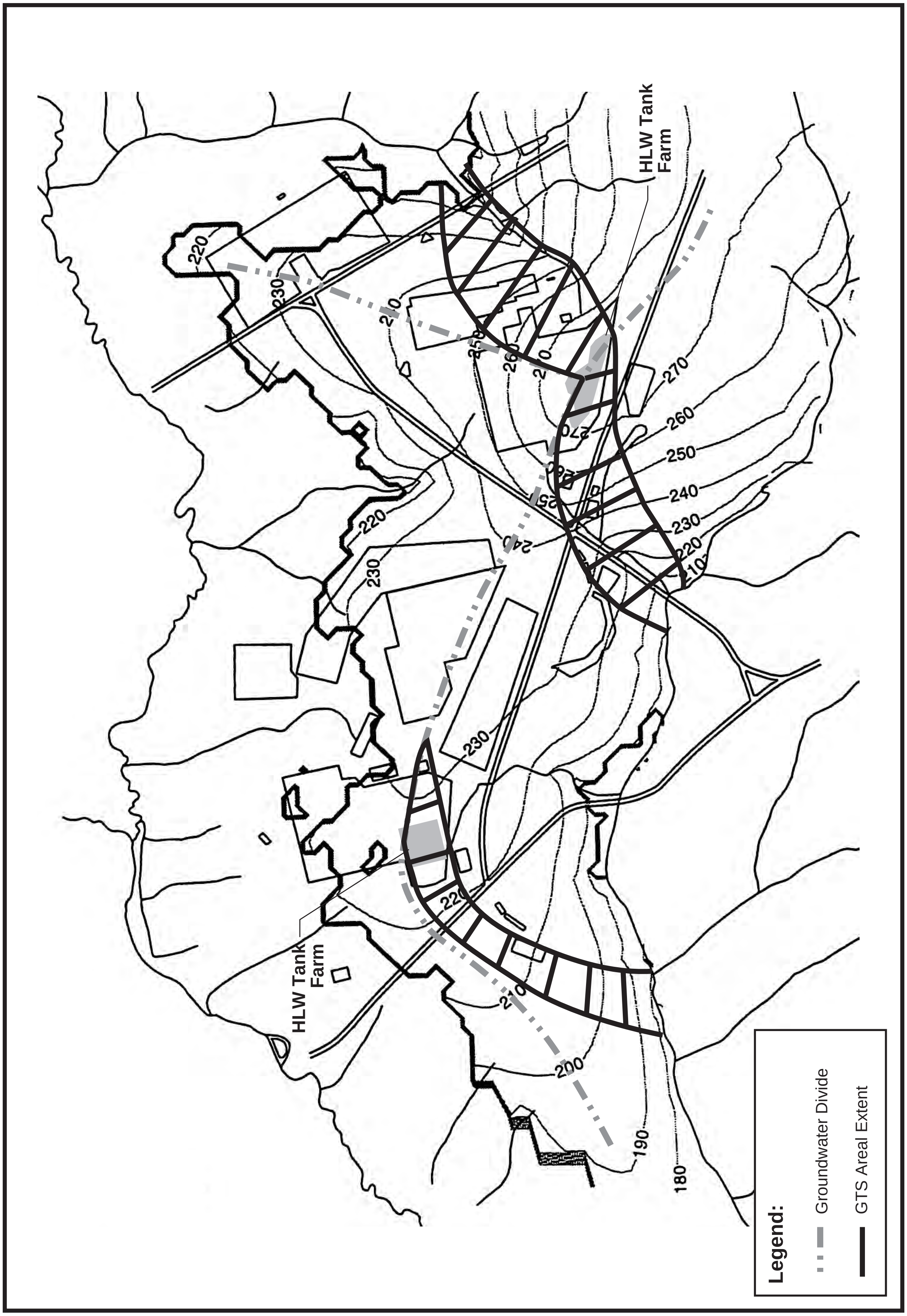
The Gordon Aquifer consists of the Congaree, Fourmile, and Snapp Formations. Table 3.1-1 provides soil descriptions for these formations. The Gordon Aquifer is partially eroded near the Savannah River and along Upper Three Runs. This aquifer is recharged directly by precipitation in the outcrop area, 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

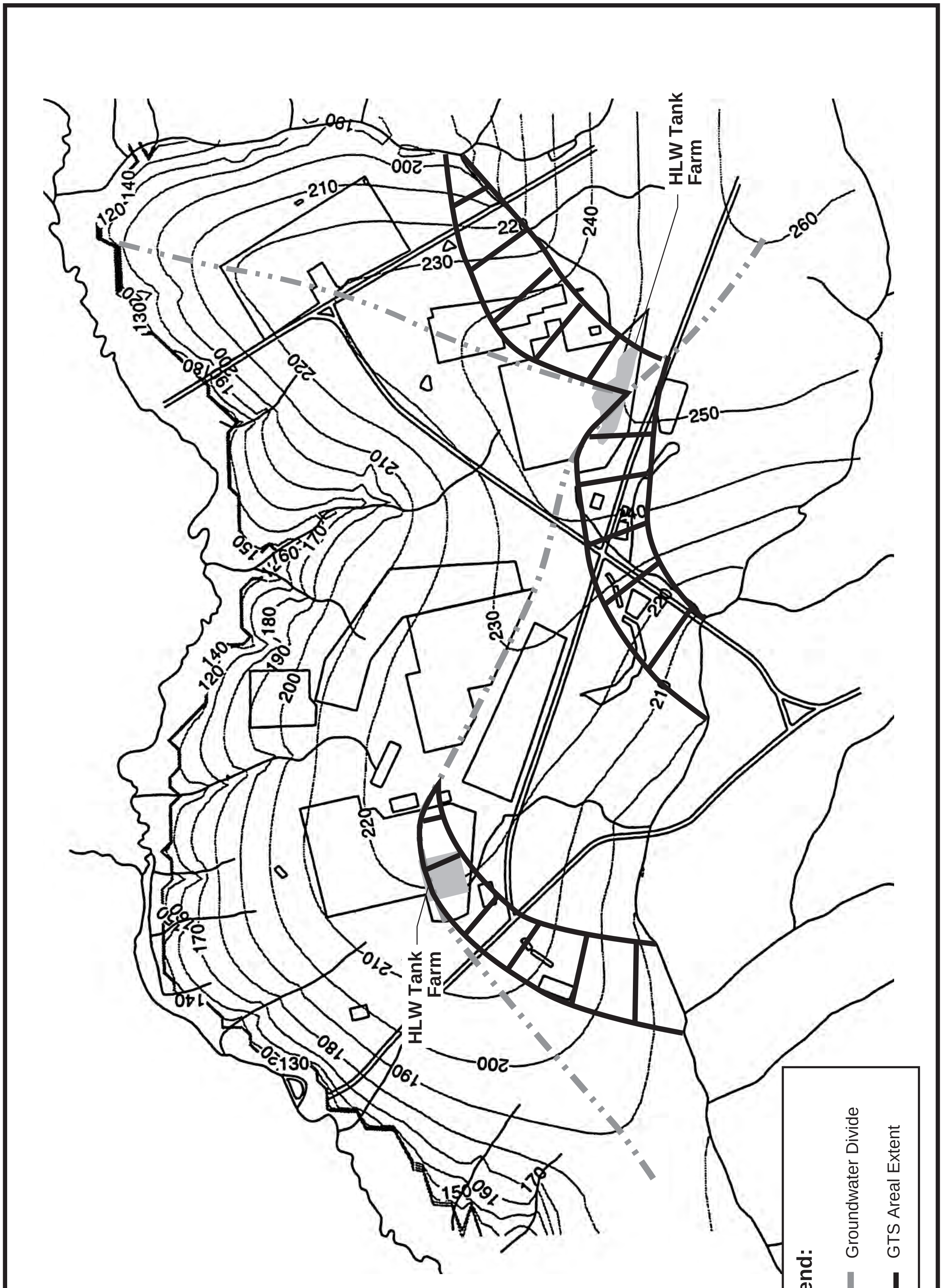


Figure 3.2-3. Calibrated potentiometric surface (ft) for the Barnwell-McBean Aquifer.

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 90^{th} 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.

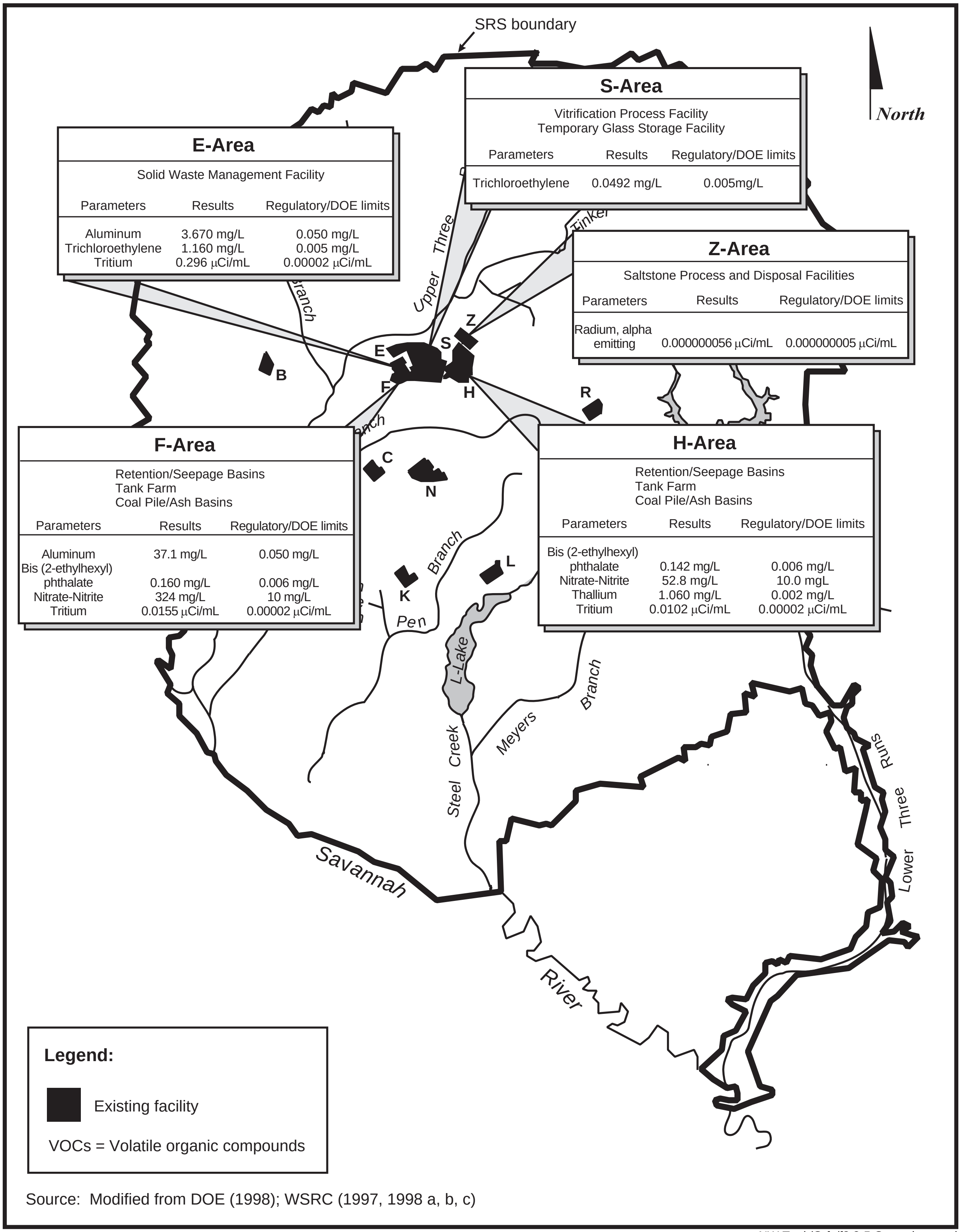
Wind directions frequently observed at SRS show that there is no prevailing wind at SRS, which is typical for the lower Midlands of South Carolina. According to wind data collected from 1992 through 1996, winds are most frequently from the southwest sector (9.7 percent) (Arnett and Mamatey 1998a). Measurements 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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L-13-4

TC

NW Tank/Grfx/f3.2-5 Groundwater.ai

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 Nonradiological Air Quality

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.

EC

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.

EC

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.

EC

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 <u>Radiological Air Quality</u>

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 ($\mu g/m^3$)[a]	Estimated SRS baseline concentration ($\mu g/m^3$)[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 $\mu g/m^3$ and an annual average limit of 15 $\mu g/m^3$) 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]

	Curies[b]						
Radionuclide	Reactors	Separations[c]	Reactor materials	Heavy water	SRTC[d]	Diffuse and fugitive[e]	Total
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 EC 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.

EC The SRS was designated as the first National Environmental Research Park by the Atomic Energy Commission in 1972. Especially EC 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.

EC

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

EC

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). EC

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

EC

H Areas (i.e., between Upper Three Runs and Fourmile Branch) will be considered in the industrial use category (DOE 1998b). EC Consequently, DOE's plan is to continue active institutional control for those areas as long as necessary to protect the public and the EC 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 EC 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.

<u>Population</u>

Based on State and Federal agency surveys and trends, the estimated 1998 population that lives EC 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. EC 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 EC 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).

<u>Employment</u>

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]

	2000		2010		2020	
Jurisdiction	Population	% ROI	Population	% ROI	Population	% 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

	2030		2040	
Jurisdiction	Population	% ROI	Population	% 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- EC income communities could receive disproportionately high and adverse human health and environmental impacts from the alternatives included in that EIS. 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.

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.

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.

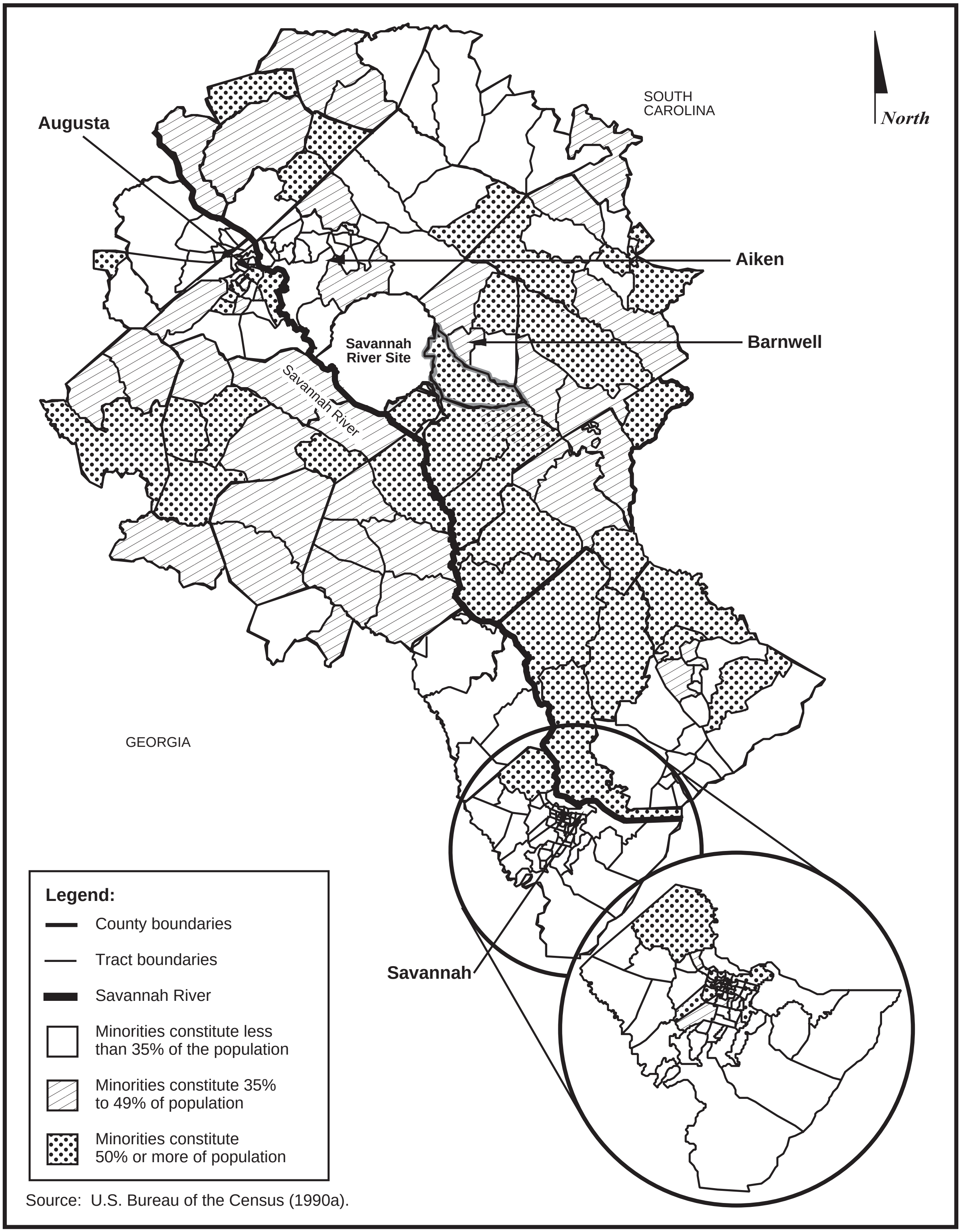

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Figure 3.6-1. Distribution of minority population by census tracts in the SRS region of analysis.

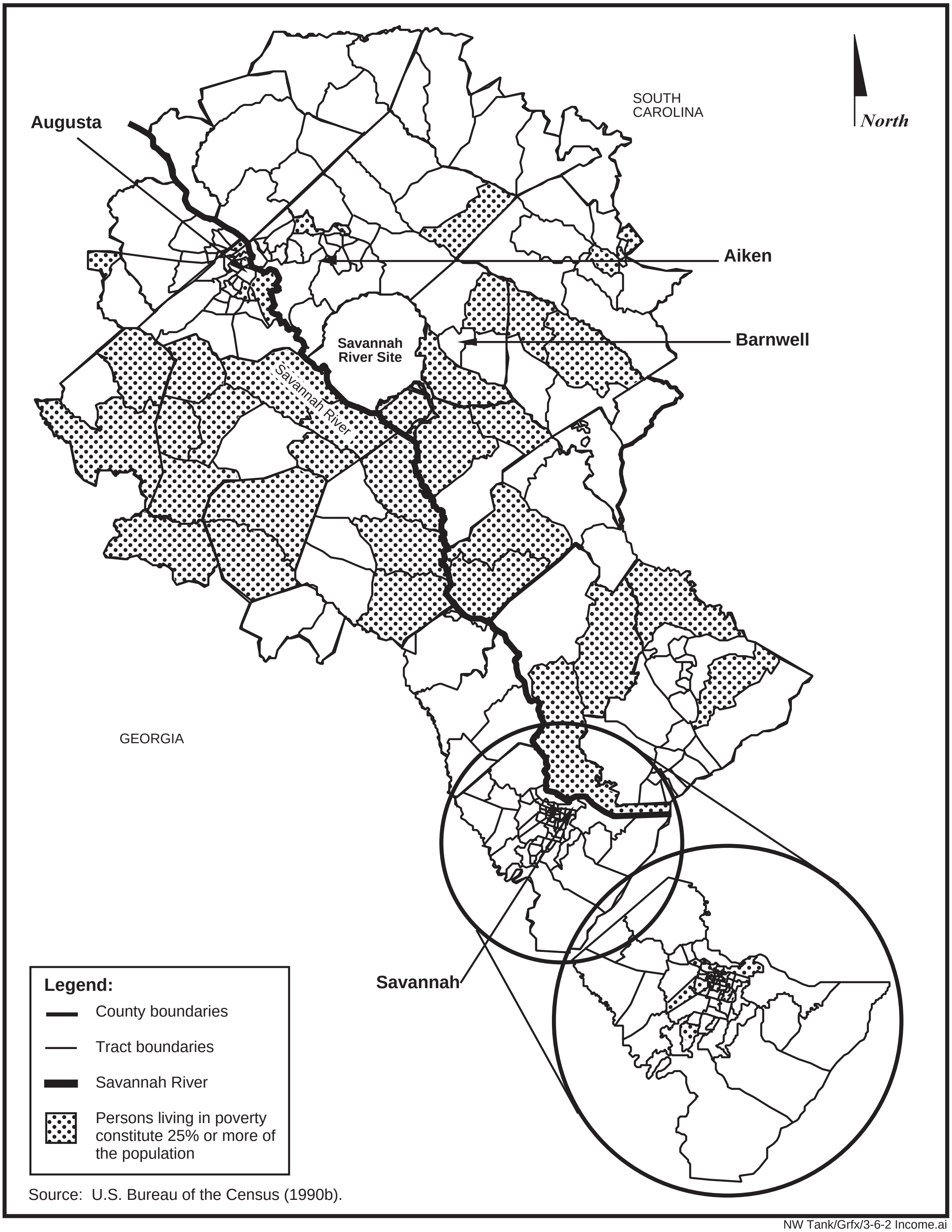

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Figure 3.6-2. Low income census tracts in the SRS region of analysis.

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.

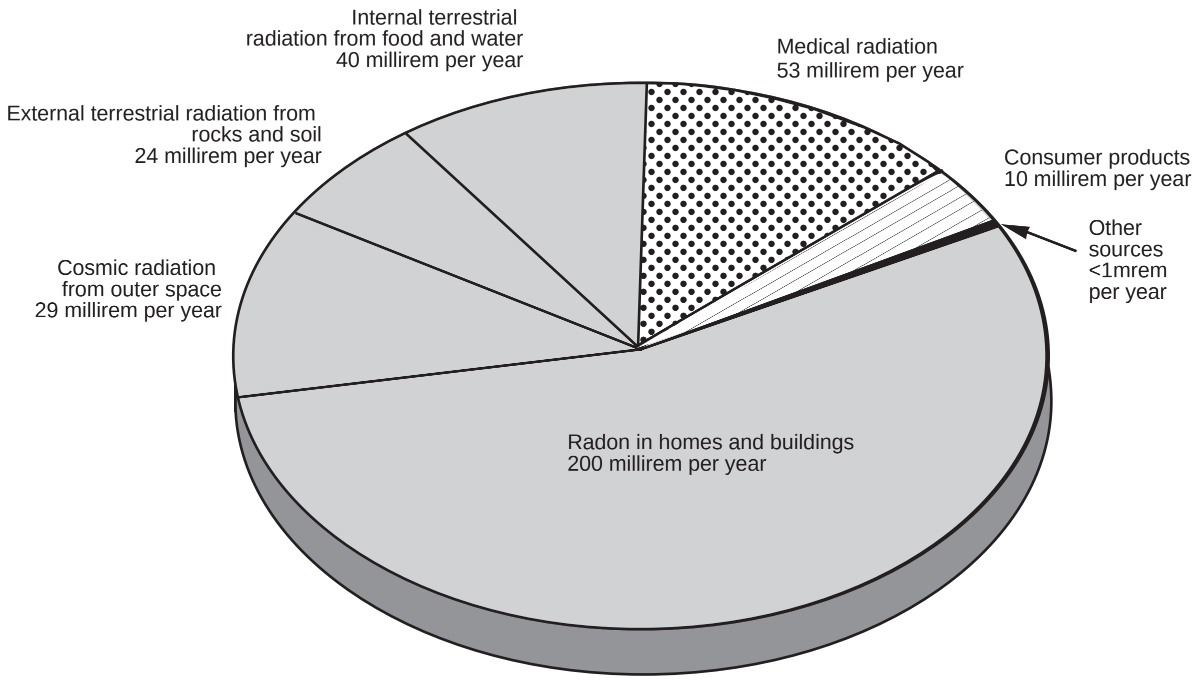
Doses of radiation are expressed as millirem, rem (1,000 millirem), and person-rem (sum of dose to all individual in population).

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



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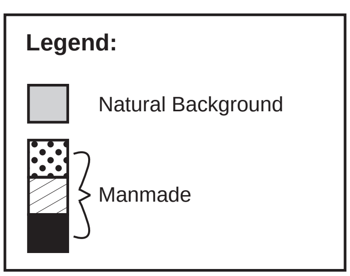
Notes: 1. Values are effective dose equivalents from NCRP (1987a) unless noted otherwise.
2. Cosmic: NCRP (1987a) reports 26 millirem per year for sea level. Multiplying value by a factor of 1.1 to correct for the altitude of 300 meters above sea level gives 29 millirem per year.
3. External terrestrial: 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.

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.

EC 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.

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 50	24 hours 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

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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 Low-Level Radioactive Waste

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 Mixed Low-Level Waste

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 High-Level Waste

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]

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.
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.

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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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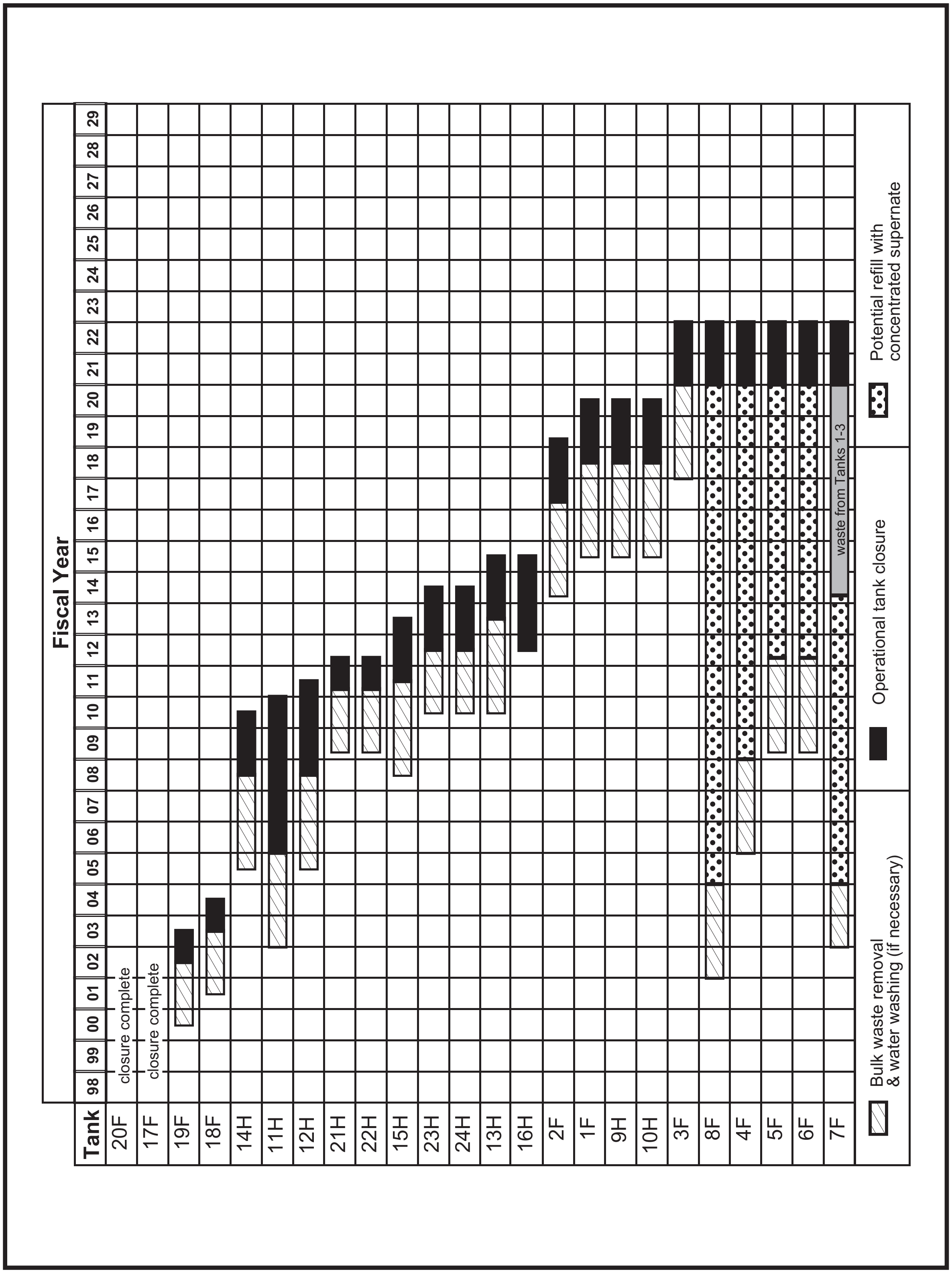

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Figure 3.9-1. Approved Federal Facility Agreement Waste Removal Plan and Schedule.

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

Storage facility	Location	Capacity	Original waste stream[b]						Status
			Low-level	HLW	Transuranic	Alpha[c]	Hazardous	Mixed Low-level	
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. 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 Sanitary Waste

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 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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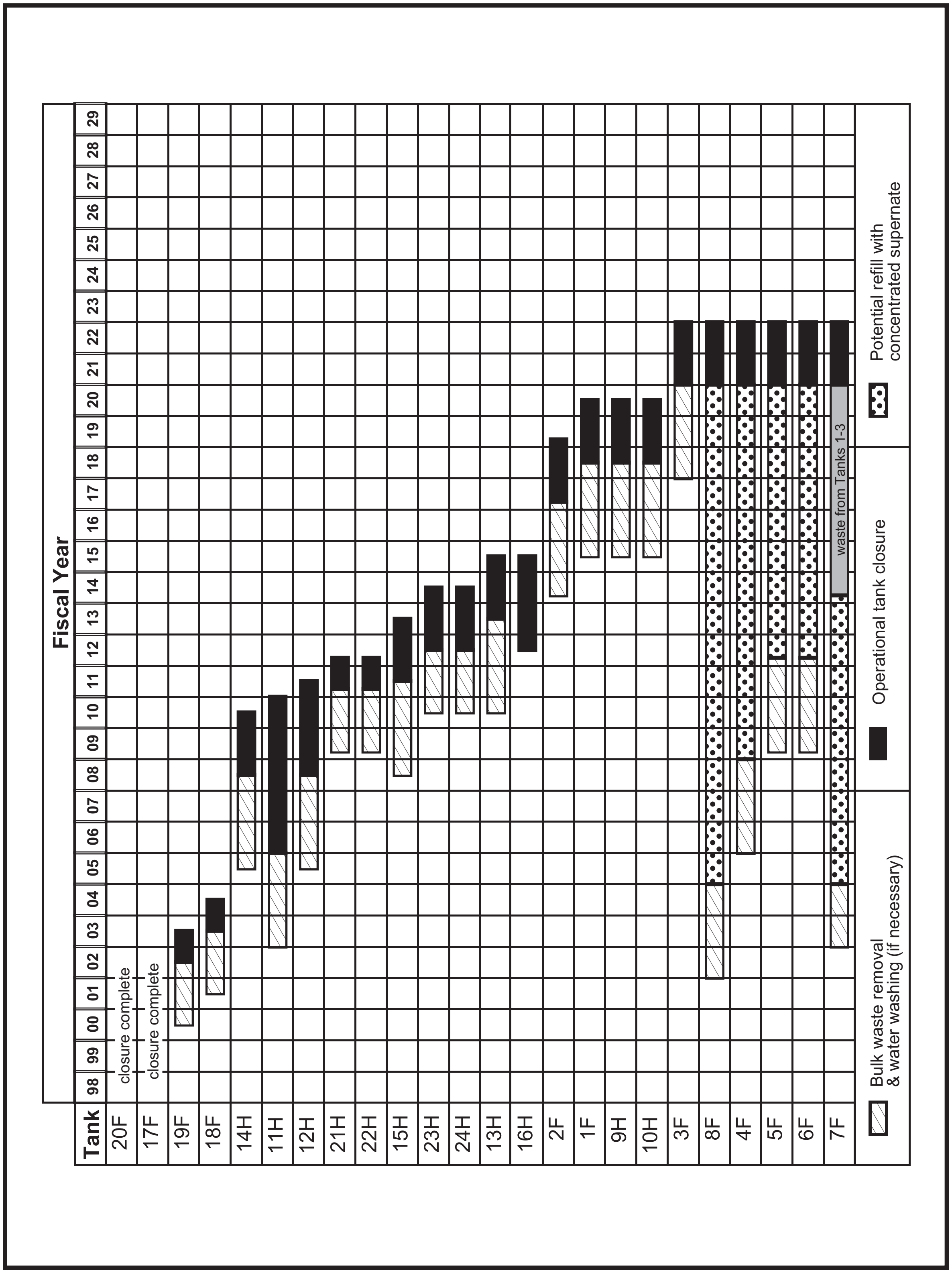

NW TANK/Final EIS/Graphic files/chp 3/3.9-1 App FFA Waste Rem Plan&Sch.ai

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 Nonradiological Air Quality

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.

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.

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.

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.

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]

TC

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).

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 EC EC EC pressure (as demonstrated by the very low tank EC 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 EC 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 TC 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. EC 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 TC 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 EC (OSHA)-regulated pollutants (milligrams per cubic meter) at the location of the noninvolved worker would be highest for the Fill with TC 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			
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)

TC

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.

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.

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.

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

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).

TC

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).

TC

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. TC

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 TC 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 EC 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 TC 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 TC

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
EC 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
EC *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 EC
cubic feet) could be required for backfill under
the Stabilize Tanks Alternative or the Clean and TC
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 EC 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* EC *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. TC 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 EC classifications: operations, engineering, design, construction, support, and project management.

Table 4.1.6-1. Estimated HLW tank closure employment. 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
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. The potential for the presence of a EC 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 <u>Radiological Health Effects</u>

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.

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EC

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 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 <u>Nonradiological Health Effects</u>

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) EC because it would require the largest number of workers. 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." EC

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." EC EC

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: EC

- 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. EC

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.

<u>Short-Term Impacts</u>

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.

<u>Subsistence Consumption of Fish, Wildlife, and Game</u>

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.

		Stabilize Tanks Alternative			
Materials	No Action Alternative	Fill with Grout Option	Fill with Sand Option	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.

		Stabilize Tanks Alternative			
	No Action Alternative	Fill with Grout Option	Fill with Sand Option	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 <u>Liquid Waste</u>

Radioactive liquid wastes would be generated as a result of tank cleaning activities under the TC 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 TC 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).

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 TC with Grout Option under the Stabilize Tanks 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			Clean and Remove Tanks Alternative
		Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	
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. While accidents are not considered L-7-80 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.

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
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.

EC 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.

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. EC 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. TC 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.

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 Stabilize Tanks Alternative would allow the soils in the vicinity of the tanks to be impacted. TC

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 System (NPDES) permits. Water quality criteria EC 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).

TC

	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	-----

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).

TC

	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	-----

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 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.

4.2.2.2 Groundwater

Contamination Source

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

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. The Fill with Grout Option would produce a source zone that consists of the residual waste covered by a low-permeability reducing grout. 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. 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.

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. 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). TC

	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.

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
L-7-5 inventory in the closed tanks.

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 L-7-5
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. 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 L-5-4

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 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 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. L-5-4

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.

<u>Groundwater Quality Impacts</u>

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.

<u>Summary of Estimated Concentrations</u>

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

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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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

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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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					
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					
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					
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

TC
TC
TC

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					
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					
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					
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

TC
TC
TC

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).

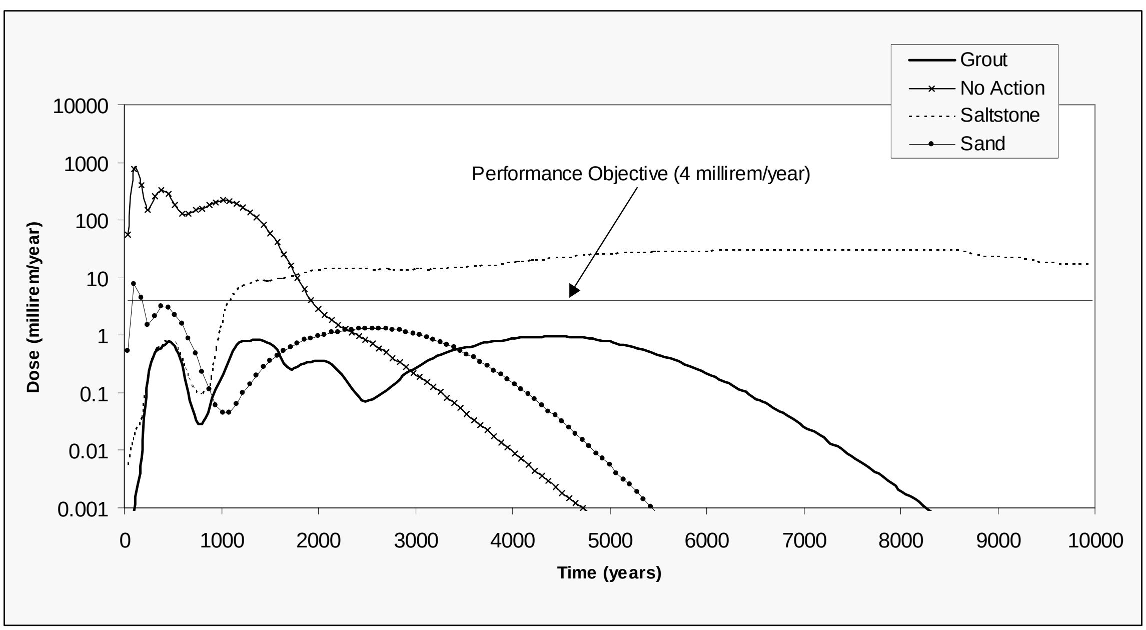

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Figure 4.2.2-1. Predicted drinking water dose over time at the H-Area seepline north of the groundwater divide in the Barnwell-McBean and Water Table Aquifers.

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 <u>Nonradiological Contaminants</u>

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

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.

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.

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.

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

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a. DOE limit is 365,000 millirad per year.

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.

TC

TC

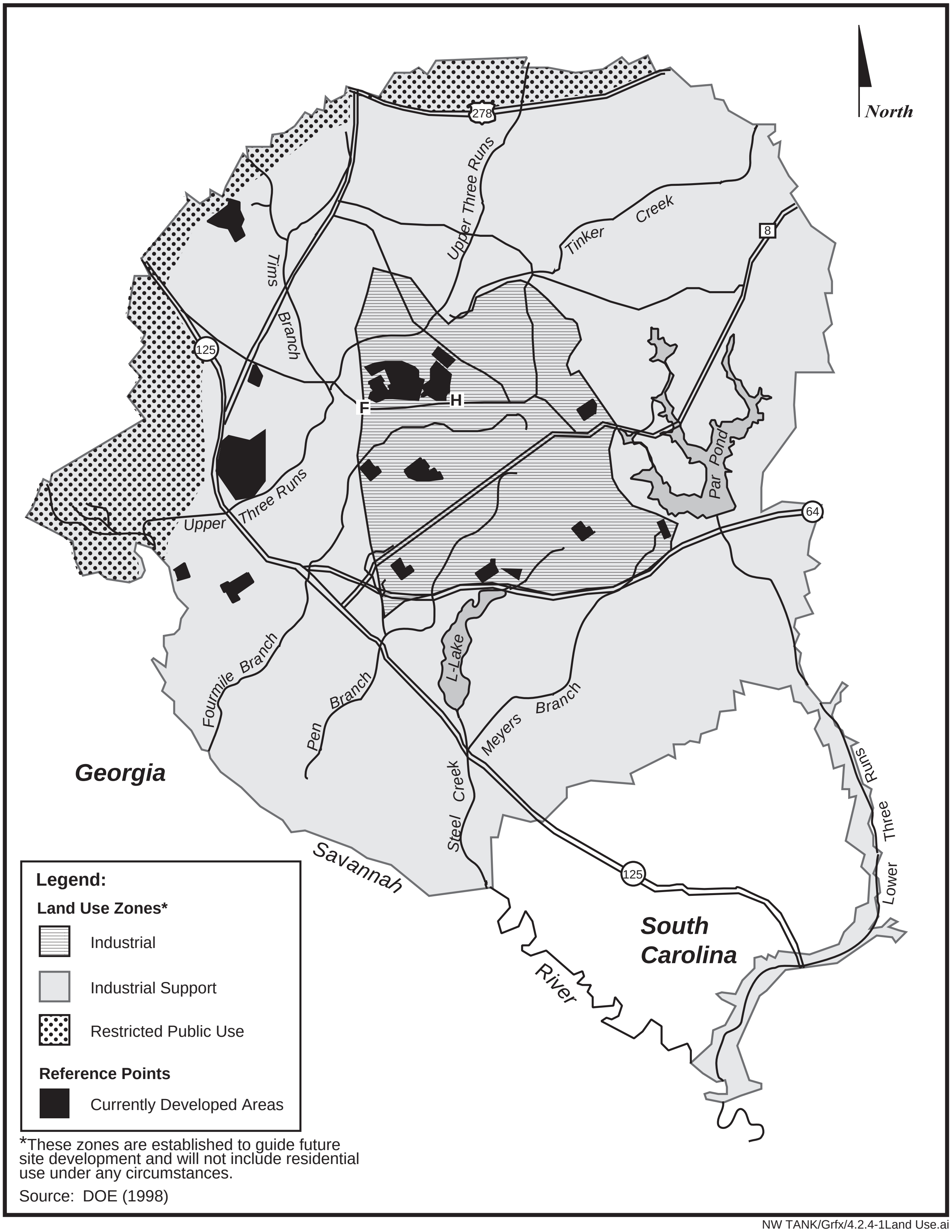
EC

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



TC

Figure 4.2.4-1. Savannah River Site land use zones.

- 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 EC 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 EC 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 EC 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 EC 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 EC 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 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 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 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 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 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]

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	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

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

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.

> 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.

<u>SRS History</u>

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).

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 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 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 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 stresses. DOE installed a Liquid Effluent Treatment Facility that minimized liquid releases of pollutants (except tritium) before discharge through a National Pollutant 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 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 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 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 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 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 $1/8^{th}$ 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.

EC

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 EC 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 EC SNF will remain in wet storage until treated and placed in dry storage in the Treatment and Storage Facility. TC

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 EC 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. EC

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 TC

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 | EC standard). 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.

Activity	Maximally exposed individual				Offsite population[a]				Workers	
	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 saltstone	-	-
Boiler slag	-	-		-	-
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).

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					
	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	Clean and Remove Tanks Alternative	No Action Alternative	TC
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.

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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

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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.

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 remove 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
EC Facility Agreement between DOE, SCDHEC, and the U.S. Environmental Protection Agency (EPA). As such, it is beyond the scope of this EIS.

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.

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.

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

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 EC 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 EC 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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APPENDIX A

TANK FARM DESCRIPTION AND CLOSURE PROCESS

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APPENDIX A. TANK FARM DESCRIPTION AND CLOSURE PROCESS

A.1 Introduction

EC Over the last 45 years, Savannah River Site (SRS) has produced special radioactive isotopes for various national programs. These isotopes were primarily produced in the Site's nuclear reactors, which generated neutrons that bombarded specifically designed targets. The neutrons bombarding the targets result in transmutation of the target atoms to produce the desired radioisotopes. The spent nuclear fuel and the targets were reprocessed to recover unused reactor fuel and the isotopes produced in the reactors. The reprocessing activity involved dissolving the fuel and targets in large, heavily shielded chemical separations facilities in the EC F and H Areas, known as the F-Canyon and H-Canyon, respectively. These facilities EC concentrated the valuable materials that the U.S. Department of Energy (DOE) wanted to recover, TC but produced large quantities of high-level waste (HLW). The HLW has been stored in the tank EC farms in F and H Areas.

DOE has recently reviewed its HLW management practices in two recent EISs: the *DWPF Supplemental EIS* (DOE 1994) and the *SRS Waste Management EIS* (DOE 1995). This *HLW Tank Closure EIS* is focused on closure of the tank farms after the HLW has been removed. Nevertheless, a discussion on how the tank farms fit into the overall SRS HLW management program is useful to understanding the nature of the residual waste in the tanks and the tanks' current use and history. Therefore, Section A.2 provides an overview of HLW management at SRS. Section A.3 describes the tank farm equipment and operations. Section A.4 describes the activities needed to close the tank farms under the various closure alternatives.

A.2 Overview of SRS HLW Management

The main processes involved in HLW management are generation, storage, evaporation, sludge processing, salt processing, vitrification, and saltstone manufacture and disposal. Figure A-1 shows the process flows among the processes.

Although the F- and H-Canyons are the only facilities at SRS that generate HLW in the regulatory sense, other facilities produce liquid radioactive waste that has characteristics similar to those of HLW. These facilities include the Receiving Basin for Offsite Fuel, the Savannah River Technology Center, the H-Area Maintenance Facility, and the reactor areas. Selected wastes from these facilities are managed at SRS as if they were HLW and are thus sent to the tank farms for storage and ultimate processing. Also, the Defense Waste Processing Facility (DWPF), which is the final EC treatment for SRS HLW, recycles wastewater back to the tank farms.

The tank farms receive the HLW, immediately isolating it from the environment, SRS workers, and the public. The tank farms provide a sufficiently long period of storage to allow many of the short-lived radionuclides to decay too much lower concentrations. After pH adjustment and introduction into the tanks, the HLW is allowed to settle, separating into a sludge layer at the bottom and a salt solution layer at the top, known as supernate. SRS uses evaporators to concentrate the supernate to produce a third form of HLW in the tank farms, known as crystallized saltcake. As a result of intertank transfers, some of the tanks are now primarily salt tanks, some are primarily sludge tanks, some tanks contain a mixture of salt and sludge, and some tanks are empty.

Before 1994, the Canyons generated two waste EC streams that were sent to the tank farms. High-radioactivity waste, which contained most of the radionuclides, was aged in a high-radioactivity waste tank before evaporation. Low-radioactivity waste, which contained lower concentrations of radionuclides, was sent directly to an evaporator. This historical practice is shown on Figure A-1. Under current

TC

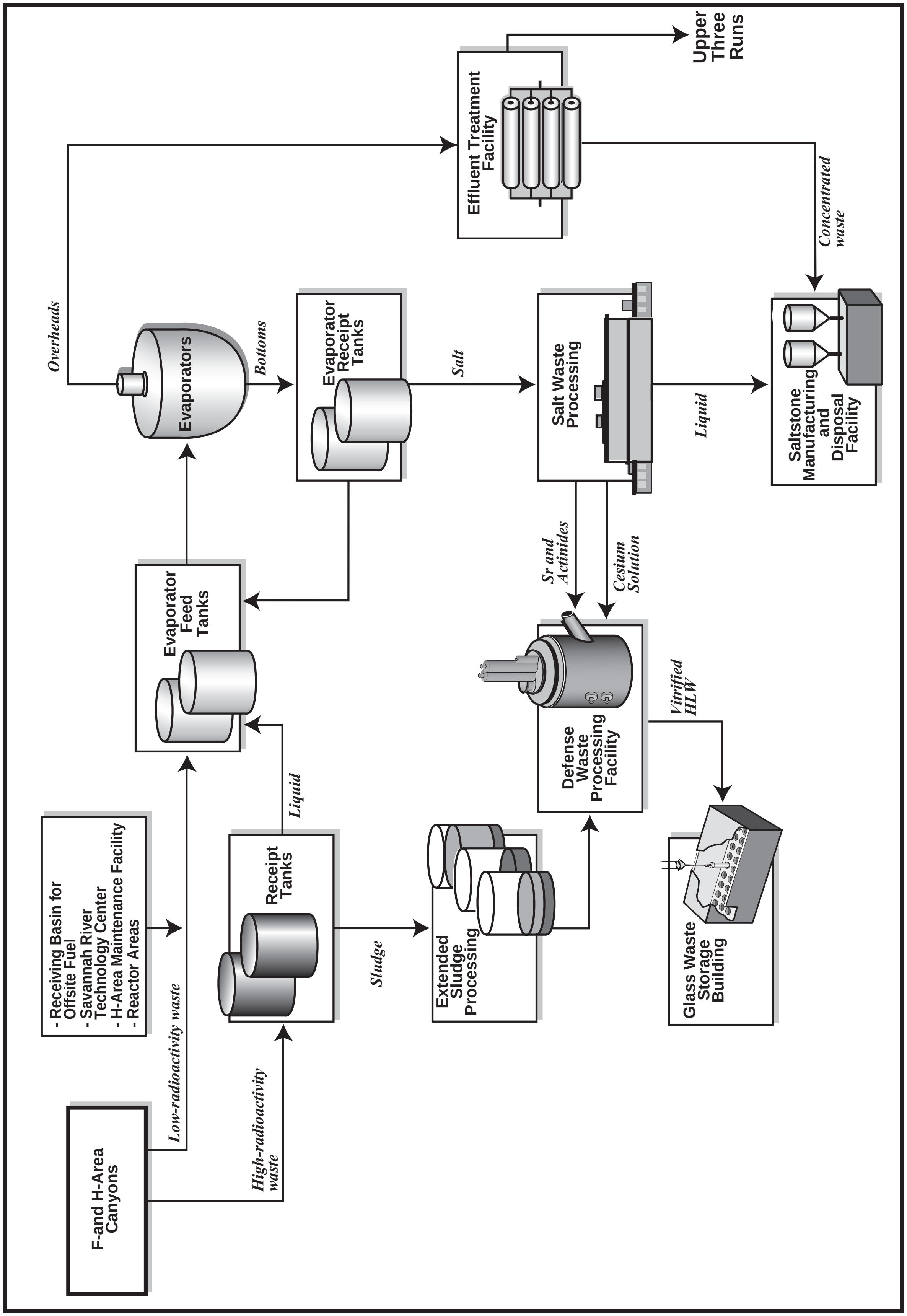


Figure A-1. Process flows for Savannah River Site high-level waste management system.

SRS operations, high-radioactivity waste is no longer generated because SRS reactors ceased operation in 1988. All incoming waste streams to the tank farms can be directed to the same receipt tanks and evaporator feed tanks.

SRS designed and built a facility using four H-Area Tank Farm tanks, known as the In-Tank Precipitation Facility, to process the saltcake and concentrated supernate. This salt processing facility was designed to receive redissolved saltcake and precipitate the chemical cesium that is responsible for the most prominent and penetrating radiation emitted from the waste. The cesium precipitate was designed to go DWPF for processing in the salt cell, with the aqueous cesium portion to be melted into a glass matrix and the organic portion sent to the Consolidated Incineration Facility. The remaining liquid salt solution was designed to go to the Saltstone Manufacturing and Disposal Facility for solidification and burial in underground vaults. DOE has concluded that the In-Tank Precipitation process, as currently configured, cannot achieve production goals and meet safety requirements. Therefore, in February 1999, DOE issued a Notice of Intent (64 FR 8558, February 22, 1999) to prepare a second Supplemental Environmental Impact Statement (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 52752, October 17, 2001). DOE selected the Caustic Side Solvent Extraction Alternative for separation of radioactive cesium from SRS salt wastes.

The sludge in the tanks, which contains approximately 54 percent of the HLW radioactivity, is treated in a process known as Extended Sludge Processing. Extended Sludge Processing uses existing tanks in the H-Area Tank Farm. The process removes aluminum hydroxide and soluble salts from the sludge before transferring the sludge to the DWPF for vitrification. Aluminum affects the hardness of the glass and the overall volume of glass waste. The soluble salts interfere with the desired chemical composition of the glass. The wastewaters from Extended Sludge Processing and the DWPF are recycled back to the tank farm.

The DWPF receives washed sludge and salt precipitate, mixes it with appropriate additives, and melts it into a glass form in a process known as vitrification. The glass is poured into stainless steel canisters and stored in the Glass Waste Storage Building, a facility containing an underground vault for canister storage. Because the In-Tank Precipitation Facility has been inoperable, the DWPF has been vitrifying only sludge waste. The DWPF will continue sludge-only processing until the feed is available from the salt processing facility. In order to minimize the number of HLW canisters that are produced, SRS planning documents (WSRC 1998a) call for maintaining the sludge and salt precipitate feeds to the DWPF in an acceptable balance to avoid having any precipitate left over when all of the sludge inventory has been vitrified. The ultimate disposition of the HLW glass canisters is a geologic repository. 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 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 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.

The Saltstone Manufacturing and Disposal Facility receives the low-activity salt solution. The salt solution is mixed with cement, slag, and flyash to form a grout having chemical and

EC physical properties designed to retard the leaching of contaminants over time. The grout is poured into disposal vaults and hardens into what is known as saltstone.

EC This is the Final Disposition of the Salt Solution. The Saltstone Manufacturing and Disposal Facility has received salt solution from the In-Tank Precipitation Process demonstration operations and concentrated wastes from the F/H-Area Effluent Treatment Facility and has been producing saltstone from these waste feeds. The Effluent Treatment Facility receives evaporator overheads from the Separations Areas and tank farms evaporators and treats the water for discharge to Upper Three Runs.

A.3 Description of the Tank Farms

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

A.3.1 TANKS

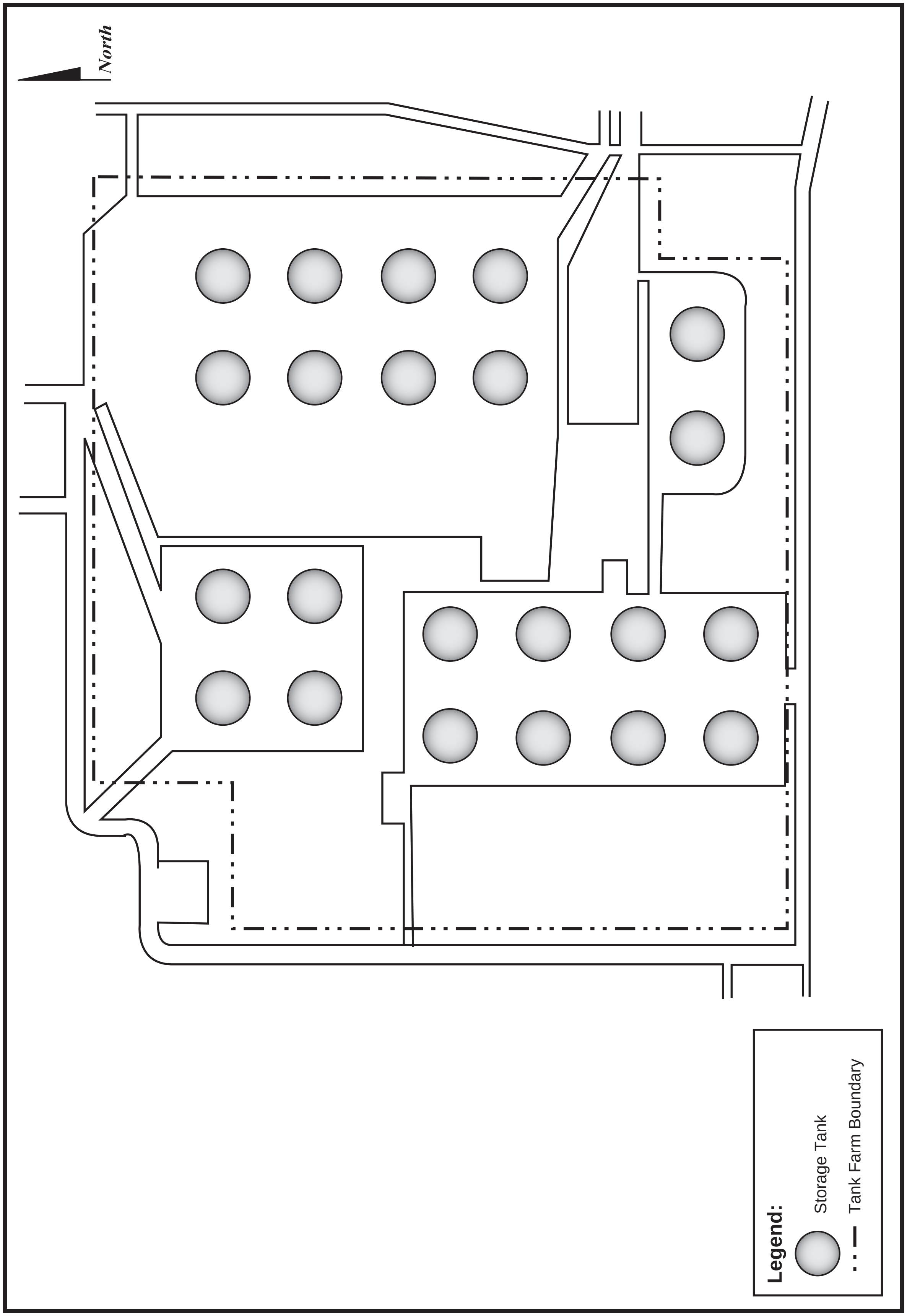
The F- and H-Area tanks are of four different designs, all constructed of carbon-steel inside reinforced concrete containment vaults. EC Two designs (Types I and II) have secondary annulus "pans" and active cooling (Figure A-4).

The 12 Type I tanks (Tanks 1 through 12) were TC built in 1952 and 1953; seven 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, L-7-56 based upon groundwater monitoring results, there is no evidence that the waste has leaked TC from the secondary containment. The level of waste in these tanks has been lowered to below these leak sites. In 1961, the fill line to Tank 8 leaked approximately 1,500 gallons to the soil and potentially to the groundwater. EC The tank tops are below grade and the bottoms of Tanks 1 through 8 are situated above the seasonal high water table. The bottoms of Tanks 9 through 12 are in the water table. TC

The four Type II tanks (Tanks 13 through 16) were built in 1956. EC All four have known leak sites, in which waste leaked from primary to secondary containment. In 1983, about 100 gallons of waste spilled onto the surface of Tank 13 through a cracked flush water line attached to an evaporator feed pump. No spilled waste reached the subsurface. The spill was cleaned up and the contaminated material returned to the waste tank or disposed (Boore et al., 1986). The contamination remaining is negligible and would affect neither tank closure nor future cleanup of the tank farm areas. TC In Tank 16, in 1962 the waste overflowed the annulus pan (secondary containment) and a few tens of gallons of waste migrated into the surrounding soil, presumably through a construction joint in the concrete encasement. Waste removal from the Tank 16 primary vessel was completed in 1980. DOE removed some waste from the annulus at that time, L-2-17 L-7-61 but some dry waste still remains in the annulus. These tanks are above the seasonal high water table.

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 A-4). EC Tanks 19 and 20 have known cracks that are believed to have been caused by groundwater corrosion of the tank walls. Small amounts of groundwater have leaked into these tanks (WSRC 2000); L-7-58 there is no evidence that waste ever leaked out. The level of the waste in Tank 19, which is the next tank scheduled to be closed, TC 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 basemat under the tank area. Tanks 17 and 20 have already been closed in a manner described in DOE's Preferred Alternative.

TC



NW TANK/Grfx/A-2 F_Tank.ai

Figure A-2. General layout of F-Area Tank Farm.

TC

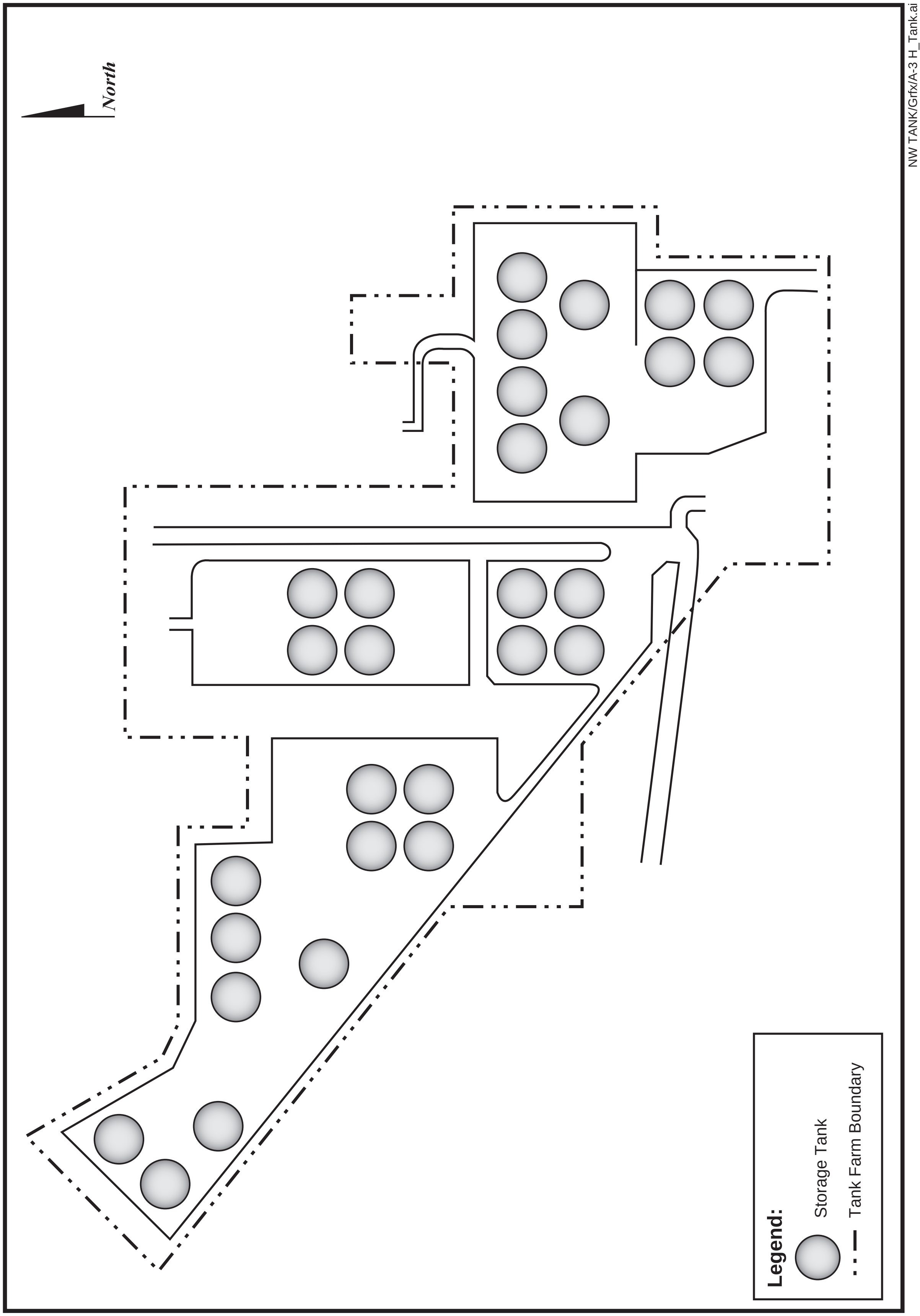


Figure A-3. General layout of H-Area Tank Farm.

TC

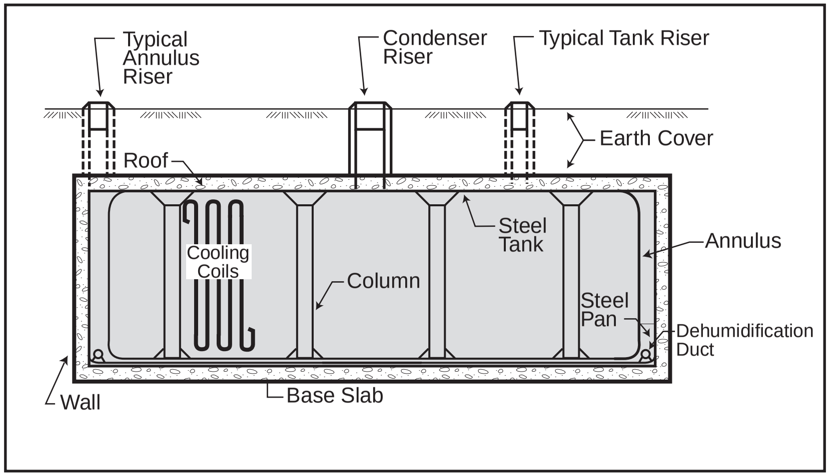


Figure A-4.A. Cooled Waste Storage Tank, Type I

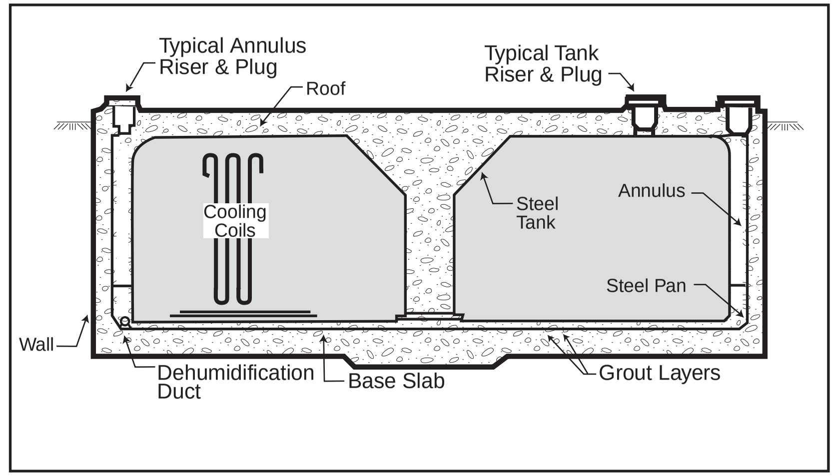


Figure A-4.B. Cooled Waste Storage Tank, Type II

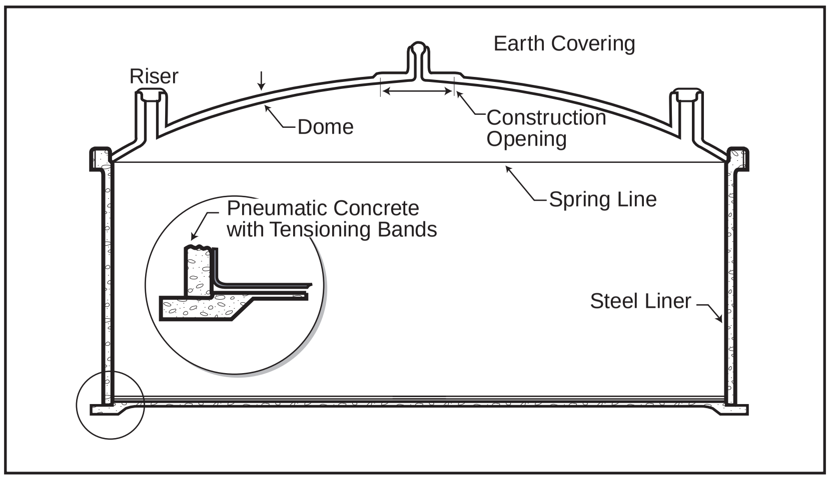


Figure A-4.C. Uncooled Waste Storage Tank, Type IV (Prestressed concrete walls)

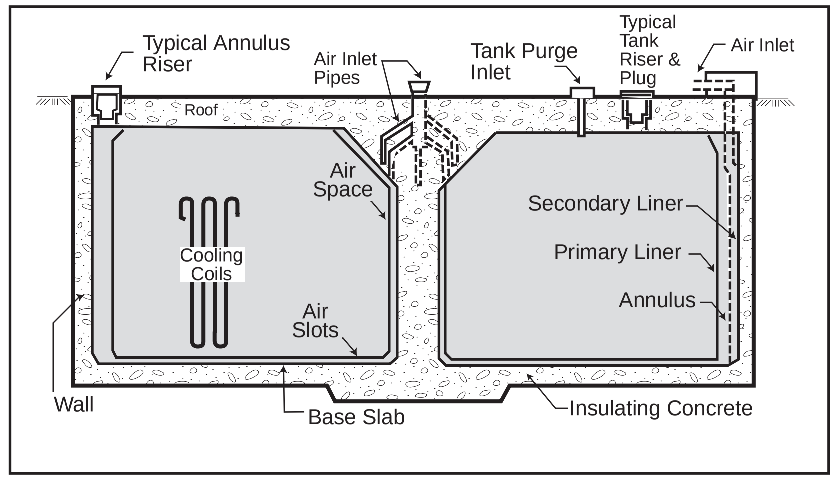


Figure A-4.D. Cooled Waste Storage Tank, Type III (Stress Relieved Primary Liner)

NW TANK/Grfx/A-4 Tank config.ai

Figure A-4. Tank configurations.

The newest design (Type III) has a full-height secondary tank and active cooling (Figure A-4). All of the Type III tanks (25 through 51) are above the water table. These tanks were placed in service between 1969 and 1986 and none of them has known leak sites. In 1989, a Tank 37 transfer line leaked about 500 pounds of concentrated waste to the environment.

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 (WSRC 1998a). The 24 Type 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. Areas of contamination in the tank farms have been identified, based on groundwater monitoring past incident reports and contamination surveys. The areas of significant contamination have been identified in the SRS Federal Facility Agreement and have been designated as Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act (RCRA/CERCLA) units or Site Evaluation Units. Controls are in place to ensure that any activities performed around these areas are conducted in a manner protective of human health and the environment, and in a way that minimizes the impact on future investigation, removal, and remedial action (WSRC 1996).

A total of 17 RCRA/CERCLA units or Site Evaluation Units have been identified in the tank farms. In 14 of the 17 areas, contamination is the result of past spills on the surface, and the contamination is on or near the surface (EPA 1993). The amount of contamination in these 14 sites appears to be small and will probably not add significantly to the dose reported in this EIS for tank closure, for the following reasons:

1. The sizes of these spills are small, compared to the residual tank contents.

2. The contamination is outside the tanks and would thus transport through the soil and groundwater much more rapidly than those contaminants bound inside the tanks. This would cause their impacts to be noncoincident in time with those from tank closure.

3. Contamination outside the tanks would be addressed in the CERCLA closure of the tank farm areas. Tank closure and CERCLA closure are being coordinated so that cumulative impacts are within limits established with SRS regulators through the risk-based closure process. Therefore, if any spill appears to produce a large contribution, it would be remediated until it produces a small contribution.

In 2 of the 17 areas, the contamination came from pipelines located below grade that leaked directly into the ground. The first area was a leak from the secondary containment of a pipeline near Tank 8, which happened in 1961. The leak resulted from an inadvertent overfill of Tank 8. The volume leaked to the soil was estimated to be 1,500 gallons (Odum 1976). The second area was a leak from a Concentrate Transfer System near the Tank 37 line, which was discovered in 1989 (the actual date of the leak is not known). The volume of this leak was estimated to be a few gallons (d'Entremont 1989).

The last area, the Tank 16 RCRA/CERCLA unit, is the only instance at SRS where waste is known to have leaked to the soil from a HLW tank. In September 1960, leaks from the Tank 16 primary tank caused the level in the annulus pan (the tank secondary containment) to exceed the top of the pan. 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. Based on soil borings around the tank, it is estimated that some tens of gallons of waste leaked into the soil (Poe 1974). 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.

Because all tanks at SRS have leak detection, it is unlikely that any large leaks have occurred that have not been detected. In eight tanks other than Tank 16, observable amounts of waste have leaked from primary containment into secondary containment. These tanks are managed to ensure that the leaked waste remains dry and L-7-66 immobile. The waste in the annuli of these L-7-67 tanks has been observed carefully over a period of years and minimal movement of the waste has been observed. Other than Tank 16, there is no evidence that waste has leaked from a tank into the soil.

A.3.2 EVAPORATOR SYSTEMS

The tank farms had five evaporators that concentrated waste following receipt from the L-7-25 Canyons. At present, three evaporators are L-7-68 operational, one in F-Area Tank Farm and two in H-Area Tank Farm. Each operational evaporator is made of stainless steel with a hastelloy tube bundle, 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 vaults) or placed underground. The process equipment is designed to be remotely operated and maintained.

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 by successive evaporations of liquid L-7-71 supernate. This concentrated waste crystallizes into a solid saltcake, which reduces its mobility.

A.3.3 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.

A.3.4 SALT PROCESSING

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 8558, February 22, 1999). TC

Therefore, in February 1999, DOE issued a Notice of Intent (64 FR 8558, February 22, 1999) to prepare a second 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 52752, October 17, 2001). DOE selected the EC Caustic Side Solvent Extraction Alternative for separation of radioactive cesium from SRS salt wastes.

Solvent Extraction is DOE's preferred alternative. The Solvent Extraction Alternative would use a highly specific organic extractant to separate high-activity cesium from the HLW salt solution. The low-activity salt solution could be TC evaluated for disposal in the Saltstone Disposal Facility. The high-activity cesium would be transferred from the aqueous salt solution into an insoluble organic phase, using a centrifugal contactor to provide high surface area contact, followed by centrifugal separation of the two phases. Recovery of the cesium by back extraction from the organic phase in to a secondary aqueous phase would generate a concentrated cesium solution (strip effluent) for vitrification in DWPF. Prior treatment of the HLW salt solution, using monosodium titanate to separate soluble strontium and actinides and filtration to remove the solids and residual sludge, would be required to meet salt solution decontamination requirements and avoid interference in the solvent extraction process. The monosodium titanate solids would be transferred to DWPF for vitrification along with the strip effluent solution. The low-activity salt solution would be transferred to the Saltstone Manufacturing and Disposal Facility for disposal as grout in onsite vaults. EC

A.3.5 SLUDGE WASHING SYSTEM

L-7-73 The waste streams generated by the F- and H-Area Canyons form insoluble and highly radioactive metal hydroxides (manganese, iron, and aluminum) that settle to the bottom of the waste tanks to form a sludge layer. In addition to the fresh waste aging, the accumulated sludge is aged to allow radioactive decay. The aged sludge is transferred to the sludge processing tanks for washing and, if necessary, aluminum dissolution with a sodium hydroxide solution. The sludge processing takes place in two Type III tanks in H Area. The washed sludge slurry is transferred to the DWPF for vitrification into a solid glass matrix that is easier to handle and much more suitable for disposal.

A.4 Tank Farm Closure Activities

A.4.1 WASTE REMOVAL

EC In the Federal Facility Agreement between DOE, the U.S. Environmental Protection Agency (EPA), and the State of South Carolina, DOE committed to removing wastes from older tanks that do not meet secondary containment requirements (Types I, II, and IV). DOE has reviewed bulk waste removal from the HLW tanks in the *Waste Management Operations, Savannah River Plant EIS* and the *Long-term Management for Defense High-Level Radioactive Wastes (Research and Development Program for Immobilization) Savannah River Plant EIS* (ERDA 1537). EC In addition, the *SRS Waste Management EIS* (DOE/EIS-0023) 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 management of HLW after it is removed from the tanks. EC As described in this EIS, however, tank closure activities would comply with the proposed plan and schedule provided under the Agreement. Also, even under the No Action Alternative, DOE would continue to remove waste from the tanks as their missions cease. All tanks would be empty by 2028.

The schedule for removing waste from the tanks is closely linked to salt and sludge processing capacity and the DWPF schedule. The priorities for determining the sequence of waste removal from the tanks are as follows:

1. Maintain emergency tank space in accordance with safety analyses
2. Control tank chemistry, including radionuclides and fissile material inventory
3. Enable continued operation of the evaporators
4. Ensure blending of processed waste to meet salt processing, sludge processing, defense waste processing, and saltstone feed criteria
5. Remove waste from tanks with leakage history
6. Remove waste from tanks that do not meet the Federal Facility Agreement requirements
7. Provide continuous radioactive waste feed to the DWPF

8. Maintain an acceptable precipitate balance with the salt processing facility

9. Support the startup and continued operation of the Replacement High-Level Waste Evaporator

10. Remove waste from the remaining tanks.

The general technique for waste removal is hydraulic slurrying. First, slurry pump support structures are installed above the tank top, along with electrical service and motor controls. Then, slurry pumps are installed in the risers of the tank, usually three for salt removal and four for sludge removal. For the salt tanks, the pump discharges are positioned just above the level of the saltcake. Water is added to the tanks and the pumps turned on to agitate and dissolve a layer of salt. When the water becomes saturated with salt, the solution is pumped out. For sludge tanks, the pumps are placed into the top layer of sludge. As with salt removal, water is added and the pumps turned on to agitate the sludge. When the sludge is well mixed, the slurry is pumped out. For both salt and sludge, the pumps are then lowered to continue the process. Pumps may be lowered one or more times before a salt or sludge transfer is made. DOE is also exploring other methods for more efficient waste removal.

A.4.2 DETERMINATION AND USE OF PERFORMANCE OBJECTIVES

DOE has identified pertinent substantive requirements with which it will comply and guidance it will consider (Chapter 7) to ensure that closure of the tank systems will be protective of human health and the environment. DOE will use these requirements and guidance to develop an overall closure performance objective that provide a basis for comparison of different closure configurations. (TC) The performance objective applies to the completed closure of all 51 tank systems; however, DOE must close the tanks one at a time over a period of decades. (TC) (DOE anticipated that the need for HLW tanks will cease some time before 2030. The tanks would be closed as their individual missions end.) Therefore, the Department evaluates the impacts of each tank closure in the context of the entire tank farm. This methodology ensures that, as tanks are closed, the total closure impacts do not exceed the overall performance objective. (TC)

To further ensure that closure of the tank system will be protective of human health and the environment, DOE also evaluates contamination from non-tank-farm-related sources. Studies of groundwater transport (DOE 1996) in the General Separations Area indicate that contaminant plumes from F and H Area tanks would not intersect. Therefore, DOE has established independent Groundwater Transport Segments for the two tank farms that represent the contaminant plumes from the tank farms. DOE requires that contributions from all contaminant sources within a Groundwater Transport Segment, both tank-farm-related and non-tank-farm-related, be considered in comparing modeled impacts to the performance objectives. (EC)

A.4.3 TANK CLEANING

If needed, DOE's first method for tank cleaning (EC) is spray water washing. In this process, heated water would be sprayed throughout a tank, using (EC) spray jets installed in the tank risers. After spraying, the contents of the tank would be (EC) agitated with slurry pumps and pumped to another HLW tank still in service.

After the spray washing, remotely operated video cameras are used to survey the interior of the tank to identify areas needing further cleaning. Based on experience with two tanks that have been spray-washed, DOE has learned that some sludge tends to remain on the bottom of the tank and that the sludge tends to be distributed around the edge of the tank bottom after the single water wash performed as the last phase of waste removal.

To determine the characteristics of the residual material that would remain in the closed HLW tanks, DOE obtained and analyzed sludge samples from waste tanks containing each of the major waste streams that have gone to the tank farms. These samples were washed in the (L-1-5) laboratory, approximating what might remain after waste removal, and the concentrations of various components in the washed sludge were measured. DOE used the results of these samples in developing the process knowledge database that was used for the modeling described in Appendix C. Samples of the actual residuals that would remain in each tank after waste removal would be collected and analyzed after the completion of waste removal in that tank.

L-1-5

Eleven HLW tanks at SRS have shown evidence of cracks in the primary tank shell. In two of the tanks, the cracks are above the current liquid level and there is no evidence that waste escaped primary containment. In the remaining nine tanks, leaked salt has been observed on the exterior of the primary tank shell. The cracks in these tanks are hairline cracks and the annuli in these tanks are ventilated to dry the waste. The waste seeped through the cracks slowly and dried in the annulus. This waste appears as dried salt deposits on the side of the primary tank and sometimes on the floor of the secondary tank (WSRC 2000). DOE has developed methods to clean the annulus, using recirculating water jets installed through annulus risers. The water is heated and circulated through the annulus into the primary tank.

In five of the tanks (Tanks 1, 11, 12, 13, and 15), photographic inspections indicate that the amount of leaked waste is small. The waste is limited to salt deposits on the walls of the tank or perhaps covering part of the floor of the annulus. The leaked waste is virtually all salt because sludge is relatively immobile and will not migrate significantly through hairline cracks. The small amount of salt in these annuli should be relatively easy to remove with water.

In the remaining four tanks (Tanks 9, 10, 14, and 16), enough waste has leaked to completely cover the floor of the annulus. The annuli of these four tanks will be the most difficult of all the tanks to clean. Because of the large amount of waste that leaked in these four tanks, some waste may have leaked underneath the primary tanks. Also, waste has entered the ventilation ducts in the annuli. Special waste removal techniques will need to be developed for these tanks to ensure that water penetrates to the locations of the waste.

EC

In three of the four tanks (Tanks 9, 10, and 14), the waste in the annulus is primarily salt, so it should be relatively easy to remove once it is dissolved. The difficulty is primarily getting the water to where it is needed and then removing the salt solution. Since the problem is limited to a few tanks, plans are to develop these techniques when needed. The techniques may differ between tanks (for example, a different annulus cleaning technique would be needed if waste has seeped underneath the primary tank).

Tank 16 is the most badly cracked tank and represents a special case for annulus cleaning. In this tank, a number of welds were sandblasted to understand the stress corrosion cracking phenomena. The sand fell on top of the salt and then mixed with the salt during a waste removal effort in 1978 that removed about 70 percent of the salt. Recent samples have shown that the sand and compounds that formed when the sand mixed with the salt make it more difficult to dissolve the waste in this annulus. Chemical cleaning (such as oxalic acid) may be needed to dissolve the waste in the Tank 16 annulus. Because this will be a one-time operation, plans are to develop the cleaning techniques when needed.

EC

It is possible that some tanks may prove to be more difficult to clean than others. To meet performance criteria for tank closure, DOE may need to perform more rigorous cleaning than spray water washing. The method DOE expects to use is oxalic acid cleaning. In this process, hot oxalic acid is sprayed through the nozzles that were used for spray washing. Oxalic acid was selected above other cleaning agents for the following reasons (Bradley and Hill 1977):

- Oxalic acid dissolves portions of the sludge and causes the particles to break down, allowing removal of sludge deposits that are difficult to mobilize using spray washing alone.

- Oxalic acid is only moderately aggressive against carbon steel. Corrosion rates are on the order of 0.001 inch per week. This rate is acceptable for a short-term process such as cleaning. More aggressive agents such as nitric acid would be more effective in tank cleaning, but they could potentially cause release of contaminants to the environment in a mobile form.

- Oxalic acid has been demonstrated in Tank 16 only and shown to provide cleaning that is much more effective than spray water washing for removal of radioactivity. However, at the present time, potential safety considerations restrict the use of oxalic acid in the HLW tanks. The *Liquid Radioactive Waste Handling Facility Safety Analysis Report* (WSRC 1998b) specifically states that oxalic acid cleaning of any waste tank is prohibited. A Nuclear Criticality Safety Evaluation would be necessary to address oxalic acid use, because oxalic acid would reduce the pH of the cleaning solution to the point where a quantity of fissile materials greater than currently anticipated would go into solution. This could create the potential for a nuclear criticality. In addition, an Unreviewed Safety Question evaluation and subsequent SAR revision would be necessary.

Between 1978 to 1980, Tank 16 was the subject of a rigorous waste removal, water washing, and oxalic acid cleaning demonstration. More than 99.9 percent of the original volume of sludge was removed during cleaning (approximately 10 kilograms of solid material was left). Based upon sample results, approximately 830 curies of strontium-90 (the predominant radionuclide) remained. The demonstration determined the increased effectiveness of oxalic acid cleaning. However, the process generates large quantities of sodium oxalate that must be disposed in the Saltstone Manufacturing and Disposal Facility. After oxalic acid cleaning is complete, the tank would be spray washed with inhibited water to neutralize the remaining acid.

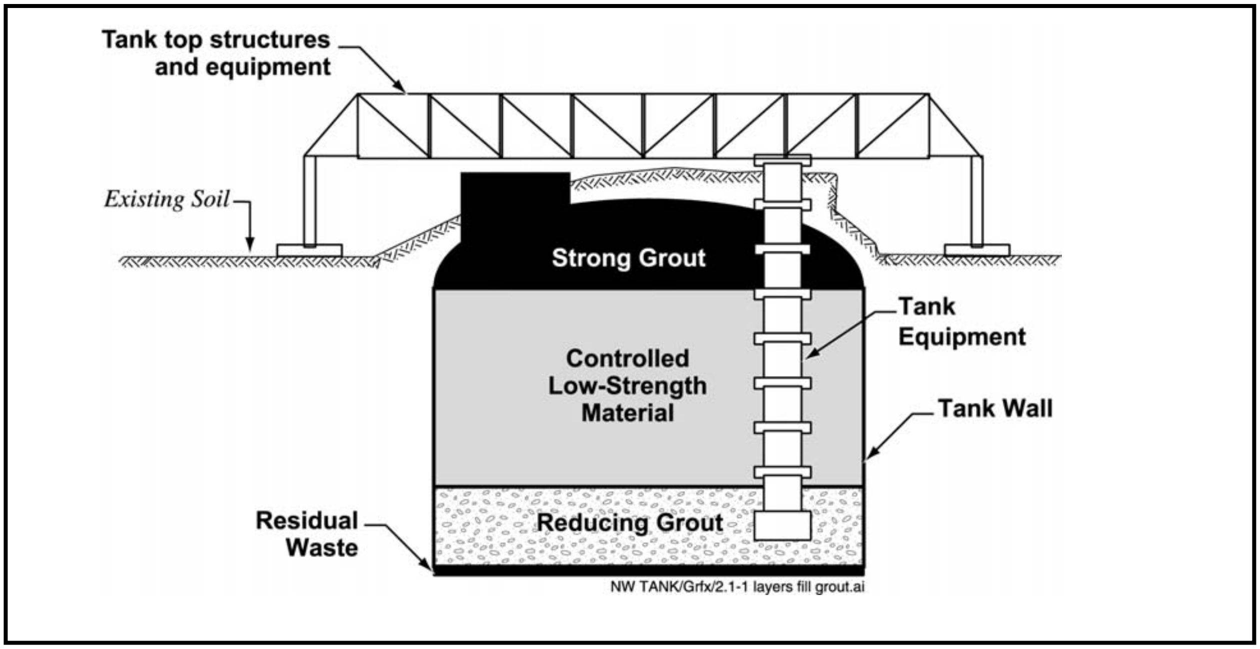
A.4.4 STABILIZATION

DOE has identified three options for tank stabilization under the Stabilize Tanks Alternative described in Chapter 2: grout fill, sand fill, and saltstone fill. In addition, another alternative would not stabilize the tank, but would remove the interior liner (which has been in contact with the HLW) from the concrete vault for disposal in some other location. The sections below describe the activities associated with the action alternatives.

Grout Fill

Each tank and its associated piping and ancillary equipment would be filled with a pumpable, self-leveling grout (a concrete-like material). The material would have a high pH to be compatible with the carbon steel of the tank. The fill material would also be formulated with chemical properties that would retard the movement of radionuclides and chemical constituents from the closed tank. A combination of different types of grout would be used. They would be mixed at a nearby batch plant constructed for the purpose and pumped to the tank. Figure A-5 shows how the sandwich layers of grout would be poured. DOE could also use an all-in-one grout, if it provided the same performance and protection. The potential combination of layers of grout is as follows:

- Reducing grout is a pumpable, self-leveling backfill material (similar in composition to that used at the SRS Saltstone Manufacturing and Disposal Facility), composed primarily of cement, flyash, and blast furnace slag. The chemical properties of the liquid that leaches through this backfill material will reduce the mobility of selected radionuclides and chemical constituents. The formulation of the backfill material for each waste tank will be adjusted, based on specific circumstances for each tank. The material is pumped into the waste tank through an available opening (e.g., tank riser). Observations of Tank 20



EC | **Figure A-5.** Typical layers of the Fill with Grout Option.

during pouring of the reducing grout indicate that the grout lifts some of the sludge on the bottom of the tank and carries it like a wave until it eventually envelops the sludge in the grout. Nevertheless, DOE's use of the reducing grout is not dependent on fully enveloping the sludge, but upon the grout's ability to chemically alter any water leaching through the grout to the sludge.

EC | • Controlled Low-Strength Material (CLSM) is a self-leveling concrete composed of sand and cement formers. Similar to reducing grout, it is pumped into the tank. The compressive strength of the material is controlled by the amount of cement in the mixture. The advantages of using CLSM rather than ordinary concrete or grout for most of the fill are:

  – The compressive strength of the material can be controlled so it will provide adequate strength for the overlying strata and yet could potentially be excavated with conventional excavation equipment. Although excavation of the tank is not anticipated, filling the tank with low-strength material would enhance the opportunity for future removal of tank contaminants or perhaps the tank itself, if future generations were to decide that excavation is desirable.

EC |

  – CLSM has a low heat of hydration, which allows large or continuous pours. The heat of hydration in ordinary grout limits the rate at which the material can be placed because the high temperatures generated by thick pours prevent proper curing of the grout. Thus, large pours of grout are usually made in layers, allowing the grout from each layer to cool before the next layer is poured.

  – CLSM is relatively inexpensive.

  – CLSM is widely used at SRS, so there is considerable experience with its formulation and placement and in controlling the composition to provide the required properties.

• Strong grout is a runny grout with compressive strengths in the normal concrete range. This formulation is advantageous near the top of the tank because:

- The runny consistency of the grout is advantageous for filling voids near the top of the tank created around risers and tank equipment. The grout would be injected in such a manner to ensure that voids were filled to the extent practicable. This may involve several injection points, each with a vent.

- A relatively strong grout will discourage an intruder from accidentally accessing the waste, if institutional control of the area is discontinued.

Other potential combinations of multiple or single grout layers may be used.

The specific actions needed before and during closure include tank isolation, tank modifications to facilitate introduction of grout, production and installation of grout, and riser cleanup. These activities are described below in more detail.

Mechanical and electrical services would be isolated from the tank such that future use is prohibited. Tank isolation is an activity that must be performed regardless of the closure option. Accessible piping and conduits would be removed and pulled back from each riser so that a physical break is made from the tank. Any transfer lines would be cut and capped.

DOE would leave the tank structures intact. No support steel would be removed unless it is necessary to be removed to disconnect services from the tank risers. Equipment already installed in the tank and equipment directly used in tank closure operations (such as temporary submersible pumps, cables, temporary transfer hoses, backfill transfer pipes or tremmies, and sample pump) would be entombed in the backfill material as part of the closure process. Items removed in preparation for closure under this module (such as slurry pump motors, instrument racks, piping, and insulation) may be decontaminated to such levels that they may be sent to the Solid Waste Management Facilities as scrap. Otherwise, they would be appropriately characterized and shipped as low-level waste.

The tank risers would be modified to permit backfill material to be placed into the tank. Provisions would be made to provide a delivery point into the tank, to manage air displacement, to address bleed water build-up, and to handle any tank top overflow.

Risers would be prepared to allow addition of the backfill material. Equipment located at the riser would be disconnected. A backfill transfer line would be inserted through an access port to allow introduction of the backfill into the tank. Tank venting would be predominantly through the existing permanently installed ventilation system until the backfill material nears the top of the tank. However, a newly constructed vent device, equipped with a breather high-efficiency particulate filter, would be supplied for the final filling operation.

During the filling process, excess water (bleed water) is expected to float to the top of the grout and CLSM. The amount of bleed water would be minimized during the actual closure operation by limiting the amount of water in the grout and CLSM and by specifying the fill material cure times. It is expected that any bleed water produced would be re-absorbed back into the fill material. The amount of re-absorption would be dictated by the cure times. Any bleed water not absorbed would be removed from the tank and (1) returned to the tank farm systems by siphoning it off and transferring it through a temporary aboveground transfer line to another waste tank or (2) processed at the Effluent Treatment Facility. The possible overflow of bleed water and grout from around the riser joints would be controlled by constructing forms around the risers and sealing those forms for watertightness as part of pre-closure preparation for riser grouting operations. Each riser would be prepared for local filling and venting to ensure that the top void spaces are filled. EC

Portable concrete batch plants would supply the grout and CLSM backfill needed to fill the tanks. The plants may require a South Carolina Department of Health and Environmental Control (SCDHEC) Bureau of Air Quality permit to operate. All process water would be recycled. EC

Backfill material produced at the plants would be introduced into the risers of the tanks through piping from the plants located just outside the tank farm fences.

The actual backfill material installation would be governed by SRS procedures in accordance with Design Engineering requirements, as outlined in the construction and subcontractor work packages. The filling progress would be monitored by an in-tank video camera. The backfill material level would be measured, using visual indications. During riser closure operations, containment provisions would be made to restrict or contain grout overflows. Tank components such as the transfer pump, slurry pumps, wiring, cables, steel tapes, hoses, and sample collection apparatus would be encapsulated during tank grouting operations.

The risers and void spaces in the installed equipment remaining in the tank would be filled with highly flowable reducing grout material to ensure that all voids are filled to the fullest extent possible. The tank fill and riser backfilling operations would be performed in such a way as to eliminate rainwater intrusion into the tank. Upon completion of the tank closure, the riser tops would be left in a clean and orderly condition. Risers would be encapsulated in concrete, using forms constructed of rolled steel plates or removable wooden forms previously installed around each riser. The riser encapsulation would be completed at the end of the tank dome fill operation.

EC | Piping and conduit at each riser that is not removed would be entombed in the riser filling operations. Each riser and the lead lining would be encased in concrete, and decontamination of the remaining riser formwork structures and adjacent areas will be performed, if necessary. The tank appurtenances, such as the riser inspection port plugs, riser plug caps, and the transfer valve box covers, which would have been removed to ensure complete backfilling of the tank, would be entombed at the same time that the associated risers are filled and backfilled.

Sand Fill

This option is similar to the Fill with Grout Option, except that sand would be used instead of grout. There would be no layers for intruder protection or chemical conditioning of leaching water. The sand would be carried by truck to an area near each tank farm and conveyed to the | EC
tank.

Sand is readily available and is inexpensive. However, its emplacement is more difficult than grout as it does not flow readily into voids. Over time, sand would settle in the tank, creating additional void spaces. The tank top would then become unsupported and would sag and crack, although there would not be the catastrophic collapse that would be anticipated in the No Action case. Also, the sand would tend to protect the contamination to some extent and prevent winds from spreading the contaminants. However, sand is highly porous and rainwater infiltrates rapidly and does not run off. Also, sand is relatively inert and could not be formulated to retard the migration of radionuclides and chemical constituents. Thus, the expected contamination levels in groundwater would be higher than for the Fill | EC
with Grout Option.

A variation of this alternative could involve filling the tanks with contaminated soils excavated during the remediation of SRS waste sites. Placement of soils in the tanks would present similar disadvantages to those described above for sand fill. In addition, handling contaminated soils would complicate the project, resulting in increased costs. Soils could not be readily formulated to retard the migration of radionuclides and chemical constituents; the | EC
additional contamination associated with the soil fill would have to be factored into the performance evaluation for the closure configuration. Because of these disadvantages, the use of contaminated soils as a fill material is not evaluated further in this EIS.

Saltstone Fill

This option is the same as the Fill with Grout Option, except that saltstone would replace the reducing grout and the CLSM. Saltstone is a low-radioactivity fraction that meets the waste Incidental to Reprocessing requirements and is mixed with cement, flyash, and slag to form a concrete-like mixture. This option has the advantage of reducing the amount of disposal space needed at the Saltstone Manufacturing and Disposal Facility; however, it has several disadvantages:

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- Because of the fast saltstone set-up times, two new saltstone mixing facilities (one in F Area and one in H Area) would be required.
- The amount of saltstone to be made is projected to be greater than 160 million gallons. This volume is considerably greater than the capacity of the HLW tanks. Therefore, the existing Saltstone Manufacturing and Disposal Facility in Z Area would still need to be operated.
- Filling the tank with a grout mixture that is contaminated would considerably complicate the project and increase worker radiation exposure, further adding to expense and risk.
- Saltstone grout cannot be poured as fast as CLSM because of its relatively high heat of hydration. Saltstone grout would have to be poured in discrete pours, allowing sufficient time between pours for the grout to cool.

Clean and Remove Tanks

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This alternative involves cleaning of the tanks beyond that described in Section A.4.3. Such cleaning could include mechanical cleaning or other steps not yet defined. The steel components (including any piping and ancillary equipment) would be sectioned, removed, placed in burial boxes for disposal, and transported to SRS low-level waste disposal facilities.

For tank removal operations, DOE would enclose the tops of the tanks with structures designed to contain airborne contamination. These structures would be fitted with air locks and operate at negative pressure during cutting operations. Air discharges from the tanks and enclosures would be filtered with high-efficiency particulate air filters. DOE would backfill the void created by tank removal with a soil type similar to soils currently surrounding the tank.

The advantages of this option are:

- This alternative has the advantage of allowing disposal of the contaminated tank system in a waste management facility that is already approved for receiving low-level waste.
- This option exposes the surrounding soils such that they could be exhumed. This is the only option that has the potential to leave the waste tank area as an unrestricted area for future uses.

The disadvantages include:

- High radiation exposure to workers during the removal process
- Extremely high cost to remove the tank
- Considerable impact on other SRS operations
- Extremely high cost to dispose of the tank components elsewhere. Also, disposal of the tank could create another zone of restricted use (i.e., the restricted use zone is merely shifted, rather than being eliminated).

A.4.5 ENVIRONMENTAL RESTORATION PROGRAM ACTIVITIES

After a tank is closed, the SRS Environmental Restoration Program will conduct field investigations and remedial actions. The Environmental Restoration Program is concerned with all aspects of assessment and cleanup of both contaminated facilities in use and sites that are no longer a part of active operations. Remedial actions, most often concerned with contaminated soil and EC groundwater, are responsibilities of this program. The investigations will take place after nearby tanks in an operational grouping are closed (to avoid interference with the other operational tanks) and conditions are determined to be safe for Environmental Restoration intrusive sampling. Once an operational grouping is closed, the HLW operations organization and the Environmental Restoration organization will establish a Co-Occupancy Plan to ensure safe and efficient soils assessment and remediation. The HLW organization will be responsible for operational control and the Environmental Restoration organization will 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 where the existing HLW management and operational procedures can be continuously utilized.

The *High-Level Waste Tank Closure Program Plan* (DOE 1996) provides general information on post-closure activities and tank-specific closure modules will also address post-closure activities. However, the investigation, determination of remediation requirements, and implementation of potential remedial actions related to soil and groundwater contamination at the tank farms will be conducted in accordance with RCRA/CERCLA requirements pursuant to the Federal Facility Agreement. The Environmental Restoration organization would have the responsibility for these activities. Plans for such postclosure measures as monitoring, inspections, and corrective action plans would also be governed by the Federal Facility Agreement and would be premature to state at this time because conditions that would exist at the restored area are not known. For example, the area may be capped or an *in situ* groundwater treatment system may be installed.

Figure A-6 presents an example of the closure EC
configuration for a group of tanks. The
necessity for a low-permeability cap, such as a
clay cap, over a tank group to reduce rainwater
infiltration would be established in accordance EC
with the Environmental Restoration Program
described in the Federal Facility Agreement
(EPA 1993). Figure A-6 shows a conceptual cap EC
design. The cap construction would ensure that
rain falling on the area drains away from the
closed tank(s) and surrounding soil. A soil
cover could be placed over the cap and seeded to
prevent erosion.

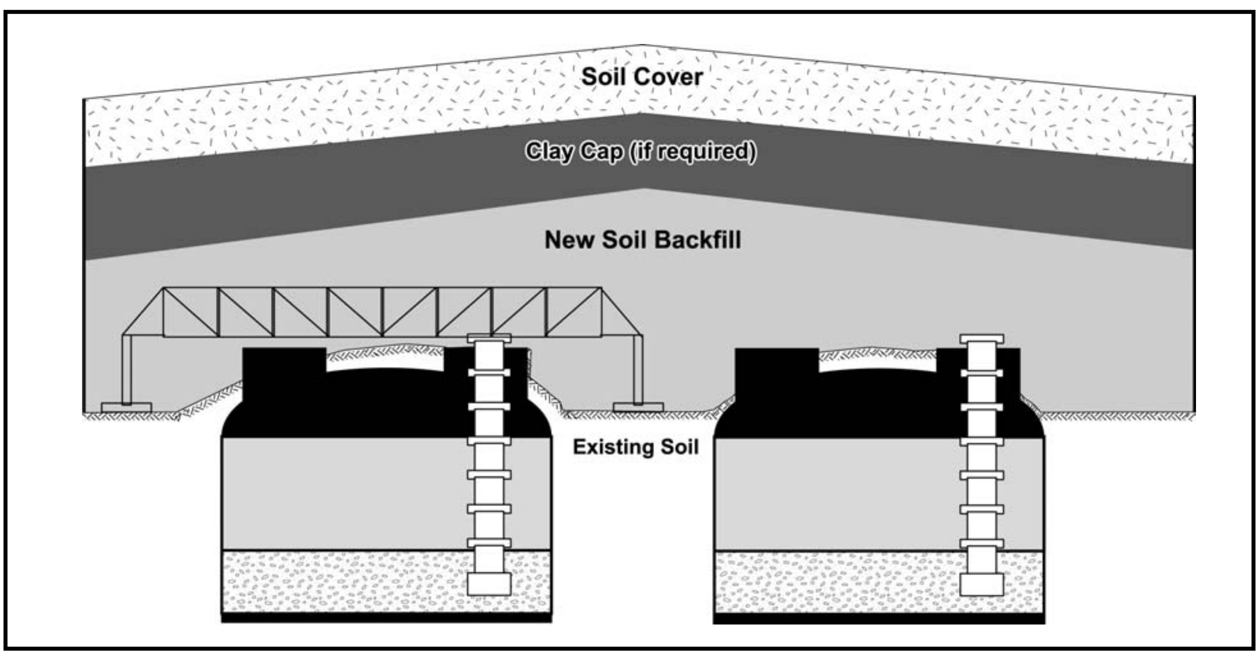

Figure A-6. Area closure example.

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APPENDIX B

ACCIDENT ANALYSIS

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APPENDIX B. ACCIDENT ANALYSIS

EC EC This appendix provides detailed information on potential accident scenarios associated with closure of the high-level waste (HLW) tanks at Savannah River Site (SRS). The appendix provides estimates of the quantity and composition of hazardous materials that could be released in an accident and the consequences to workers and the public, estimated in terms of dose and latent cancer fatalities for radiological releases and of concentration levels for chemical releases.

The primary sources of information for the accident analyses are a specific calculation (Yeung 1999) and the *Safety Analysis Report - Liquid Radioactive Waste Handling Facility* (WSRC 1998a).

B.1 General Accident Information

EC An accident, as discussed in this appendix, is an inadvertent release of radiological or chemical hazardous materials as a result of a sequence of one or more probable events. The sequence usually begins with an initiating event, such as a human error, equipment failure, or earthquake. This is 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.

The likelihood of an accident occurring and its consequences usually depend on the initiator and the sequence of events and their frequencies or probabilities. Accidents can be grouped into four categories–anticipated, unlikely, extremely unlikely, and beyond extremely unlikely, as described in Table B-1. The U.S. Department of Energy (DOE) based the frequencies of accidents at the liquid radioactive waste handling facility on safety analyses and historical data about event occurrences. EC

B.2 Accident Analysis Method

For the alternatives for HLW tank closure, Yeung (1999) identified potential accident scenarios that involved the release of both radiological and nonradiological, hazardous materials. Section B.2.1 provides information about the various alternatives for tank closure. EC Section B.2.2 provides details about the specific analytical methods that were used in this appendix. EC

The accident sequences analyzed in this environmental impact statement (EIS) would occur at frequencies generally greater than once in 1,000,000 years. However, the analyses considered accident sequences with smaller frequencies, if their impacts could provide information important to decision making. EC

Table B-1. Accident frequency categories.

Accident frequency category	Frequency range (occurrences per year)	Description
Anticipated	Less than once in 10 years, but greater than once in 100 years	Accidents that might occur several times during facility lifetime
Unlikely	Less than once in 100 years, but greater than once in 10,000 years	Accidents that are not likely to occur during facility lifetime; natural phenomena include Uniform Building Code-level earthquake, maximum wind gust, etc.
Extremely unlikely	Less than once in 10,000 years, but greater than once in 1,000,000 years	Accidents that probably will not occur during facility life cycle; this includes the design basis accidents
Beyond extremely unlikely	Less than once in 1,000,000 years	All other accidents

Source: DOE (1994).

B.2.1 HIGH-LEVEL WASTE TANK CLOSURE ALTERNATIVES

DOE has organized the accident data in this appendix by alternative. DOE has also organized the accident impacts in Chapter 4 by alternative to reflect potential accident occurrences for each associated alternative. EC

Approximately 37 million gallons of HLW are stored in underground tanks in F Area and H Area. DOE intends to remove from service all 51 HLW tanks. Because two of these tanks (Tanks 17 and 20) are already closed, this appendix addresses the potential impacts from accidents associated with the closure of the 49 remaining waste tanks.

The alternatives considered in this EIS include:

- 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

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B.2.2 RADIOLOGICAL HAZARDS

The accidents identified for HLW tank closure are described in Section B.3. These descriptions include an approximation of the material at risk (MAR) that would potentially be involved in a given accident. Depending on the particular scenario, release fractions have been applied to the MAR to determine the amount of the materials that would be released to the environment. This amount is referred to as the source term. Source terms are provided in Yeung (1999) for airborne, ground surface runoff, and underground releases. The airborne releases are of short duration and could have impacts to the worker and offsite populations. The surface runoff and underground releases, however, would not have short-term impacts to any of the analyzed receptors. In the case of surface runoff, DOE would employ mitigative actions to prevent the release from reaching the Savannah River (i.e., clean-up actions, berms, dams in surface water pathways, etc.). In the unlikely event that radionuclides reached the river, DOE's mitigative actions would include notification of municipalities downstream that use the Savannah River for drinking water supplies. These mitigative actions would preclude any offsite dose from a liquid release pathway. In the case of underground releases, radiological materials released directly into the soil would take a long period of time to reach any of the human receptors evaluated in this analysis. The potential consequences of such

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releases are determined as part of the EIS long-term impacts.

The analysis of airborne releases used the computer code AXAIRQ to model accidental atmospheric radioactive releases from SRS that are of relatively short duration. AXAIRQ strictly follows the guidance in Regulatory Guide 1.145 (NRC 1982) on accidental releases and has been verified and validated (Simpkins 1995a and 1995b). Because all considered accidents would occur at or below ground level, the releases for AXAIRQ assumed ground-level releases with no modification for release height. In accordance with the Regulatory Guide, the code considers plume meander and fumigation under certain conditions. Information on plume rise due to buoyancy or momentum is not available. The program uses a 5-year meteorological database for SRS and determines the shortest distance to the Site boundary in each of the 16 sectors by determining the distance to one of 875 locations along the boundary. The impacts that were derived from the use of this code used the average (50 percent) meteorology. Because these accidents could occur in either F or H Area at SRS, the largest unit dose conversion factor was chosen (applicable to F or H Area), dependent on the receptor being evaluated. The code uses the shortest distance in each sector to calculate the concentration for that sector. DOE used the computer code PRIMUS, which was developed by the Oak Ridge National Laboratory, to consider decay and daughter ingrowth.

Simpkins (1997) provided unit dose conversion factors for a wide list of radionuclides for release locations in F and H Areas. These factors were applied to the airborne source terms to calculate the doses to the various receptors.

The analysis assumes that all tritium released would have the form of tritium oxide and, following International Commission on Radiological Protection methodology, the dose conversion factor for tritium has been increased by 50 percent to account for absorption through the skin. For population dose calculations, age-specific breathing rates are applied, but adult dose conversion factors are used. Radiation doses were calculated to the maximally exposed individual, to the population within 50 miles of the facility, and to a noninvolved worker assumed to be 640 meters downwind of the facility.

After DOE calculated the total radiation dose to the public, it used dose-to-risk conversion factors established by the National Council on Radiation Protection and Measurements (NCRP) to estimate the number of latent cancer fatalities (LCFs) that could result from the calculated exposure. No data indicate that small radiation doses cause cancer; however, to be conservative, the NCRP assumes that any amount of radiation has some risk of inducing cancer. DOE has adopted the NCRP factors of 0.0005 LCF for each person-rem of radiation exposure to the general public and 0.0004 LCF for each person-rem of radiation exposure to radiation workers (NCRP 1993).

B.2.3 CHEMICAL HAZARDS

For chemically toxic materials, the long-term health consequences of human exposure to hazardous materials are not as well understood as those related to radiation exposure. A determination of potential health effects from exposures to chemically hazardous materials, as compared to radiation, is more subjective. Therefore, the consequences from accidents involving hazardous materials are expressed in terms of airborne concentrations at various distances from the accident location, rather than in terms of specific health effects.

To determine the potential health effects to workers and the public that could result from accidents involving hazardous materials, the airborne concentrations of such materials released during an accident at varying distances from the point of release were compared to the Emergency Response Planning Guideline (ERPG) values (AIHA 1991). The American Industrial Hygiene Association established these values, which depend on the chemical substance, for the following general severity levels to ensure that the necessary emergency actions occur to minimize exposures to humans.

- ERPG-1 Values. Exposure to airborne concentrations greater than ERPG-1 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience mild transient adverse health effects or perception of a clearly defined objectionable odor.

- ERPG-2 Values. Exposures to airborne concentrations greater than ERPG-2 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience or develop irreversible or other serious health effects or symptoms that could impair a person's ability to take protective action.

- ERPG-3 Values. Exposure to airborne concentrations greater than ERPG-3 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience or develop life-threatening health effects.

Not all hazardous materials have ERPG values. For chemicals that do not have ERPG values, a comparison was made to the most restrictive available exposure limits established by other guidelines to control worker accidental exposures to hazardous materials. In this document, the ERPG-2 equivalent that is used is the PEL-TWA (Permissible Exposure Limit – Time Weighted Average) from 29 Code of Federal Regulations (CFR) Part 1910.1000, Subpart Z.

B.3 Postulated Accident Scenarios Involving Radioactive Materials

These sections describe the potential accident scenarios associated with each alternative that could involve the release of radioactive materials. The impacts of these scenarios are shown in Section B.4.

B.3.1 STABILIZE TANKS ALTERNATIVE

The Stabilize Tanks Alternative, including all of its stabilization options, could require cleaning the inside of the tank. This cleaning could involve a two-step process. Initially, after bulk waste removal, the waste tank interiors would be water-washed, using rotary spray jets put down into the tank interior through the tank risers. Water for these jets would be supplied from a skid-mounted tank and pump system. Following water washing, additional cleaning may be required, using a hot oxalic acid solution through the same spray jets.

Six potential accident scenarios associated with the cleaning process that required evaluation were identified in Yeung (1999). These included:

- Deflagration
- Transfer errors
- Vehicle impacts
- Chemical (oxalic acid) spill
- Seismic event
- Tornado

Criticality was not addressed as a potential accident scenario in Yeung (1999) because DOE considers inadvertent criticality to be beyond extremely unlikely in the HLW tanks (Nomm 1995). The criticality safety of the waste sludge was based on the neutron-absorbing characteristics of the iron and manganese contained in the sludge. However, the review assumed that the waste would remain alkaline and did not address the possibility that chemicals wold be used that would dissolve sludge solids. Therefore, the *Safety Analysis Report - Liquid Radioactive Waste Handling Facility* (WSRC 1998) specifically states that oxalic acid cleaning of any waste tank is prohibited.

A formal Nuclear Criticality Safety Evaluation (Unreviewed Safety Question Evaluation and subsequent Safety Analysis Report revision) must be completed before oxalic acid could be introduced into the tank farms. Oxalic acid can dissolve uranium, plutonium, and the two neutron poisons that are credited for preventing a criticality - iron and manganese. The Nuclear Criticality Safety Evaluation would address the relative rates at which each of these species dissolves and would examine potential scenarios that could cause fissile material to concentrate.

The tanks would be back-filled with a pumpable material (grout, sand, or saltstone). Yeung (1999) indicated that the scenarios identified above for the cleaning operations bound all postulated accidents during back-filling the waste tanks with either grout or sand. Because saltstone is a radioactive material, any uncontrolled release of radioactive materials associated with the Fill with Saltstone Option must be evaluated. WSRC (1992a) evaluated a failure of the Salt Solution Hold Tank. Yeung (1999) identified no accident scenarios for the post-closure period for this alternative.

B.3.1.1 <u>Deflagration</u>

Scenario: One postulated accident during cleaning of the waste tanks would be a release of radiological materials due to an explosion inside of the waste tank. The explosion could possibly consist of a deflagration or detonation. The transition from deflagration to detonation would occur only if the deflagration flame front accelerates to sonic speeds. In order for the deflagration to occur, flammable chemicals must be introduced into the waste tanks as a result of human error, and ignition sources must be present (Yeung 1999).

Probability: The determination of the probability of this event was based on the availability of flammable chemicals, the potential that they would be introduced into the waste tanks, and the fact that an ignition source is present. There are no flammable chemicals required for the cleaning process. For a deflagration to occur, multiple operator errors and violation of multiple administrative controls would be required. From Benhardt et al. (1994), the combined probability of violation of an administrative control bringing in the flammable chemical and chemical addition into the tank would be 1.5×10^{-6} per year. Considering that, in addition to the above, a significant amount of flammable material would be required to be introduced into a tank (e.g., 440 kilograms of benzene), by engineering judgment, the additional probability of this event was estimated to be 1×10^{-2} per year (Yeung 1999). Therefore, the probability of a deflagration during the cleaning process was estimated to be 1.5×10^{-8} per year. Because the tanks are relatively free of internal structures, the transition from deflagration to detonation occurs less than one time in a hundred for a near stoichiometric mixture. Therefore, the frequency of a detonation event was estimated to be 1×10^{-10} per year (Yeung 1999).

Because the likelihood of these events is well below 1×10^{-7}, they are considered beyond extremely unlikely and are not evaluated further in this EIS.

B.3.1.2 <u>Transfer Errors</u>

Scenario: The *Safety Analysis Report - Liquid Radioactive Waste Handling Facility* (WSRC 1998a) reports that all transfer error events in the Liquid Radioactive Waste Handling Facility can be bounded by a waste tank overflow event, which would result in an aboveground spill of 15,600 gallons of waste (520 [gpm] for 30 minutes). A postulated accident during water spray washing of the waste tanks would be a release of diluted waste, due to continuous maximum flow through a transfer line direct to the environment for 30 minutes without operator intervention. WSRC (1998a) assumed that the spill would occur aboveground and result in seepage into the ground and evaporation into the air. This scenario would bound all leak/spill events, including loss of containment. L-7-83

Probability: It is considered unlikely that aboveground equipment failures leading to leakage or catastrophic release of the tank contents would go undetected (WSRC 1998a). Therefore, failures of aboveground equipment and the failure of the operators to detect and stop the leaks were considered in Yeung (1999). It was estimated that equipment failures and operator errors to detect and stop the leaks leading to the release of the bounding source terms described below could occur with a frequency of 1×10^{-3} per year (Yeung 1999). This frequency is in the unlikely range.

Source Term: After bulk waste removal and before spray washing, there would be approximately 9,000 gallons of HLW in the form of sludge or sludge slurry left in each tank. Based on the bounding sludge dose potential as given in the *Safety Analysis Report* (WSRC 1998a), it was assumed that the sludge slurry before spray washing would be characterized by the activities of 81,000 curies (Ci) of plutonium-238 (Pu-238) and 2,180,000 Ci of strontium-90 (Sr-90). The volume of the water used for spray cleaning was assumed to be 140,000 gallons (WSRC 1998b). This would result in a total waste volume of 149,000 gallons, with nuclide concentrations in the diluted waste solution estimated at 0.54 Ci/gallons and 14.63 Ci/gallons for Pu-238 and Sr-90, respectively. The instantaneous airborne release for a spill of 15,600 gallons was estimated to be 0.34 Ci of Pu-238 and 9.1 Ci of Sr-90 (Yeung 1999). An additional entrainment source term of 0.34 Ci of Pu-238 and 9.1 Ci of Sr-90 was estimated, assuming no mitigative actions were taken within a 10-hour period following the event.

B.3.1.3 Vehicle Impact

Scenario: Another postulated accident during cleaning of the waste tanks would be a release of diluted waste, due to failure of the aboveground pumping equipment and piping resulting from a construction vehicle impact. It was assumed that the equipment used to pump out the wastewater slurry from the tanks would be damaged to the point where pumping continued, releasing the slurry onto the ground.

Probability: The frequency of a vehicle crash occurring over all the Liquid Radioactive Waste Handling Facilities is bounded between 7.4×10^{-4} and 4.7×10^{-3} events per year (WSRC 1998a). The *Safety Analysis Report* (WSRC 1998a) conservatively assumes that 0.1 percent of the accidents occurring at the H Area and F Area Tank Farms impact aboveground equipment, resulting in an overall frequency of 2.7×10^{-6} per year. The possibility that a fire could occur following a crash was also evaluated. Assuming that 97.7 percent of all truck accidents are minor (WSRC 1992b), and that fires resulting from minor accidents have an extremely low probability, the overall frequency of a fire resulting from a vehicle crash is estimated to be 6.2×10^{-8} per year. Therefore, vehicle impacts involving a coincident fire were considered to be beyond extremely unlikely.

Source Term: The MAR for this scenario was assumed to be the same as that in Section 3.1.2. EC Because the source term for this scenario is the same as estimated for the transfer errors and the expected frequency is smaller, the risk associated with this scenario would be bounded by the transfer errors accident. No further evaluation of vehicle impacts is required in this EC appendix.

B.3.1.4 Chemical (Oxalic Acid) Spill

This accident would involve the release of nonradiological hazardous materials, which is addressed in Section B.5.

B.3.1.5 Seismic Event

Scenario: Yeung (1999) postulated that a design basis earthquake could occur during cleaning of the waste tanks, resulting in a release of liquid radiological materials. Only one tank in each tank farm would undergo closure at any one time. It was therefore assumed that the earthquake would occur immediately following water spray washing, which had been performed on two tanks simultaneously (one in each tank farm). The seismic event was assumed to fail the same transfer piping and equipment as was mentioned in the previous scenarios.

Probability: The design basis earthquake has an annual probability of exceedance of 5×10^{-4} (WSRC 1998c). Assuming that the cleaning of two tanks would take approximately 14 days, a release of the bounding source term would occur at an annual probability of 1.9×10^{-5}. This accident would be categorized as extremely unlikely.

Source Term: The aboveground MAR was assumed to be same as in Section 3.1.2, except that the source term would be doubled because two tanks would be involved. Yeung (1999) provided the source term as an instantaneous airborne release of 0.68 Ci of Pu-238 and 18 Ci of Sr-90. If mitigation measures were not taken, entrainment would result in an additional airborne release of 0.68 Ci of Pu-238 and 18 Ci of Sr-90 over a 10-hour period.

B.3.1.6 <u>Tornado</u>

The design basis tornado was postulated to occur during water spray washing of the waste tanks. From WSRC (1998a), it was assumed that administrative controls stipulate the cessation of waste transfer operations at the first instance of a tornado/high wind warning.

All waste tanks are underground and are protected by concrete roofs. With all transfer operations stopped, there would be no MAR aboveground. Some aboveground components of the transfer system may fail, but their contributions to the release of radiological materials were considered insignificant (Yeung 1999). As a result, this scenario would be bounded by several other scenarios and is not evaluated further.

B.3.1.7 <u>Failure of Salt Solution Hold Tank</u>

Scenario: This scenario assumes that a Saltstone Mixing Facility would be built in F Area and H Area, similar to that currently operating in Z Area. This accident would involve a worst-case release of the salt solution contained in a Salt Solution Hold Tank, prior to mixing with cement, flyash, and slag to form the saltstone. The Salt Solution Hold Tank was assumed to contain 45,000 gallons of salt solution. The entire volume was assumed to be released and allowed to evaporate over a 2-hour period (WSRC 1992a). No credit was taken for operator intervention, absorption into the ground, or containment of the spill in the diked area of the tank. In reality, this would significantly reduce the airborne release. It would take an extremely high-energy event to vaporize such a large quantity in such a short period of time (WSRC 1992a). Failure of the Salt Solution Hold Tank was assumed to occur during the design basis earthquake.

Probability: The design basis earthquake has an annual probability of exceedance of 5×10^{-4} (WSRC 1998c). Assuming that the Salt Solution Hold Tank has a 10 percent chance of failing during the earthquake, a release of the bounding source term was estimated to occur at an annual probability of 5×10^{-5}. This scenario would be extremely unlikely.

Source Term: The 45,000 gallons of salt solution (1.2 kilograms per liter) in the Salt Solution Hold Tank was assumed to contain the radionuclides in Table B-2 (WSRC 1992a). Table B-2 also contains the assumed release fractions resulting in the final estimated source terms (unmitigated) (WSRC 1992a). This accident would also involve the release of nonradiological hazardous materials. The evaluation of these releases is addressed in Section B.5.

B.3.2 CLEAN AND REMOVE TANKS ALTERNATIVE

Following bulk waste removal, water spray washing, and additional cleaning (including the use of oxalic acid), additional cleaning steps (yet to be defined) would be performed until the tanks are clean enough to remove. The additional cleaning steps would increase worker radiation exposure and contamination. They would also increase the potential for industrial safety accidents. Following cleaning, the tank components would be sectioned, removed, placed in burial boxes for disposal, and transported to onsite waste disposal facilities.

The scenarios in Section B.3.1 were assumed to bound any postulated tank accident scenarios associated with this alternative.

B.3.2.1 <u>Flooding</u>

Scenario: Yeung (1999) postulated that abandoning the waste tanks in place following waste removal would lead to long-term tank degradation, failure of the tank roofs, and exposure of the radiological materials to potential flooding and release to the environment. DOE has assumed that institutional control would be maintained for a period of at least 100 years. Beyond institutional control, it has been assumed that the waste tanks would retain their basic structural

Table B-2. Radiological source term for failure of Salt Solution Hold Tank.

Radionuclide	Activity (curies)[a]	Assumed release fraction	Total airborne activity released (curies)[a]
H-3	380	1.0	380
Co-60	15	1.0×10^{-4}	0.0015
Sr-89	13	1.0×10^{-4}	0.0013
Sr-90	13	1.0×10^{-4}	0.0013
Tc-99	210	1.0×10^{-2}	2.1
Ru-106	130	1.0×10^{-2}	1.3
Sb-125	31	1.0×10^{-2}	0.31
I-129	4.2	3.0×10^{-1}	1.3
Cs-137	21	1.0×10^{-2}	0.21
Ba-137m	21	1.0×10^{-2}	0.21
Eu-154	3.4	1.0×10^{-4}	0.00034
Total alpha	11	1.0×10^{-4}	0.0011
Other beta-gamma	840	1.0×10^{-4}	0.084
Total	1680		383

Source: WSRC (1992a)
a. Values rounded to 2 significant figures.

integrity for another 100 years without catastrophic failure. Therefore, this EIS considers any impacts associated with failure of these waste tanks after a period of 200 years to be long-term impacts and they are not addressed further in this appendix.

B.3.3 NO ACTION ALTERNATIVE

For the No Action Alternative, no action would be taken to remove waste from the tanks beyond that which is included in bulk waste removal. Flooding was the only scenario identified in Yeung (1999), applicable to this alternative, which would result in an airborne release of radiological materials.

B.4 Accident Impacts Involving Radioactive Materials

This section presents the potential impacts associated with the accident scenarios involving the release of radioactive materials identified in Section B.3. Table B-3 provides the accident impacts for each of the scenarios from airborne releases. It also provides the resultant LCFs expected from the offsite impacts.

B.5 Postulated Accidents Involving Nonradioactive Hazardous Materials

This section summarizes the potential accident scenarios involving hazardous chemicals for the various alternatives. Two accidents involving hazardous material releases were identified in Yeung (1999).

B.5.1 OXALIC ACID SPILL

Scenario: A postulated accident during cleaning of the waste tanks would be a worst-case spill of 10,000 gallons of 4 percent (concentration) oxalic acid from any cause (vehicle crash, earthquake, or tornado). It was assumed that oxalic acid used for cleaning would be stored in an aboveground 10,000-gallon stainless steel portable tank. The oxalic acid was assumed to be heated to a temperature of 80°C. This scenario would bound all accidents involving a chemical release of oxalic acid.

Table B-3. Radiological impacts from airborne releases.

Accident	Total curies released	Accident frequency	Non-involved worker (rem)	Maximally exposed individual (rem)	Offsite population (person-rem)	Latent cancer fatalities
Transfer errors	19	Once in 1,000 years	7.3	0.12	5,500	2.8
Seismic (DBE)	38	Once in 53,000 years	14.6	0.24	11,000	5.5
Salt Solution Hold Tank failure	380	Once in 20,000 years	0.015	0.00042	16.7	0.0084

Probability: The annual probability of exceedance for the design basis earthquake is 5.0×10^{-4} (WSRC 1998c). Assuming that the oxalic acid tank would be used for 30 days of the year, the overall frequency was calculated to be 4.1×10^{-5} per year. For the design basis tornado, the annual probability of exceedance is 2×10^{-5} (WSRC 1998c). Combined with the 30-day time at risk, probability resulted in an overall annual probability of 1.6×10^{-6}. If the tank were moved into a shelter or protected by administrative controls (e.g., erect missile barrier and/or tie down the tank), the annual probability for this event could be reduced to 8×10^{-8} (Yeung 1999). If a vehicle crash is considered, the frequency of a vehicle crash occurring over all the Liquid Radioactive Waste Handling Facilities is bounded between 7.4×10^{-4} and 4.7×10^{-3} events per year (WSRC 1998a). Conservatively assuming that 0.1 percent of the accidents occurring at the F- and H-Area Tank Farms (WSRC 1998a) impact the oxalic acid tank resulted in an overall frequency of 2.7×10^{-6} per year. Considering these three different initiating events, the most credible scenario would be a design basis earthquake with an annual probability of 4.1×10^{-5}. This scenario would be extremely unlikely.

Source Term: The chemical release MAR would consist of 10,000 gallons of 4 percent oxalic acid. The oxalic acid source term was conservatively estimated to be an airborne release of 150 grams of 100-percent oxalic acid at a release rate of 168 milligrams per second (Yeung 1999).

B.5.2 FAILURE OF SALT SOLUTION HOLD TANK

Scenario: As described in Section B.3.1.7, this scenario would involve the failure of the Salt Solution Hold Tank, which would be used in one of the options in the Stabilize Tanks Alternative during preparation of the saltstone that would be used to backfill the empty tanks. The Salt Solution Hold Tank would contain both radiological and hazardous materials. The radiological impacts are discussed in Section B.4.

Probability: The initiating event that was assumed to cause the Salt Solution Hold Tank failure was a design basis earthquake with an annual probability of exceedance of 5×10^{-4} (WSRC 1998c). Assuming that the Salt Solution Hold Tank has a 10-percent chance of failing during the earthquake, a release of the bounding source term was estimated to occur at an annual probability of 5×10^{-5}. This scenario would be extremely unlikely.

Source term: The source term for hazardous materials released from the failed Salt Solution Hold Tank is given in Table B-4. It was obtained from the *Safety Analysis Report for the Saltstone Facility* (WSRC 1992a).

Table B-4. Chemical source term for failure of Salt Solution Hold Tank.

Chemical	Total inventory in Salt Solution Hold Tank (kg)	Assumed release fraction	Evaporation release rate (milligrams per second)
Arsenic	170	1.0×10^{-4}	2.4
Barium	170	1.0×10^{-4}	2.4
Cadmium	51	1.0×10^{-4}	0.71
Chromium	340	1.0×10^{-4}	4.7
Lead	170	1.0×10^{-4}	2.4
Mercury	85	1.0×10^{-4}	1.2
Selenium	60	1.0×10^{-4}	0.83
Silver	170	1.0×10^{-4}	2.4
Benzene	0.52	1.0	73
Phenol	170	1.0×10^{-2}	240

Source: Yeung (1999).

B.6 Accident Impacts Involving Nonradioactive Hazardous Materials

As Section B.4 provided for the radiological consequences of identified accidents; this section provides the potential impacts associated with the release of nonradioactive hazardous materials from the two accident scenarios.

B.6.1 OXALIC ACID SPILL

The oxalic acid spill, described in Section B.5.1, would result in the release of 150 grams of oxalic acid at a release rate of 168 milligrams per second. Table B-5 provides atmospheric dispersion factors for the two individual receptors, the uninvolved worker and the maximally exposed offsite individual (Hope 1999). By applying these factors, the maximum concentrations at those receptor locations were calculated. These concentrations are also presented in Table B-5.

EC Because the Permissible Exposure Limit – Time Weighted Average (PEL-TWA), which equates to the ERPG-2 value described in Section B.2.3, is 1.0 milligrams per cubic meter for oxalic acid, there would be no significant impacts to the onsite or offsite receptors from this accident.

B.6.2 FAILURE OF SALT SOLUTION HOLD TANK

The failure of the Salt Solution Hold Tank, described in Section B.5.2, would result in the release of the hazardous chemical inventory provided in Table B-4. Table B-6 provides atmospheric dispersion factors for the two individual receptors, the non-involved worker and the maximally exposed offsite individual (Hope 1999). By applying these factors, the maximum concentrations at those receptor locations were calculated. These concentrations are also presented in Table B-6.

Because the most restrictive exposure limits for these hazardous materials is 0.5 milligrams per cubic meter, there would be no significant impacts to the onsite or offsite receptors from this accident. EC

EC

B.7 Environmental Justice

In the event of an accidental release of radioactive or hazardous chemical substances, the dispersion of such substances would depend on meteorology conditions (such as wind direction) at the time. Given the variability of meteorology conditions, the low probability of accidents, the location of minority and low-income communities in relation to SRS, and the

Table B-5. Chemical concentrations to various receptors for oxalic acid spill accident.

Chemical	Evaporation release rate (milligrams per second)	Atmospheric dispersion factor (seconds per cubic meter)		Resultant concentration (micrograms per cubic meter)	
		Noninvolved worker	Maximally exposed individual	Noninvolved Worker	Maximally exposed individual
4-percent oxalic acid	168	1.7×10^{-4}	5.7×10^{-7}	0.03	0.0001

Table B-6. Chemical concentrations to various receptors for failure of the Salt Solution Hold Tank.

Chemical	Evaporation release rate (milligrams per second)	Atmospheric dispersion factor (seconds per cubic meter)		Resultant concentration (milligrams per cubic meter)	
		Noninvolved worker	Maximally exposed individual	Noninvolved Worker	Maximally exposed individual
Arsenic	2.4	1.7×10^{-4}	5.7×10^{-7}	0.0004	1.4×10^{-6}
Barium	2.4	1.7×10^{-4}	5.7×10^{-7}	0.0004	1.4×10^{-6}
Cadmium	0.71	1.7×10^{-4}	5.7×10^{-7}	0.0001	4.0×10^{-7}
Chromium	4.7	1.7×10^{-4}	5.7×10^{-7}	0.0022	2.7×10^{-6}
Lead	2.4	1.7×10^{-4}	5.7×10^{-7}	0.0004	1.4×10^{-6}
Mercury	1.2	1.7×10^{-4}	5.7×10^{-7}	0.0002	6.7×10^{-7}
Selenium	0.83	1.7×10^{-4}	5.7×10^{-7}	0.0001	4.7×10^{-7}
Silver	2.4	1.7×10^{-4}	5.7×10^{-7}	0.0004	1.4×10^{-6}
Benzene	73	1.7×10^{-4}	5.7×10^{-7}	0.012	4.2×10^{-5}
Phenol	240	1.7×10^{-4}	5.7×10^{-7}	0.040	1.4×10^{-4}

small magnitude of estimated offsite impacts, disproportionately high or adverse human health and environmental impacts to minorities or low-income populations are not expected to be very likely. EC

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APPENDIX C

LONG-TERM CLOSURE MODELING

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APPENDIX C. LONG-TERM CLOSURE MODELING

This appendix provides a discussion of the fate and transport modeling that was performed to determine the long-term impacts from the alternatives described in Chapter 2 of this environmental impact statement (EIS). This modeling estimates the potential human health and ecological impacts of residual contamination remaining in closed high-level waste (HLW) tanks for all alternatives and estimates the concentrations and dose levels at the locations where the groundwater outcrops into the environment (i.e., the seeplines).

In the modeling described in this appendix, the F- and H-Area Tank Farms were modeled, assuming conditions that would exist after tank closure for four scenarios as follows: (1) No Action Alternative, (2) Fill with Grout Option, (3) Fill with Sand Option, and (4) Fill with Saltstone Option. None of the analyzed scenarios took credit for engineered caps to be placed after completion of closure activities.

Potential impacts to the following hypothetical individuals were analyzed:

- *Worker:* An adult who has authorized access to and works at the tank farms and surrounding areas, but is considered to be a member of the public for compliance purposes. This analysis assumes that the worker remains on the banks of Fourmile Branch or Upper Three Runs during working hours.
- *Intruder:* A teenager who gains unauthorized access to the tank farms 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 and near one of the streams.
- *Nearby child resident:* A child who lives in a dwelling across either Fourmile Branch or Upper Three Runs, downgradient of the tank farms and near the streams.

In addition to the hypothetical individuals identified above, concentrations and dose levels were calculated at the groundwater seepline point of exposure. Concentrations and dose levels were also calculated at 1-meter and 100-meters downgradient from the edge of the F- and H-Area Tank Farms, and an estimate of the doses from all pathways at these locations was performed.

Uncertainty in Analysis

In this EIS, the U.S. Department of Energy (DOE) has made assumptions on numerical parameters that affect the calculated impacts. There is some uncertainty associated with the values of these parameters, due to unavailable data and the current state of knowledge about closure processes and the long-term behavior of materials.

The principal parameters that affect modeling results are the following:

- **Inventory:** The amount of material in a tank directly affects the concentrations at any given location, unless the amount of material is so great that the solubility limit is exceeded. Once the solubility limit is exceeded, greater amounts of source material do not necessarily result in increased concentrations at receptor locations. In this modeling effort, both plutonium and uranium were assumed to be limited by solubility. Inventory results are based primarily on process knowledge at this time. As each tank is prepared for closure, specific sampling will be conducted to determine the inventory.
- **Hydraulic conductivity:** The actual rate of water movement through the material is ultimately affected by the hydraulic conductivity of the strata underneath the

source. Generally, the grout or concrete basemat is the limiting layer, with regard to water infiltration. At the time of structural failure, the hydraulic conductivity is increased dramatically, making more water available to carry contaminants to the aquifer. In general, this will result in greater doses/concentrations, due to the increased movement of material.

- **Distribution coefficient:** The distribution coefficient (K_d) affects the rate at which contaminants move through strata. Large K_d values provide holdup time for short-lived radionuclides.

- **Vadose zone thickness:** The thickness of the strata between the contaminated region and the aquifer does not necessarily reduce the concentration as much as it slows the progress toward the aquifer. Therefore, for shorter-lived radionuclides, extra time granted by thicker strata can decrease the activity before the contaminants reach the aquifer. EC

- **Distance downgradient to receptor location:** The distance to a given receptor location affects (a) the time at which contaminants will arrive at the location and (b) how much dispersion occurs. For greater distances, longer travel times will be encountered, resulting in lower activity values for short-lived radioactive constituents and greater dispersion for all constituents.

DOE recognizes that, over the period of analysis in this EIS, there is also uncertainty in the structural behavior of materials and the geologic and hydrogeologic setting of the Savannah River Site (SRS). DOE realizes that overly conservative assumptions can be used to bound the estimates of impacts; however, DOE believes that this approach could result in a masking of differences of impacts among alternatives. Therefore, DOE has attempted to use assumptions in its modeling analysis that are reasonable, based on current knowledge, so that meaningful comparisons among alternatives can be made. EC

C.1 Analyzed Scenario

The hydrogeology under various areas of the SRS has been modeled several times in the last few years. Most of the modeling has focused on specific locations (e.g., the Saltstone Manufacturing and Disposal Facility in Z Area, the seepage basins in F- and H Areas) and is thus subject to updating as new information becomes available. DOE is continually refining the model for the General Separations Area, based on recent hydrogeologic measurements. DOE has prepared this EIS using the methodology and modeling assumptions presented in the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems*. DOE recognizes that future refining of the models described in the closure plan may result in slightly different estimates of impacts. However, DOE believes that using the methodology described in the closure plan provides a consistent basis for evaluating the alternatives. EC

The tank farms were modeled individually to determine the impacts from their respective sources. In the analyzed scenarios, the mobile contaminants in the tanks are assumed to gradually migrate downward through unsaturated soil to the groundwater aquifer. The aquifers underneath F-Area Tank Farm were assumed to discharge primarily to Fourmile Branch, while the aquifers underneath H-Area Tank Farm were assumed to discharge to both Fourmile Branch and Upper Three Runs. Therefore, the contaminants would be transported by the groundwater to the seepline and subsequently to Fourmile Branch or Upper Three Runs. Upon reaching the surface water, some contaminants would migrate to the sediments at the bottom of the streams and the shoreline. Aquatic organisms in the streams and plants along the shorelines would be exposed to the contaminants. Terrestrial organisms might then ingest the contaminated vegetation and also obtain their drinking water from the EC contaminated streams. Humans are assumed to be exposed to contaminants through various pathways associated with the surface water.

The following sections describe specific assumptions incorporated into the modeling calculations for the analyzed alternatives.

C.1.1 SCENARIO 1 – NO ACTION ALTERNATIVE

The No Action Alternative assumes that, for the 100 years of institutional control, the tanks would contain necessary ballast water that would be treated to minimize corrosion. A tank is assumed to have a constant leak rate (simulated and limited by the hydraulic conductivity of the intact concrete basemat), which causes some passage through the tank bottom. At 100 years, the tanks are filled with water and abandoned, but not capped.

At some point in the future, degradation associated with the aging of the tanks would destroy the tanks. The contaminants are then assumed to reside at the bottom of a hole equal to the depth of the tank (generally 30 to 40 feet). Although debris would exist in the hole, it is assumed to play no role in inhibiting infiltration or preventing flow into the soil. Because of the lack of structural support, the tanks and concrete basemats are assumed to fail completely at 100 years, exposing the contaminated media to rainfall with subsequent infiltration to groundwater.

L-4-24 The No Action Alternative is the only alternative that, after tank closure, could conceivably expose individuals by the atmospheric pathway from the tank area, because each of the other alternatives would fill the tanks with material that would cover the contaminants and prevent their escape via atmospheric dispersion. The only foreseeable occurrence of an atmospheric release under No Action would be if the tank structures collapsed, causing the suspension of particulates containing contaminants. However, the likelihood of an atmospheric release is considered to be minimal, at best, for the following reasons:

- The amount of rainfall in the area would tend to keep the tank contents damp through the time of failure. After failure, a substantial amount of debris on top of the contaminated material would prevent release, even if the contents were to dry during a period of drought.
- The considerable depth of the tanks below grade would tend to discourage resuspension of any of the tanks' contents.

Based on these reasons, no analyses were performed for the atmospheric pathway. Section 4.1.3.2 describes the potential airborne emissions associated with the tank closure activities (i.e., during the short-term tank closure phase). L-4-24

C.1.2 SCENARIO 2 –FILL WITH GROUT OPTION TC

Scenario 2 assumes that the tanks would be filled with grout and engineered structures would not be used to reduce the infiltration of rain water. By analogy with the analysis presented in the *Radiological Performance Assessment for the E-Area Vaults Disposal Facility* (WSRC 1994a), the concrete tank structure could enter a period of degraded performance due to cracking at around 1,400 years. Assuming that the approximately 34 feet of grout continue to support the tank roof and provide an additional barrier to infiltration for an indefinite period of time (WSRC 1992), water infiltration should occur much later than 1,400 years. However, for this scenario, the assumption is made that the tank tops, grout, and basemats fail at 1,000 years, with a corresponding increase in their respective hydraulic conductivities.

EC EC

C.1.3 SCENARIO 3 –FILL WITH SAND OPTION TC

Scenario 3 assumes that the tanks would be filled with sand and engineered structures would not be used to reduce the infiltration of rain water. Eventually, the sides and roofs of the tanks would collapse, allowing water to infiltrate the tank and leach the contaminants down to the aquifers. DOE has assumed that a tank fails at 100 years.

TC

C.1.4 SCENARIO 4 –FILL WITH SALTSTONE OPTION

Scenario 4 is similar to Scenario 2 in that a cementitious material is used to fill the tanks. However, in this scenario, the fill material is saltstone, a composite material made of cement, flyash, slag, and slightly contaminated media
EC from HLW processing. Currently, saltstone is disposed in Z Area; under this option, saltstone would be used to fill the tanks and (as in Scenario 2) would be assumed to remain intact for 1,000 years following tank closure.

C.1.5 CONSIDERATION OF POST-CLOSURE ACCIDENTS

L-7-80

Because the tanks are assumed to fail after either 100 (Scenarios 1 and 3) or 1,000 years (Scenarios 2 and 4), the probability of a release from the tanks is one (i.e., it is assumed that the tank will fail). If an accident severe enough to cause tank failure were to occur before the 100- to 1,000-year post-closure periods, the impacts would not be significantly different than the calculated long-term impacts for the following reasons. First, the probability of such an accident occurring in the first 100 or 1,000 years post-closure would be much smaller than one. Therefore, any impacts from accidents that cause tank failures to occur prior to 100 or 1,000 years would have to be multiplied by this small probability of premature failure. Second, due to the long transport times of the contaminants in groundwater, the difference between the impacts from an early release would be insignificant compared to the calculated impacts based on releases occurring at 100 or 1,000 years.

C.2 Methodology

C.2.1 HUMAN HEALTH ASSESSMENT

C.2.1.1 <u>General Methodology</u>

Utilizing the Multimedia Environmental Pollutant Assessment System (MEPAS) computer code (Buck et al. 1995), a multi-pathway risk model developed by Pacific Northwest Laboratory, calculations were performed to assess the impacts of the leaching of contaminants to the groundwater for each of the four tank closure scenarios. To model the four closure scenarios, infiltration rates were selected for each closure alternative that EC
represent the vertical moisture flux passing through the tanks. These infiltration rates are dependent upon the chemical and physical characteristics of the tank fill material for each scenario.

Based on the calculated inventories of chemical and radioactive contaminants remaining in the tanks after bulk waste removal and spray washing, the model was set up to simulate the transport of contaminants from the contaminated zone (residual waste layer), through the concrete basemat (first partially saturated zone), the vadose zone directly beneath the basemat (second partially saturated zone), and into the underlying aquifers (saturated zones). Model runs were completed for both early timeframes (before the assumed failure occurs) and late timeframe (after assumed failure occurs) conditions. Figure C-1 illustrates the conceptual model that DOE used in this analysis. L-4-18

In addition to the four tank closure scenarios, modeling was performed for pollutants remaining in the ancillary equipment and piping above the tanks. In this calculation, the piping and equipment were considered to be the contaminated zone, while the partially saturated zone was the layer of soil extending from the surface to the saturated zones.

L-4-18

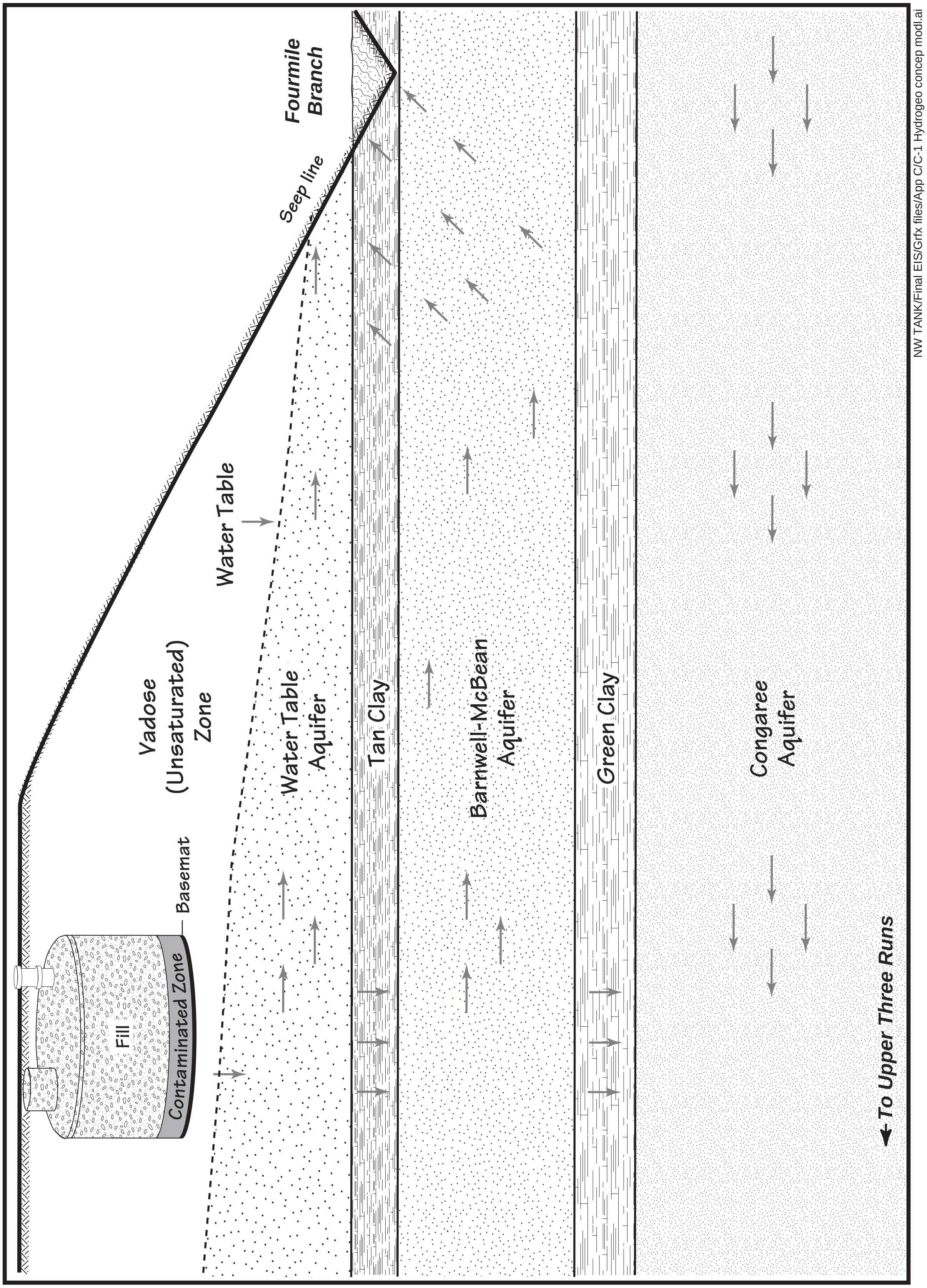


Figure C-1. Example hydrogeologic conceptual model (F-Area Tank Farm).

Calculated pollutant concentrations and dose levels are provided at 1 meter and 100 meters downgradient from the edges of the tank farms, at the seeplines, and in the surface waters of Fourmile Branch and Upper Three Runs for the hypothetical individuals discussed in Section C.2.1.2. DOE has not calculated groundwater concentrations underneath the tanks because of inherent limitations involved in those calculations. Specifically, the large size of the tank farms and the pattern(s) of groundwater movement make calculations EC speculative for locations in proximity to the source.

C.2.1.2 Receptors

The potential receptors and exposure pathways are identified in the following sections and illustrated in Figure C-2.

Worker

The worker is assumed to be located in the area including and surrounding either of the tank farms. Because institutional controls are in place, the potential for exposure of the worker to the primary source (residual at the bottom of the tanks) is minimal, owing to the structural integrity of the tanks, the lack of any industrial work that would be performed over the tanks, and safety measures that would be taken to further reduce potential exposure. Therefore, this analysis assumes that the worker is located constantly at the nearest place where contaminants would be accessible (i.e., on the bank of Fourmile Branch or Upper Three Runs, as part of his work duties). The assumption is conservative because the worker has a greater potential for exposure to contaminants at the seepline. However, the fact that he is a worker limits and, hence, eliminates pathways that might be considered if he were considered a resident. The potential exposure pathways for the seepline worker are:

- Direct irradiation from the deposits along the banks of the streams (radioactive contaminants only)
- Ingestion of the soil from the deposits along the banks of the streams
- Dermal contact with dust from the deposits along the banks of the streams.

Exposure from inhalation of resuspended soil was not evaluated because the soil conditions at the seepline (i.e., the soil is very damp) are such that the amount of soil resuspended and potentially inhaled would be minimal.

Intruder

Another potential receptor is the intruder, a person who gains unauthorized access to the tank farm sites and becomes exposed to the contaminants in some manner. The intruder scenario is analyzed for a time period after EC institutional controls have ceased. Because the intruder is assumed not to have residential habits, he or she would not have exposure pathways like those of a resident (e.g., the EC intruder does not build a house, grow produce, etc.); instead, the intruder is potentially exposed to the same pathways as the seepline worker, but for a shorter duration (4 hours per day, as noted in Section C.3.2.4). EC

Nearby Adult Resident/Nearby Child Resident

Nearby residents could also potentially be exposed to contaminants from the tank farms. Members of the public are assumed to construct a dwelling near the tank farms on SRS (but outside the tank farm sites). The location of the residential dwelling is assumed to be downgradient near one of the two main streams (Fourmile Branch or Upper Three Runs) on the side opposite the tank farms at a point 100 meters downstream of the groundwater outcropping in these streams. The residents of this dwelling include both adults and children. The adult resident was modeled separately from the child resident because of different body weights and consumption rates.

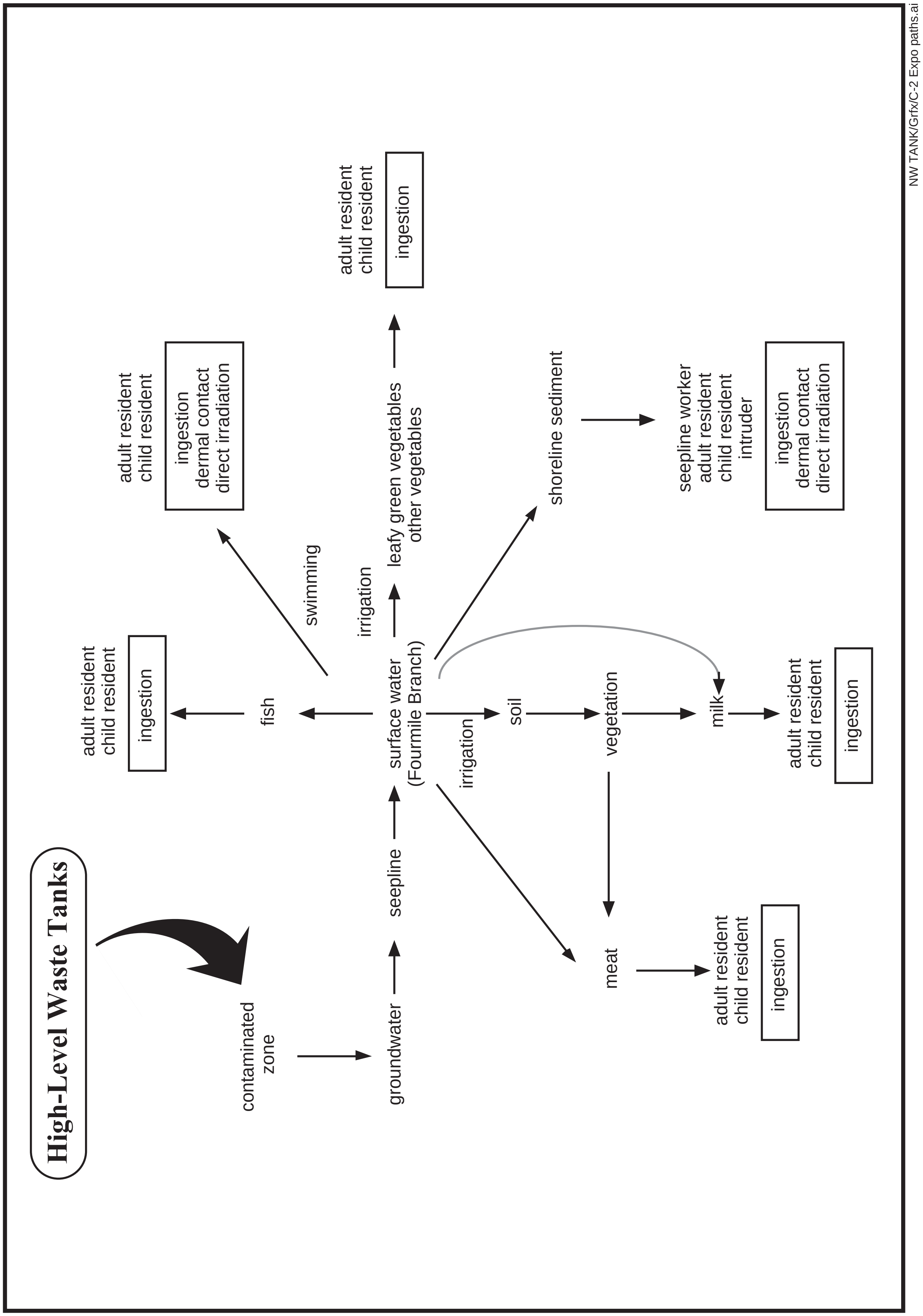


Figure C-2. Potential exposure pathways for human receptors.

The resident is assumed to use the stream for recreational purposes, to grow and consume produce irrigated with water from the stream, to obtain milk from cows raised on the residential property, and to consume meat that was fed contaminated vegetation from the area. Therefore, potential exposure pathways for both the nearby adult and nearby child resident are the following:

- Incidental ingestion of contaminated soil from deposits along the banks of the streams
- Inhalation of contaminated soil from deposits along the banks of the streams
- Direct irradiation from deposits along the banks of the streams (radioactive contaminants only)
- Direct irradiation from surface water (radioactive contaminants only - recreation)
- Dermal contact with surface water
- L-7-90 Ingestion of surface water
- Ingestion of contaminated meat
- Ingestion of produce grown on contaminated soil irrigated with water from Fourmile Branch
- Ingestion of milk from cows that are fed contaminated vegetation
- Ingestion of aquatic foods (e.g., fish) from Fourmile Branch.

Because of the physical circumstances of the fate and transport modeling, the most likely locations for soil ingestion are on the shorelines EC of the streams. Figure C-2 shows this pathway, which is identified as "shoreline sediment" along with the appropriate exposure pathways: ingestion, dermal contact, and direct irradiation. While analyses of some waste sites do show that soil ingestion is a dominant pathway, this usually occurs when the residents have direct access to the highly contaminated soils excavated from the waste site. Because of the depth of the waste tanks, so far below grade, and the fill material that would be in place, there is no credible situation by which the residents L-4-11 could have direct access to this material. In this EC EIS, therefore, the soil ingestion pathway is not dominant.

Although the basic assumption for the residents is that they are not located at the tank farms, DOE has nevertheless estimated the impact if residents are allowed access to the tank farms.

<u>Atmospheric Pathway Receptors</u>

Based on the reasoning presented in Sections C.1.1 and C.2.1.2, no analyses were performed for the atmospheric pathway.

C.2.1.3 <u>Computational Code</u>

Groundwater and surface water concentrations and human health impacts were calculated by EC using the MEPAS computer code (Buck et al. 1995). MEPAS was developed by Pacific Northwest National Laboratory under DOE contract and integrates source-term, transport, and exposure models for contaminants. In the MEPAS code, contaminants are transported from a contaminated area to potentially exposed humans through various transport pathways (groundwater, surface water, soils, food, etc.). These exposed individuals then receive doses, both chemical and radiation, through exposure or intake routes (ingestion, dermal contact, inhalation, etc.) and numerous exposure pathways (drinking water, leafy vegetables, meat, etc.).

MEPAS includes models to estimate human health impacts from radiation exposure (radionuclides and direct radiation), carcinogenic chemicals, and noncarcinogenic chemicals. Health effects resulting from radiation and radionuclide exposures are calculated as annual dose (millirem per year). Cancer incidence rates are calculated for carcinogens.

The MEPAS code is widely used (PNL 1999) and accepted throughout the DOE complex and has been presented to and accepted by other regulatory agencies, such as the U.S. Environmental Protection Agency (EPA). Examples of its use by DOE include the EH-Environmental Survey Risk Assessment and the Complex-Wide Programmatic Waste Management EIS Impact Analysis. This code has been used to demonstrate environmental impacts in Resource Conservation and Recovery Act (RCRA)-Subpart X permit applications to various EPA regions; these analyses were accepted and permits based on them were issued.

C.2.1.4 <u>Calculational Methodology</u>

The modeling results presented in this appendix are based on the amounts of contaminants remaining in the tanks after bulk waste removal and spray washing (except for No Action, which assumes only bulk waste removal with no spray washing). The results can generally be scaled to differing amounts of residual contaminants left in a tank. Although the waste is present as supernate (salt solution), damp saltcake, and sludge, the total residual waste volume was assumed to be sludge, based on the assumption that all the residual contaminants reside in the sludge (Newman 1999).

Analyses were performed specifying infiltration rates that relate to the four closure scenarios. An infiltration rate of 40 centimeters per year (average infiltration rate for SRS soils) was used to model time periods after tank failure (WSRC 1994a). This value takes into account the average annual precipitation and the amount of rainfall that evaporates, flows to streams and land surface, etc., and is not available for infiltration into soil. An infiltration rate of 122 centimeters per year was used for the No Action Alternative to simulate infiltration of 100 percent of the average annual precipitation, assuming no runoff or evaporation. The latter assumption is considered to be reasonable given the fact that the tanks are located in depressions that could fill with rainwater if the storm drain system fails.

As discussed in Section C.1.1, tank failure for the No Action Alternative would involve an initial release of the ballast water that would be limited by the hydraulic conductivity.

MEPAS calculations were performed for early (before structural failure) and late (after structural failure) conditions for each closure scenario. As discussed above, a failure time was assumed for each closure scenario, based on anticipated performance of the tank fill material and concrete basemat. The tank fill and concrete basemat were assumed to fail simultaneously and completely, in terms of retaining waste. Failure was simulated for modeling purposes by increasing the infiltration rate to 40 centimeters per year (except for No Action, which remains at 122 centimeters per year) and increasing the hydraulic conductivity of the basemat to that of sand. Because radionuclide and chemical pollutants could leach through the concrete before failure occurs, the original source term was reduced by an amount equal to the quantities released to the aquifer during the pre-failure period. In addition, radionuclides continually decay, further changing the source term. Thus, for late runs, in addition to changing the infiltration rates and hydraulic conductivities, the source term concentrations were adjusted to reflect losses and decay occurring before failure.

In the groundwater transport pathway, infiltration causes leaching of pollutants from the tanks through distinct media found below the waste unit down to the groundwater aquifer (saturated zone). To model the movement of pollutants from the waste unit to the aquifer, MEPAS requires identifying the distinct strata that the pollutants encounter. For modeling the farms, the residual at the bottom of the tanks was considered to be the contaminated zone.

Between the contaminated zone and the saturated zone, two discernible layers were identified: the concrete basemat of the tank and the unsaturated (vadose) zone. Parameters describing the concrete layer were defined for both pre- and post-failure conditions because values for parameters such as porosity, field capacity, and hydraulic conductivity change with degradation state. Analysis of flow through the vadose zone is complicated in that movement varies with soil moisture content and wetting and drying conditions. Therefore, values for saturated zone soil parameters (e.g., density, porosity) were used to describe the unsaturated zone.

For each of the four layers identified for this site (contaminated zone, concrete basemat, vadose zone, and saturated zone), surface distribution coefficients, K_d values, were selected for each radionuclide and chemical for each modeled layer. Because distribution coefficients are a chemical property, the K_d values were not changed for degraded or failed materials. The identification and derivation of the K_d values is discussed in detail in Section C.3.2.1.

As contaminants are transported from the contaminated zone to the seepline, they are longitudinally (along the streamline of fluid flow), vertically, and transversely (out sideways) dispersed by the transporting medium. MEPAS incorporates longitudinal dispersivity of pollutants moving downward through the partially saturated zone layers (i.e., concrete basemat and vadose zone) in concentration calculations. In the saturated zone, MEPAS incorporates into concentration calculations the three-dimensional dispersion along the length of travel. Dispersion distances were calculated through the concrete basemat, the vadose zone, and the groundwater aquifer. Logically, dispersion generally increases with longer travel distances, and it should be noted that the travel distance is determined by the hydraulic gradients and not by linear distance.

Groundwater concentrations and doses due to ingestion of water are calculated at hypothetical wells 1 meter and 100 meters downgradient from the edges of the respective tank farms, at the respective seeplines, and in Fourmile Branch and Upper Three Runs.

As discussed earlier, impacts to adult and child residential receptors are evaluated at a point 100 meters downstream of the groundwater outcroppings in Fourmile Branch and Upper Three Runs. The concentrations of contaminants in the streams were also calculated. Based on the dimensions, flow rate, and stream velocities, MEPAS accounts for mixing of the contaminant-containing water from the aquifer with stream water and other groundwater contributions. For both adult and child residents, ingestion rates were based on site-specific parameters. Parameters and associated assumptions used in calculating human impacts are presented in Section C.3.2.2. | EC

In addition to the four closure scenarios, MEPAS runs were performed to determine the effects of leaving in place the piping, vessels, and other tank-specific systems outside the tanks, all of which contain residual pollutants. It was assumed that an additional 20 percent of the radioactive contaminants remaining in the tanks after bulk cleaning and spray washing would be distributed in the ancillary equipment (d'Entremont 1996). Modeling was performed for two options: (1) leaving the piping and other equipment as they currently exist (assumed for the No Action Alternative and Fill with Sand Option), and (2) filling, where possible, the piping and other outside equipment with grout (assumed for the Fill with Grout and Fill with Saltstone Options). For modeling in MEPAS, the ancillary equipment was considered to be the contaminated zone, and the entire distance between the contaminated zone and the saturated zone was characterized as one layer of typical SRS soil. Therefore, no credit was taken for the additional reduction of leachate afforded by the tanks, thus providing conservative results. | TC | TC

C.2.2 ECOLOGICAL RISK ASSESSMENT

C.2.2.1 <u>General Methodology</u>

Several potential contaminant release mechanisms were considered for assessing ecological risks associated with tank closure. These included contamination of runoff water during rainstorms, soil contamination from air emissions following tank collapse, and contamination of groundwater. Onsite inspection showed that the tanks are well below

(4 to 7 meters) the surrounding, original land surface. Therefore, runoff or soil contamination was not a reasonable assumption. Groundwater contamination was determined to be the most likely means of contaminant transport.

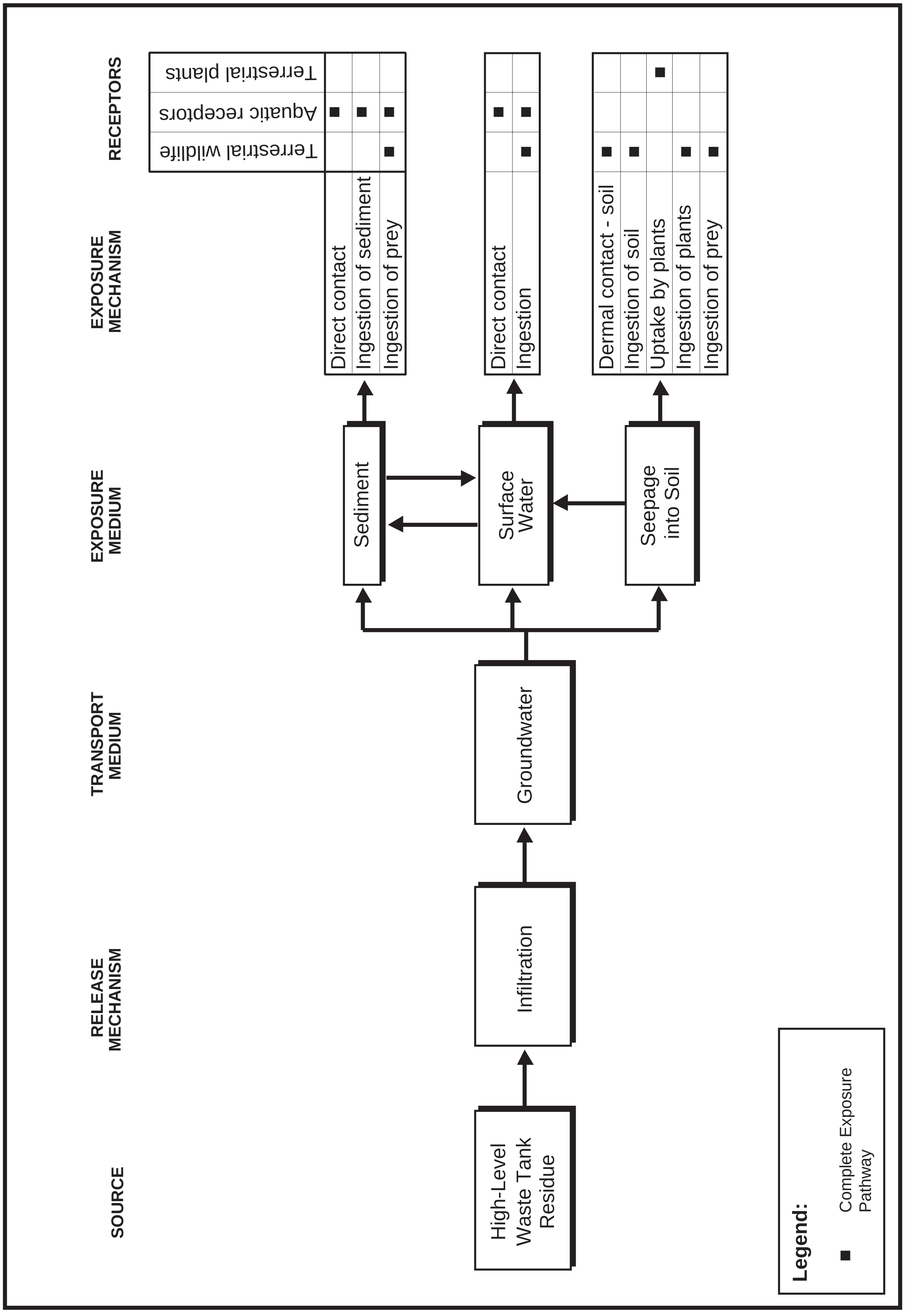
Several contaminant migration pathways were evaluated which, for half of H Area (south of the groundwater divide), include seepage of the groundwater from the Water Table and Barnwell-McBean Aquifers at a downgradient outcrop (seepline) and subsequent mixing in Fourmile Branch, and outcrop from the Congaree Aquifer and subsequent mixing in Upper Three Runs. For the other half of H Area (north of the groundwater divide), all three aquifers outcrop at Upper Three Runs, with subsequent mixing with this stream. For F Area, the analysis included seepage of the groundwater from the Water Table and Barnwell-McBean Aquifers at a downgradient outcrop (seepline) and subsequent mixing in Fourmile Branch, and outcrop from the Congaree Aquifer and subsequent mixing in Upper Three Runs. Each of these migration pathways was evaluated using four methods for tank stabilization, including the Fill with Grout Option, the Fill with Sand Option, the Fill with Saltstone Option, and the No Action Alternative (no stabilization). The groundwater-to-surface water contaminant migration pathway, together with potential routes of entry into ecological receptors, is shown in the conceptual site model (Figure C-3).

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.

Potential impacts to terrestrial receptors at the seepline and aquatic receptors in Fourmile Branch and Upper Three Runs were evaluated. For the assessment of risk due to toxicants, the aquatic receptors are treated as a group because water quality criteria have been derived for protection of aquatic life in general. These criteria, or equivalent values, are used as threshold concentrations. For the radiological risk assessment, the redbreast sunfish was selected as an indicator species, due to its abundance in Fourmile Branch and Upper Three Runs (Halverson et al. 1997).

There are no established criteria for the protection of terrestrial organisms from toxicants. Receptor indicator species are usually selected for risk analysis and the results extrapolated to the populations, communities, or feeding groups (e.g., herbivores, predators) they represent. Two terrestrial animal receptors, the southern short- tailed shrew and the mink, were selected in accordance with EPA Region IV guidance, which calls for investigation of small animals with small home ranges. The guidance also calls for investigation of predators when biomagnifying contaminants (such as mercury) are being studied. The southern short-tailed shrew is small and is one of the most common mammals on the SRS; the mink is a small-bodied predator associated with waterways and is also found on SRS (Cothran et al. 1991). Species that are more abundant on SRS than the mink and with similar ecologies were considered for use in this assessment, including the raccoon. However, the mink has a small body size relative to similar species, which results in a more conservative estimate of exposure. Also, the mink is considered to be a highly contaminant-sensitive species, and is almost exclusively carnivorous (which maximizes toxicant exposure). The short-tailed shrew and mink are also used in the radiological assessment.

The seepage areas are estimated to be small, about 0.5 hectare (DOE 1997), 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.



NW TANK/Grfx/C-3 Eco Risk.ai

Figure C-3. Ecological Risk Assessment Conceptual Site Model.

The following exposure routes were chosen for calculating absorbed radiation dose to the terrestrial mammals of interest (shrew and mink) located on or near the seeplines: ingestion of food (earthworms, slugs, insects, and similar organisms for the shrew, and shrews for the mink); ingestion of soil; and ingestion of water. EC The exposure routes chosen for calculating absorbed dose to aquatic animals of interest (sunfish) living in Fourmile Branch and Upper EC Three Runs were 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, soil ingestion rate, and bioaccumulation factors were used (see Section C.3.3).

C.2.2.2 Exposure and Toxicity Assessment

Exposure to Chemical Toxicants

Exposure for aquatic receptors is simply expressed as the concentrations of contaminants in the water surrounding them. This is the surface water exposure medium shown in the EC conceptual site model (Figure C-3). The conceptual model also includes sediment as an exposure medium; sediment can become contaminated from the influence of surface water or from seepage that enters sediment directly. As a result, terrestrial wildlife could L-4-26 incidentally ingest sediment while feeding on aquatic organisms. 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.

Exposure for terrestrial receptors is based on dose, expressed as milligrams of contaminant ingested per kilogram of body mass per day. The routes of entry (exposure routes) used for estimating dose were ingestion of food and water. Dermal absorption is a possibility, but the fur of shrews and minks was considered to be an effective barrier against this route. 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 (mink), ingested in aquatic prey (mink), and transferred to soil, soil invertebrates, shrews, and mink through a simple terrestrial food chain.

Chemical Toxicity Assessment

The goal of the toxicity assessment is to derive threshold exposure levels that are protective of EC the receptors (Table C.2.2-1). For aquatic receptors, most of the threshold values are ambient water quality criteria for chronic exposures. Others include the concentration for silver, which is an acute value (no chronic level was available).

For terrestrial receptors, toxicity thresholds are based on the lowest oral doses found in the literature that are no-observed-adverse-effect-levels (NOAELs) or lowest-observed-adverse-effect-levels (LOAELs) for chronic endpoints that could affect population viability or fitness (Table C.2.2-2). Usually the endpoints are adverse effects on reproduction or development. Uncertainty factors are applied to these doses to extrapolate from LOAELs to NOAELs and from subchronic or acute-to-chronic study durations. The derivation of these values is listed in Table C.2.2-3. Adjustments for differences in metabolic rates between experimental animals, usually rats or mice, and indicator species are made by applying a factor based on relative differences in estimated body surface area to mass ratios.

C.2.2.3 Calculational Design

Chemical Contaminants

For terrestrial receptors, the exposure calculation is a ratio of total contaminant intake to body mass, on a daily basis. This dose is divided by the toxicity threshold value to obtain a hazard quotient. Modeled surface water concentrations in Fourmile Branch and Upper Three Runs were divided by aquatic threshold levels to obtain hazard quotients.

Table C.2.2-1. Threshold toxicity values.

Contaminant	Aquatic receptors (milligrams per liter)	Terrestrial receptors (milligrams per kilograms per day)	
		Shrew	Mink
Aluminum	0.087	27.7	6.4
Barium	0.0059	1.78	0.41
Chromium	0.011	11.6	2.7
Copper	0.0014[a]	52.2	12
Fluoride	NA	8.3	2.5
Iron	1.0	NA	NA
Lead	0.00013[a]	0.012	0.003
Manganese	NA	52.9	12.1
Mercury	0.000012	0.082	0.019
Nickel	0.019[a]	29.7	6.8
Nitrate (as N)	NA	(b)	(b)
Silver	0.000055[a]	0.33	0.077
Uranium	0.00187	4.48	1.01
Zinc[a]	0.0127	14.0	3.17

a. Based on a hardness of 8.2 mg $CaCO_3$/L.
b. Screening for MCL (10 mg/L) in seep water considered protective for nitrate.
NA = Not applicable (normally not a toxin for this type of receptor).

TC

Radioactive Contaminants

Animal ingestion dose conversion factors (DCFs) for both terrestrial animals (shrew and mink) were estimated for purposes of these calculations by assuming that the animals possess similar metabolic processes as humans with regard to retention and excretion of radioisotopes; the chemistry of radioisotopes in the animals' bodies is assumed to be similar to that of humans. This assumption is appropriate because much of the data used to determine the chemistry of radioisotopes in the human body were derived from studies of small mammals. Equations from the International Commission on Radiological Protection (ICRP) Publication 2 (ICRP 1959) were used to predict the uptake rate and body burden of radioactive material over the life span of the animals. All isotopes were assumed to be uniformly distributed throughout the body of the animal. DCFs for the aquatic animal, sunfish, were calculated by assuming a steady-state concentration of radioactive material within the tissues of the animal and a uniform concentration of radioactive material in the water surrounding the sunfish.

The quantity of radioactivity ingested by the organisms of interest was estimated by assuming that the organisms live their entire lives in the contaminated region (the seepline area for the terrestrial organisms and Fourmile Branch and Upper Three Runs near the seepline for the sunfish). The shrews are assumed to drink seepline water at the maximum calculated concentrations of radioactivity and to eat food that lives in the soil/sediments near the seepline. The concentrations of radioactivity in these media were derived from the calculated seepline and Fourmile Branch or Upper Three Runs concentrations. The mink is assumed to drink Fourmile Branch or Upper Three Runs water and eat only shrews that live near the seepline.

The estimated amount of radioactivity that the terrestrial organism would ingest through all postulated pathways was then multiplied by the DCFs to calculate an annual radiation dose to

Table C.2.2-2. Toxicological basis of NOAELs for indicator species.

Analyte	Surrogate species	LOAEL (milligrams per kilograms per day)	Duration	Effect	NOAEL (milligrams per kilograms per day)	Reference	Notes
Inorganics							
Aluminum	Mouse	–	13 mo	Reproductive system	19	Ondreicka et al. (1966) in ATSDR (1992)	
Barium	Rat	5.4	16 mo	Systemic	0.54	Perry et al. (1983) in Opresko, Sample, and Suter (1995)	EC
Chromium VI	Rat	–	1 y	Systemic	3.5	Mackenzie et al. (1958) in ATSDR (1993)	
Copper	Mink	15	50 w	Reproductive	12	Aulerich et al. (1982) in Opresko, Sample, and Suter (1995)	EC
Fluoride	Rat	5	60 d	Reproductive	–	Araibi et al. (1989) in ATSDR (1993)	
	Mink	5	382 d	Systemic	–	Aulerich et al. (1987) in ATSDR (1993)	Systemic LOAEL < reproductive
Iron							Data inadequate; essential nutrient
Lead	Rat	0.28	30 d	Reproductive	0.014	Hilderbrand et al. (1973)	
Manganese	Rat	–	100-224 d	Reproductive	16	Laskey, Rehnberg, and Hein (1982)	
Mercury	Mink	0.25	3 mo	Death; devel.	0.15	Wobeser et al. (1976) in Opresko, Sample, and Suter (1995)	EC
Nickel	Rat	18	3 gens	Reproductive	–	Ambrose, Larson, and Borzelleca (1976)	Based on first-generation effects
Nitrate (as N)							MCL of 10 mg/L at seepline is protective
Silver	Mouse	23	125 d	Behavioral	–	Rungby and Danscher (1984)	
Uranium	Mouse	–	~102 d	Reproductive	3.07	Paternain et al. (1989) in Opresko, Sample, and Suter (1995)	EC
Zinc	Mouse	96	9-12 mo	Systemic	–	Aughey et al. (1977)	Small data base

Table C.2.2-3. Derivation of NOAELs for indicator species.

Contaminant of concern	Surrogate species	NOAEL or LOAEL in surrogate species (milligrams per kilograms per day)	UF[a]	Body surface area conversion factor	Indicator species	Indicator species NOAEL (milligrams per kilograms per day)	Notes
Inorganics							
Aluminum	Mouse	19	1	0.33	Mink	6.4	
	Mouse	19	1	1.46	Shrew	27.7	
Barium	Rat	0.54	1	0.76	Mink	0.41	
	Rat	0.54	1	3.30	Shrew	1.78	
Chromium VI	Rat	3.5	1	0.76	Mink	2.7	
	Rat	3.5	1	3.30	Shrew	11.6	
Copper	Mink	12	1	1.00	Mink	12.0	
	Mink	12	1	4.35	Shrew	52.2	
Fluoride	Mink	5	2	1.00	Mink	2.5	UF from less serious LOAEL
	Rat	5	2	3.30	Shrew	8.3	UF from less serious LOAEL
Iron							Data inadequate; essential nutrient
Lead	Rat	0.014	4	0.76	Mink	0.003	UF for study duration
	Rat	0.014	4	3.30	Shrew	0.012	UF for study duration
Manganese	Rat	16	1	0.76	Mink	12.1	
	Rat	16	1	3.30	Shrew	52.9	
Mercury	Mink	0.15	8	1.00	Mink	0.019	UF for study duration
	Mink	0.15	8	4.35	Shrew	0.082	UF for study duration
Nickel	Rat	18	2	0.76	Mink	6.8	UF from LOAEL: NOAEL in 2nd and 3rd generations
	Rat	18	2	3.30	Shrew	29.7	UF from LOAEL: NOAEL in 2nd and 3rd generations
Nitrate (as N)							MCL of 10 mg/L at seepline is protective
Silver	Mouse	23	100	0.33	Mink	0.077	UF for LOAEL and nature of study
	Mouse	23	100	1.46	Shrew	0.33	UF for LOAEL and nature of study
Uranium	Mouse	3.07	1	0.33	Mink	1.01	
	Mouse	3.07	1	1.46	Shrew	4.48	
Zinc	Mouse	96	10	0.33	Mink	3.17	UF: LOAEL to NOAEL
	Mouse	96	10	1.46	Shrew	14.0	UF: LOAEL to NOAEL

a. UF = Uncertainty factor.

the organism. For the sunfish, the concentration of radioactivity in the surface water was multiplied by the submersion and uptake DCFs to calculate an annual radiation dose. These radiation doses are compared to the limit of 1,000 millirad per day (365,000 millirad per year).

C.3 Assumptions and Inputs

C.3.1 SOURCE TERM

C.3.1.1 Radionuclides

Radioactive material source terms for the tank farms and ancillary piping residual used for the modeling are listed in Table C.3.1-1. L-2-8 L-7-18 L-7-33 L-14-4 Table C.3.1-2 lists the volume of residual material assumed for modeling purposes to remain in the closed HLW tanks and do not represent a commitment or goal for waste removal. The ancillary piping and evaporator residual was conservatively estimated to be equal to 20 percent of the tank inventories.

The No Action Alternative analyzed in this EIS assumes that only bulk waste removal is performed. Based on experience in removing waste from Tanks 16, 17, and 20, DOE has assumed that the volume of material remaining TC after only bulk waste removal would be 10,000 gallons per tank. Also, the Fill with Saltstone Option would introduce additional radioactive material into the HLW tanks. DOE used inventory estimates from the *Final Supplemental Environmental Impact Statement for the Defense Waste Processing Facility* (DOE 1994) for saltstone content to account for this additional radioactivity.

C.3.1.2 Chemicals

Chemical material source terms used in this modeling are listed in Table C.3.1-3. These TC source terms are based on the volume estimates listed in Table C.3.1-2. As with the radioactive source term, the ancillary piping and evaporator residual was conservatively estimated to be equal to 20 percent of the tank inventories. In addition, the lead in the tank top risers (500 pounds per riser, 6 risers per tank) was modeled.

The No Action Alternative analyzed in this EIS assumes that only bulk waste removal is performed. Consequently, DOE has assumed that the volume of material remaining after only bulk waste removal would be 10,000 gallons per tank. Also, the Fill with Saltstone Option would introduce additional material into the HLW tanks. DOE used inventory estimates from the TC *Final Supplemental Environmental Impact Statement for the Defense Waste Processing Facility* (DOE 1994) for saltstone content to account for this additional material.

C.3.2 CALCULATIONAL PARAMETERS

The modeling described in this appendix was designed to be specific to the tank farms. This was accomplished by utilizing site-specific data where available. For the hundreds of MEPAS input parameters, default values were used only for the distribution coefficients for chemical constituents.

For the four closure scenarios modeled, the majority of the MEPAS input parameters remain constant. Examples of constant parameters include contaminants of concern (radionuclide and chemical) and their respective initial source terms, spatial dimensions and elevation of the contaminated zone, strata thicknesses, chemical and physical properties (hydraulic conductivity and gradient, distribution coefficients) of SRS soil, exposure pathways, dose conversion factors and downgradient distances to compliance points.

Input parameters that changed for the various closure scenarios and were shown by sensitivity analyses to markedly affect the breakthrough times and peak concentrations include constituent and strata specific distribution factors, rainwater infiltration factors, and concrete basemat hydraulic conductivities. These and other important parameters are discussed in the following sections.

Table C.3.1-1. Tank farm residual after bulk waste removal.[a] EC

	F-Area Tank Farm		H-Area Tank Farm		
Radionuclide	Total Curies	Average Concentration (curies/gallon)	Total Curies	Average Concentration (curies/gallon)	
Se-79	1.2	8.5×10^{-5}	1.7	3.6×10^{-4}	
Sr-90	6.2×10^{4}	4.4	9.5×10^{4}	20	
Tc-99	270	0.019	390	0.083	
Sn-126	2.2	1.5×10^{-4}	2.2	4.7×10^{-4}	L-2-8
Cs-135	0.013	9.2×10^{-7}	0.02	4.3×10^{-6}	L-14-4
Cs-137	4,300	0.3	5,600	1.2	
Eu-154	350	0.025	1,200	0.26	
Np-237	0.06	4.2×10^{-6}	0.12	2.6×10^{-5}	
Pu-238	0[b]	0[b]	1,680	0.36	
Pu-239	130	9.2×10^{-3}	22	4.7×10^{-3}	

a. Derived from Newman (1999) and Hester (1999). Ancillary equipment is assumed to constitute an additional 20 percent of contaminants.
b. Only trace amounts of Pu-238 are present in F-Area Tank Farm.

Table C.3.1-2. Assumed volume of residual waste remaining in closed HLW tanks.[a]

Tank #	Area	Tank Type	Residual Material Volume (gal)	Tank #	Area	Tank Type	Residual Material Volume (gal)	
1	F	I	100	27	F	III	1,000	
2	F	I	100	28	F	III	1,000	
3	F	I	100	29	H	III	100	
4	F	I	100	30	H	III	100	
5	F	I	100	31	H	III	100	
6	F	I	100	32	H	III	100	
7	F	I	100	33	F	III	100	
8	F	I	100	34	F	III	100	
9	H	I	100	35	H	III	100	
10	H	I	100	36	H	III	100	
11	H	I	100	37	H	III	100	L-2-8
12	H	I	100	38	H	III	100	L-7-18
13	H	II	100	39	H	III	100	L-14-4
14	H	II	100	40	H	III	100	L-7-33
15	H	II	100	41	H	III	100	
16	H	II	100	42	H	III	100	
17[b]	F	IV	2,200	43	H	III	100	
18	F	IV	1,000	44	F	III	1,000	
19	F	IV	1,000	45	F	III	1,000	
20[b]	F	IV	1,000	46	F	III	1,000	
21	H	IV	100	47	F	III	1,000	
22	H	IV	100	48	H	III	100	
23	H	IV	1,000	49	H	III	100	
24	H	IV	100	50	H	III	1,000	
25	F	III	1,000	51	H	III	100	
26	F	III	1,000					

a. These volumes are an assumption for modeling purposes only and do not represent a commitment or goal for waste removal.
b. Tank has been closed.

Table C.3.1-3. Tank farm residual after bulk waste removal and spray washing (kilograms).[a]

Constituent	F-Area Tank Farm	H-Area Tank Farm
Iron	2,300	1,000
Manganese	240	140
Nickel	55	26
Aluminum	820	250
Chromium VI	20[b]	6.7[b]
Mercury	6.3	89
Silver	27	0.9
Copper	14	1.7
Uranium	450	4.3
Nitrate	150	62
Zinc	27	8.6
Fluoride	14.2	2
Lead [c]	24	12

a. Derived from Newman (1999) and Hester (1999). Ancillary equipment is assumed to constitute an additional 20 percent of contaminants.
b. All chromium was modeled as Chromium VI.
c. Additional lead from risers are not included in this value.

C.3.2.1 Distribution Coefficients

The distribution coefficient, K_d, is defined for two-phased systems as the ratio of the constituent concentration in the solid (soil) to the concentration of the constituent in the interstitial liquid (leachate). For a given element, this parameter may vary over several orders of magnitude depending on such conditions as soil pHand clay content. Experiments have been performed (Bradbury and Sarott 1995) that have demonstrated that strong oxidizing or reducing environments tend to affect the K_d values markedly. Because this parameter is highly sensitive in relation to breakthrough and peak times (but not necessarily peak concentration), careful selection is imperative to achieve reasonable results. For this reason, several literature sources were used to assure the most current and appropriate K_d values were selected for the example calculation.

For modeling purposes, four distinct strata were used for groundwater contaminant transport for all four closure scenarios (except for ancillary equipment and piping, which used only three, see below). These four strata are identified as (1) contaminated zone (CZ), (2) first partially saturated zone or concrete basemat, (3) second partially saturated zone or vadose zone, and (4) saturated zone. Distribution coefficients for each of these zones differ depending on the closure scenario-specific chemical and physical characteristics.

The models for ancillary equipment/piping and tanks were similar, except the piping model was assumed to have only one partially saturated zone. For this model, the concrete basemat was conservatively assumed to have no effect on reducing the transport rate of contaminants to the saturated zone. The thickness of the vadose zone was increased to 45 feet to reflect the higher elevation of the piping in relation to the saturated zone.

Distribution coefficients for each strata under various conditions are listed in Table C.3.2-1. A detailed discussion of the selection process is provided for each closure scenario.

Scenario 1 – No Action Alternative

For this scenario, K_d values for the CZ were assumed to behave similarly to that of clay found in the vicinity of the SRS tank farms. For the radionuclides and chemicals of interest, these K_d values are listed in Column V of Table C.3.2-1.

For the first partially saturated zone (concrete basemat), K_d values were selected for concrete in a non-reducing environment and are listed in Column II of Table C.3.2-1. K_d values for the second partially saturated zone (vadose zone) and the saturated zone are the same and were selected to reflect characteristics of SRS soil. These values are listed in Column I of Table C.3.2-1. For the ancillary equipment and piping, K_d values for the CZ are presented in Column V, partially saturated and saturated zones are listed in Column I of Table C.3.2-1.

Table C.3.2-1. Radionuclide and chemical groundwater distribution coefficients, cubic centimeters per gram.

	I		II		III		IV		V		VI	
	SRS Soil	Ref.	Non-Reducing Concrete[l]	Ref.	Reducing[j] Concrete	Ref.	Reducing[j] CZ	Ref.	Non-Reducing CZ	Ref.	Saltstone	Ref.
Se-79[a]	5	b	0	b	0.1	i	0.1	i	740[m]	b	7	s
Sr-90	10	b	10	b	1	i	1	i	110[m]	b	10	s
Tc-99	0.36	b	700	b	1,000	i	1,000	i	1[m]	b	700	s
Sn-126	130	b	200	b	1,000	i	1,000	i	670[m]	b	t	
Cs-135, 137	100	b	20	b	2	i	2	i	1,900[m]	b	t	s
Eu-154[p]	800[d]	c	1,300	e	5,000[q]	i	5,000[q]	i	1,300	e	t	
Np-237	10	b	5,000	b	5,000	b	5,000	i	55	b	t	
Pu-238, 239	100	b	5,000	b	NA	f	NA	f	5,100[m]	b	t	
Iron	15	g	15	n	1.5	o	1.5	o	15	n	t	
Manganese	16.5	g	36.9	n	100	i	100	i	36.9	n	t	
Nickel	300	b	650	n	100	i	100	i	650	n	t	
Aluminum	35,300	g	35,300	n	353	o	353	o	35,300	n	t	
Chromium VI[h]	16.8	g	360	n	7.9	o	7.9	o	360	n	t	
Mercury	322	g	5,280	n	5,280	o	5,280	o	5,280	n	t	
Silver	0.4	g	40	n	1	i	1	i	40	n	t	
Copper	41.9	g	336	n	33.6	o	33.6	o	336	n	t	
Uranium	50	b	1,000	n	NA	u	NA	u	1,600	b	t	
Nitrate	0	g	0	n	0	o	0	o	0	n	0	s
Zinc	12.7	g	50	n	5	o	5	o	50	n	t	
Fluoride	0	g	0	n	0	o	0	o	0	n	t	
Lead	234	g	NA	r	NA	r	NA	r	NA	r	NA	r

a. Values also used for chemical contaminants.
b. E-Area RPA (WSRC 1994a), Table 3.3-2, page 3-69.
c. (Yu 1993), Table 32.1, page 105.
d. Value used for loam from c.
e. Value used for clay from c.
f. Solubility limit of 4.4×10^{-13} mols/liter used, (WSRC 1994a), page C-32.
g. MEPAS default for soil <10% clay and pH from 5-9.
h. For conservatism, all chromium modeled as VI valence.
i. (Bradbury and Sarott 1995), Table 4, Region 1, page 42.
j. Reducing environment assumed for grout fill.
k. Non-reducing environments assumed for No Action and sand fill option.
l. Values used for basemat concrete for No Action and sand fill option.
m. Value used for clay from WSRC (1994a).
n. MEPAS default used for soil >30% clay and pH from 5-9.
o. MEPAS default used for soil >30% clay and pH >9.
p. Characteristics similar to Sm per Table 3, page 16 of Bradbury and Scott (1995).
q. Characteristics similar to Am per Table 3, page 16 of Bradbury and Scott (1995).
r. Lead is outside of reducing environments for all cases. Therefore, value from Column I is used for all cases.
s. Z-Area Saltstone Radiological Performance Assessment (WSRC 1992), page A-13.
t. Values of K_d for these contaminants were based on non-reducing concrete.
u. Solubility limit of 3.0×10^{-10} µ/liter used to determine K_d, E-Area (WSRC 1994a) p. D-34.

TC **Scenario 2 – Fill With Grout Option**

This scenario assumes that the tanks and ancillary piping would be filled with a strongly reducing grout. Therefore, for the tank model, K_d values for the CZ, first and second partially saturated zones, and the saturated zone are listed in Columns IV, III, I, and I of Table C.3.2-1, respectively.

Similarly, for the piping model, K_d values for the CZ, partially saturated zone, and the saturated zone are listed in Columns IV, I, and I of Table C.3.2-1, respectively.

TC **Scenario 3 – Fill With Sand Option**

This scenario uses the same K_d values as for scenario 1.

TC **Scenario 4 – Fill With Saltstone Option**

This scenario assumes that the tanks and ancillary piping would be filled with saltstone with composition like that in the Z-Area Saltstone Manufacturing and Disposal Facility. Therefore, for the tank model, K_d values for the CZ, first and second partially saturated zones, and the saturated zone are listed in Columns VI, III, I, and I of Table C.3.2-1, respectively.

C.3.2.2 MEPAS Groundwater Input Parameters

Table C.3.2-2 lists input parameters used for the partially saturated zones for the various closure scenarios, and Table C.3.2-3 lists input parameters for the saturated zone. The values used for the concrete basemat and vadose layer for the partially saturated zone were constant for all tank groups within both tank farms with the exception of the vadose zone thickness. Because there are significant differences in the bottom elevation between the various tank groups, the thickness of the vadose zone was modeled specifically for each tank group. Some tank groups in the H Area were modeled without a vadose zone because the tanks are situated in the Water Table Aquifer. When horizontal flow was modeled in each of the aquifer layers, all of the overlying layers were treated as part of the partially saturated zone (i.e., vertical transport only) for that simulation.

The values for the remaining partially saturated zone layers and for all of the saturated zone layers are constant for all tank groups within either the F or H Area that have groundwater flow to the same point of discharge (i.e., to Fourmile Branch or Upper Three Runs). The parameters do vary, however, among the different layers and along different groundwater flow paths. For this reason, Tables C.3.2-2 and C.3.2-3 contain three sets of input parameters: flow from the F-Area Tank Farm toward Fourmile Branch (all tank groups); flow from the H-Area Tank Farm toward Fourmile Branch (four tank groups); and flow from the H-Area Tank Farm toward Upper Three Runs (three tank groups). Because only one-dimensional vertical flow was considered for the Tan Clay and Green Clay layers in both the partially saturated and saturated conditions, the input parameters were the same for these layers for each of the groupings shown in the tables.

C.3.2.3 Hydraulic Conductivities

Because leach rate is ultimately limited by the lowest hydraulic conductivity of the strata and structures above and below the contaminated zone, this parameter is highly sensitive in its effect on breakthrough times and peak concentrations at the receptor locations. For modeling purposes, it was assumed that excess water has a place to run off (over the sides of the basemat) and that ponding above the contaminated zone does not occur.

C.3.2.4 Human Health Exposure Parameters and Assumed Values

Because the impact on a given receptor depends in large part on the physical characteristics and habits of the receptor, it is necessary to stipulate certain values to obtain meaningful results. Certain of these values are included as default

Table C.3.2-2. Partially saturated zone MEPAS input parameters.

	Concrete basemat		Vadose Zone layer	Water Table layer	Tan clay layer	Barnwell-McBean layer	Green clay layer
	Intact	Failed					
F-Area Tank Farm, flow toward Fourmile Branch							
Thickness (centimeters)	18[a]	18[a]	Varies[b]	1,200[c]	91[c]	1,800[c]	150[c]
Bulk density (grams per cubic centimeters)	2.21[d]	1.64[e]	1.59[d]	1.59[d]	1.36[e]	1.59[d]	1.39[e]
Total porosity	15%[d]	38%[e]	35%[f]	35%[f]	40%[f]	35%[f]	40%[f]
Field Capacity	15%[d]	9%[e]	12%[e]	35%[e]	33.4%[e]	35%[e]	32.5%[e]
Longitudinal dispersion (centimeters)[g]	0.18	0.18	Varies	12	0.91	18	1.5
Vertical hydraulic conductivity (centimeters per second)	9.6×10^{-9}[d]	6.6×10^{-3}[e]	7.1×10^{-4}[h]	7.1×10^{-4}[h]	1.6×10^{-6}[h]	5.6×10^{-4}[h]	4.4×10^{-9}[h]
H-Area Tank Farm, flow toward Fourmile Branch							
Thickness (centimeters)	18[a]	18[a]	Varies[b]	1,900[i]	300[i]	2,000[i]	300[i]
Bulk density (grams per cubic centimeters)	2.21[d]	1.64[e]	1.59[d]	1.59[d]	1.36[e]	1.59[d]	1.39[e]
Total porosity	15%[d]	38%[e]	35%[f]	35%[f]	40%[f]	35%[f]	40%[f]
Field capacity	15%[d]	9%[e]	12%[e]	35%[j]	33.4%[j]	35%[j]	32.5%[j]
Longitudinal dispersion (centimeters)[g]	0.18	0.18	Varies	19	3.0	20	3.0
Vertical hydraulic conductivity (centimeters per second)	$9.\times10^{-9}$[d]	6.6×10^{-3}[e]	1.6×10^{-4}[i]	1.6×10^{-4}[i]	3.2×10^{-7}[i]	1.6×10^{-4}[i]	3.5×10^{-8}[i]
H-Area Tank Farm, flow toward Upper Three Runs							
Thickness (centimeters)	18[a]	18[a]	Varies[b]	1,900[i]	300[i]	1,800[i]	300[i]
Bulk density (grams per cubic centimeters)	2.21[d]	1.64[e]	1.59[d]	1.59[d]	1.36[e]	1.59[d]	1.39[e]
Total porosity	15%[d]	38%[e]	35%[f]	35%[f]	40%[f]	35%[f]	40%[f]
Field capacity	15%[d]	9%[e]	12%[e]	35%[j]	33.4%[j]	35%[j]	32.5%[j]
Longitudinal dispersion (centimeters)[g]	0.18	0.18	Varies	19	3.0	18	3.0
Vertical hydraulic conductivity (centimeters per second)	9.6×10^{-9}[d]	6.6×10^{-3}[e]	1.3×10^{-4}[i]	1.3×10^{-4}[i]	3.0×10^{-7}[i]	1.3×10^{-4}[i]	3.5×10^{-8}[i]

a. Type IV tank shown; Type I = 3.54, Type III = 2.74.
b. Distance between tank bottom elevation (see a. above) and historic groundwater elevation.
c. GeoTrans (1987).
d. WSRC (1994a). Radiological Performance Assessment for the E-Area Vaults Disposal Facility (U), WSRC-RP-94-218.
e. Buck et al. (1995), MEPAS Table 2.1.
f. Aadland et al. (1995). EC
g. Buck et al. (1995); calculated using MEPAS formula for longitudinal dispersivity, based on total travel distance.
h. GeoTrans (1993); where Kz = 0.1 Kx for aquifer layers.
i. WSRC (1994b). WSRC E-7 Procedure Document Q-CLC-H-00005, Revision 0.
j. Buck et al. (1995), MEPAS Table 2.1; assumes aquifer layers are saturated and clay layers nearly saturated.

Table C.3.2-3. MEPAS input parameters for the saturated zone.

	Water Table Aquifer	Barnwell-McBean Aquifer	Congaree Aquifer
F-Area Tank Farm, flow toward Fourmile Branch			
Thickness (centimeters) [a]	1,200	1,800	3,000
Bulk density (grams per cubic centimeter) [b]	1.59	1.59	1.64
Total porosity [c]	35%	35%	34%
Effective porosity [d]	20%	20%	25%
Longitudinal dispersion (centimeters)	1/20th of the flow distance		
Hydraulic conductivity (centimeters per second)	7.1×10^{-3}	5.6×10^{-3}	0.013
Hydraulic gradient [a]	0.006	0.004	0.006
H-Area Tank Farm, flow toward Fourmile Branch			
Thickness (centimeters) [a]	1,900	2,000	3,000
Bulk density (grams per cubic centimeter) [b]	1.59	1.59	1.64
Total porosity [c]	35%	35%	34%
Effective porosity [d]	20%	20%	25%
Longitudinal dispersion (centimeters)	1/20th of the flow distance		
Hydraulic conductivity (centimeters per second)	1.6×10^{-3}	1.6×10^{-3}	1.4×10^{-3}
Hydraulic gradient [a]	0.014	0.011	0.004
H-Area Tank Farm, flow toward Upper Three Runs			
Thickness (centimeters) [a]	1,900	1,800	3,000
Bulk density (grams per cubic centimeter) [b]	1.59	1.59	1.64
Total porosity [c]	35%	35%	34%
Effective porosity [d]	20%	20%	25%
Longitudinal dispersion (centimeters)	1/20th of the flow distance		
Hydraulic conductivity (centimeters per second)	1.3×10^{-3}	1.3×10^{-3}	1.4×10^{-3}
Hydraulic gradient [a]	0.015	0.009	0.003

a. GeoTrans (1987 and 1993).
b. Buck et al. (1995), MEPAS Table 2.1.
c. Aadland et al. (1995).
d. EPA (1989) and WSRC (1994b) WSRC E-7 Procedure Document Q-CLC-H-00005, Revision 0.

values in MEPAS; however, others must be specified so the receptors are modeled appropriately for the scenario being described.

For this modeling effort, site-specific values were used as much as possible; that is, values that had been used in other modeling efforts for the SRS were incorporated when available and appropriate. Table C.3.2-4 lists the major parameters that were used in assigning characteristics to the receptors used in the calculations.

Table C.3.2-4. Assumed human health exposure parameters.

Parameter	Applicable receptor	Value	Comments
Body mass	Adult	70 kg	This value is taken directly from ICRP (1975). In radiological dose calculations, this is the standard value in the industry.
	Child	30 kg	This value was obtained from ICRP (1975). Both a male and female child 9 years of age has an average mass of 30 kg.
Exposure period	All	1 year	This value is necessary so that MEPAS will calculate an annual radiation dose. Lifetime doses can be calculated by multiplying the annual dose by the assumed life of the individual.
Leafy vegetable ingestion rate	Adult	21 kg/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	8.53 kg/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates for maximum individuals in NRC (1977).
Other vegetables ingestion rate	Adult	163 kg/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	163 kg/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates for maximum individuals in NRC (1977).
Meat ingestion rate	Adult	43 kg/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	16 kg/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates for maximum individuals in NRC (1977).
Milk ingestion rate	Adult	120 L/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	128 L/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates for maximum individuals in NRC (1977).
Water ingestion rate	All	2 L/day	This value is standard in MEPAS and is consistent with maximum drinking water rates in NRC (1977).
Finfish ingestion rate	Adult	9 kg/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	2.96 kg/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates for maximum individuals in NRC (1977).
Time spent at shoreline	Adult resident	12 hrs/yr	This is a default value from MEPAS and is consistent with NRC (1977).
	Child resident	12 hrs/yr	This is a default value from MEPAS and is consistent with NRC (1977).
	Seepline worker	2080 hrs/yr	This value is based on the assumption of continuous exposure of the seepline worker during each working day.
	Intruder	1040 hrs/yr	This value is based on the conservative assumption of half-time exposure during each working day.
Time spent swimming	Adult resident	12 hrs/yr	This is a default value from MEPAS and is consistent with NRC (1977).
	Child resident	12 hrs/yr	This is a default value from MEPAS and is consistent with NRC (1977).

C.3.3 ECOLOGICAL RISK ASSESSMENT

The exposure factors used in calculating doses to the shrew and mink are listed in Table C.3.3-1. An important assumption of the exposure calculation is that no feeding or drinking takes place outside the influence of the seepage, even though the home ranges of the shrew and the mink typically are larger than the seep areas. EPA (1993) presents a range of literature-based home ranges for the short-tailed shrew that vary from 0.03 to 1.8 hectare. Home ranges for the mink also vary widely in the literature from 7.8 to 770 Hectare (EPA 1993). The bioaccumulation factor for soil and soil invertebrates is 1 for all metals, as is the factor for soil invertebrates and shrews. K_d values for estimating-contaminant concentrations in soil due to the influence of seepage are from Baes et al. (1984). Bioconcentration factors for estimating contaminant concentrations in aquatic prey items are from the EPA Region IV water quality criteria table. For contaminants with no listing in the Region IV table for a bioconcentration factor, a factor of 1 is used. 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.

C.4 Results

C.4.1 HUMAN HEALTH ASSESSMENT

For each scenario, the maximum concentration or dose was identified for each receptor and for each contaminant along with the time period during which the maximum occurred within a 10,000-year performance period. In addition, for radiological constituents, the total dose was calculated to allow evaluation of the impact of all radiological constituents. Because the maximum doses for each radionuclide do not necessarily occur simultaneously, it is not appropriate to add the maximum doses for each radionuclide. Rather, it is more appropriate to assess the doses as a function of time, sum the doses from all radionuclides for each time increment, and then select the maximum total dose from this compilation. Therefore, the total dose reported in the following tables for radiological constituents may not necessarily correlate to the maximum dose or time period for any individual radionuclide because of the contributions from all radionuclides at a given time. In addition to total dose, the gross alpha concentration was calculated to enable comparison among the alternatives

Nonradiological constituent concentrations in the various water bodies were calculated to allow direct comparison among the alternatives. For each constituent, the maximum concentration was calculated along with the time period during which the maximum concentration occurred. None of the nonradiological constituents are known ingestion carcinogens; therefore cancer risk was not calculated for these contaminants.

Tables C.4.1-1 through C.4.1-26 list impact estimates for the four scenarios described in Section C.2. For those tables describing radiological impacts, doses are presented for postulated individuals (i.e., Adult Resident, Child Resident, Seepline Worker, and Intruder) and at the seepline. Additional calculations were performed at groundwater locations close to the tank farm and are reported as drinking water doses to allow comparison to the appropriate maximum contaminant level. DOE estimates that the total dose at the locations would not exceed the drinking water doses by more than 20%. For nonradiological constituents, the maximum concentration of each contaminant is reported for each water location. | EC

For the case of No Action, the reported doses are those arising strictly from the water pathways; impacts from air pathways, in principle, would increase the total dose to a given receptor. It is expected, however, that atmospheric release of the tanks' contents would not be appreciable because:

The amount of rainfall in the area would tend to keep the tank contents damp through the time of failure. After failure, a substantial amount of

Table C.3.3-1. Parameters for foodchain model ecological receptors.

Receptor	Feeding group	Parameter	Value	Notes; Reference
Southern short-tailed shrew (*Blarina carolinensis*)	Insectivore	Body weight	9.7 grams	Mean of 423 adults collected on SRS; Cothran et al. (1991)
		Water ingestion	2.2 grams/day	0.223 g/g/day X 9.7g; EPA (1993)
		Food ingestion	5.2 grams/day	0.541 g/g/day X 9.7g; Richardson (1973) cited in Cothran et al. (1991)
		Soil ingestion	10% of diet	Between vole (2.4%) and armadillo (17%); Beyer et al. (1994)
		Home range	0.96 ha	Mean value on SRS; Faust et al. (1971) cited in Cothran et al. (1991)
Mink (*Mustela vison*)	Carnivore	Body weight	800 grams	"Body weight averages 0.6 to 1.0 kg"; Cothran et al. (1991)
		Water ingestion	22.4 grams/day	0.028 g/g/day X 800g; EPA (1993)
		Food ingestion	110 grams/day	Mean of male and female estimates; EPA (1993)
		Soil ingestion	5% of diet	Between red fox (2.8%) and raccoon (9.4%); Beyer et al. (1994)
		Home range	variable	7.8-20.4 ha (Montana);
				259-380 ha (North Dakota; EPA 1993)
				Females: 6-15 ha, males: 18-24 ha (Kansas; Bee et al. 1981)

debris on top of the contaminated material would prevent release even if the contents were to dry during a period of drought.

- The considerable depth of the tanks below grade would tend to discourage resuspension of any of the tanks' contents.

As discussed in Chapters 3 and 4 of this EIS, DOE performed groundwater modeling calculations for the three uppermost aquifers underneath the tank farms: the Water Table Aquifer, the Barnwell-McBean Aquifer, and the Congaree Aquifer. Tables C.4.1-1 through C.4.1-26 present results for each tank farm and by aquifer. Although more than one aquifer may outcrop to the same point on the seepline, the concentration values at the seepline are not additive. Therefore, DOE uses only the maximum seepline concentration for Fourmile Branch and Upper Three Runs from the alternatives in its comparison of impacts among the alternatives.

Table C.4.1-1. Radiological results for F-Area Tank Farm in the Water Table Aquifer (millirem per year).

		Maximum concentration			
		Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	Maximum value Time of maximum (yrs)	1.9×10^{-2} 385	2.9×10^{-2} 175	1.7×10^{-1} 7035	3.3 1155
Child resident (total dose)	Maximum value Time of maximum (yrs)	1.7×10^{-2} 385	2.7×10^{-2} 175	1.6×10^{-1} 7035	3.1 1155
Seepline worker (total dose)	Maximum value Time of maximum (yrs)	(a) (a)	(a) (a)	(a) (a)	9.6×10^{-3} 105
Intruder (total dose)	Maximum value Time of maximum (yrs)	(a) (a)	(a) (a)	(a) (a)	4.8×10^{-3} 105
1-meter well (drinking water dose)	Maximum value Time of maximum (yrs)	4.3×10^{1} 385	1.3×10^{2} 35	3.0×10^{2} 5705	3.6×10^{5} 245
100-meter well (drinking water dose)	Maximum value Time of maximum (yrs)	1.6×10^{1} 315	5.1×10^{1} 35	1.4×10^{2} 7035	6.0×10^{3} 315
Seepline (drinking water dose)	Maximum value Time of maximum (yrs)	1.0 385	1.4 175	9.5 7455	1.8×10^{2} 1155
Surface water (drinking water dose)	Maximum value Time of maximum (yrs)	6.9×10^{-3} 385	1.1×10^{-2} 175	6.3×10^{-2} 7035	1.2 1155

TC

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

Table C.4.1-2. Radiological results for F-Area Tank Farm in the Barnwell-McBean Aquifer (millirem per year).

		Maximum concentration			
		Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	Maximum value	2.7×10^{-2}	5.1×10^{-2}	3.7×10^{-1}	6.2
	Time of maximum (yrs)	875	245	7525	1225
Child resident (total dose)	Maximum value	2.4×10^{-2}	4.7×10^{-2}	3.4×10^{-1}	5.7
	Time of maximum (yrs)	875	245	7525	1225
Seepline worker (total dose)	Maximum value	(a)	(a)	1.0×10^{-3}	1.8×10^{-2}
	Time of maximum (yrs)	(a)	(a)	7525	1225
Intruder (total dose)	Maximum value	(a)	(a)	(a)	9.0×10^{-3}
	Time of maximum (yrs)	(a)	(a)	(a)	1225
1-meter well (drinking water dose)	Maximum value	1.3×10^{2}	4.2×10^{2}	7.9×10^{2}	3.5×10^{4}
	Time of maximum (yrs)	665	105	6965	35
100-meter well (drinking water dose)	Maximum value	5.1×10^{1}	1.9×10^{2}	5.1×10^{2}	1.4×10^{4}
	Time of maximum (yrs)	665	105	6685	35
Seepline (drinking water dose)	Maximum value	1.9	3.5	2.5×10^{1}	4.3×10^{2}
	Time of maximum (yrs)	875	245	6475	1225
Surface water (drinking water dose)	Maximum value	9.8×10^{-3}	1.9×10^{-2}	1.3×10^{-1}	2.3
	Time of maximum (yrs)	875	245	7525	1225

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

TC

Table C.4.1-3. Radiological results for F-Area Tank Farm in the Congaree Aquifer (millirem per year).

EC

		Maximum concentration			
		Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	Maximum value	(a)	(a)	1.4×10^{-2}	1.1×10^{-1}
	Time of maximum (yrs)	(a)	(a)	8855	1365
Child resident (total dose)	Maximum value	(a)	(a)	1.3×10^{-2}	1.0×10^{-1}
	Time of maximum (yrs)	(a)	(a)	8855	1365
Seepline worker (total dose)	Maximum value	(a)	(a)	(a)	(a)
	Time of maximum (yrs)	(a)	(a)	(a)	(a)
Intruder (total dose)	Maximum value	(a)	(a)	(a)	(a)
	Time of maximum (yrs)	(a)	(a)	(a)	(a)
1-meter well (drinking water dose)	Maximum value	9.1×10^{-1}	1.2	3.0×10^{1}	1.7×10^{2}
	Time of maximum (yrs)	4935	2905	6615	1155
100-meter well (drinking water dose)	Maximum value	2.2×10^{-1}	2.5×10^{-1}	6.4	4.2×10^{1}
	Time of maximum (yrs)	1225	3115	8435	1295
Seepline (drinking water dose)	Maximum value	6.5×10^{-3}	8.7×10^{-3}	1.9×10^{-1}	1.6
	Time of maximum (yrs)	5495	3325	7805	1295
Surface water (drinking water dose)	Maximum value	(a)	(a)	5.0×10^{-3}	4.2×10^{-2}
	Time of maximum (yrs)	(a)	(a)	8855	1365

TC

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

EC
TC

Table C.4.1-4. Radiological results for H-Area Tank Farm in the Water Table Aquifer (millirem per year).

			Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	1.4×10^{-3}	1.2×10^{-2}	2.6×10^{-2}	1.2
		Time of maximum (years)	455	105	6125	105
	South of Groundwater Divide	Maximum value (mrem/yr)	1.0×10^{-2}	1.6×10^{-2}	1.9×10^{-1}	2.4
		Time of maximum (years)	455	175	6125	1015
Child resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	1.3×10^{-3}	1.1×10^{-2}	2.4×10^{-2}	1.1
		Time of maximum (years)	455	105	6125	105
	South of Groundwater Divide	Maximum value (mrem/yr)	9.3×10^{-3}	1.5×10^{-2}	1.8×10^{-1}	2.2
		Time of maximum (years)	455	175	6125	1015
Seepline worker (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	3.5×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	105
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	7.0×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1015
Intruder (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	1.7×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	105
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	3.5×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1015
1-meter well (drinking water dose)	North of Groundwater Divide	Maximum value (mrem/yr)	1.0×10^{5}	1.3×10^{5}	1.0×10^{5}	9.3×10^{6}
		Time of maximum (years)	175	175	175	105
	South of Groundwater Divide	Maximum value (mrem/yr)	1.2×10^{2}	2.5×10^{2}	5.5×10^{2}	8.3×10^{5}
		Time of maximum (years)	315	385	4725	245
100-meter well (drinking water dose)	North of Groundwater Divide	Maximum value (mrem/yr)	3.0×10^{2}	9.2×10^{2}	8.7×10^{2}	9.0×10^{4}
		Time of maximum (years)	245	35	5915	35
	South of Groundwater Divide	Maximum value (mrem/yr)	2.9×10^{1}	6.1×10^{1}	2.9×10^{2}	6.1×10^{3}
		Time of maximum (years)	315	35	5635	35
Seepline (drinking water dose)	North of Groundwater Divide	Maximum value (mrem/yr)	2.5	2.5×10^{1}	4.6×10^{1}	2.5×10^{3}
		Time of maximum (years)	455	105	5635	105
	South of Groundwater Divide	Maximum value (mrem/yr)	9.5×10^{-1}	1.4	1.6×10^{1}	2.0×10^{2}
		Time of maximum (years)	455	175	5425	1015
Surface water (drinking water dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	4.3×10^{-3}	9.6×10^{-3}	4.5×10^{-1}
		Time of maximum (years)	(a)	105	6125	105
	South of Groundwater Divide	Maximum value (mrem/yr)	3.7×10^{-3}	6.0×10^{-3}	7.1×10^{-2}	9.0×10^{-1}
		Time of maximum (years)	455	175	6125	1015

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

Table C.4.1-5. Radiological results for H-Area Tank Farm in the Barnwell-McBean Aquifer (millirem per year).

			Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	2.1×10^{-3}	1.1×10^{-2}	2.4×10^{-1}
		Time of maximum (years)	(a)	455	6195	385
	South of Groundwater Divide	Maximum value (mrem/yr)	3.4×10^{-3}	7.8×10^{-3}	1.2×10^{-1}	1.4
		Time of maximum (years)	4515	385	6335	1155
Child resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	2.0×10^{-3}	1.0×10^{-2}	2.2×10^{-1}
		Time of maximum (years)	(a)	455	6195	385
	South of Groundwater Divide	Maximum value (mrem/yr)	3.1×10^{-3}	7.2×10^{-3}	1.1×10^{-1}	1.3
		Time of maximum (years)	4515	385	6335	1155
Seepline worker (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	4.2×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1155
Intruder (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	2.1×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1155
1-meter well (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	9.7×10^{1}	1.9×10^{3}	1.7×10^{3}	1.7×10^{5}
		Time of maximum (years)	1155	105	4165	105
	South of Groundwater Divide	Maximum value (mrem/yr)	5.3×10^{1}	1.4×10^{2}	4.3×10^{2}	2.5×10^{4}
		Time of maximum (years)	4445	245	5005	945
100-meter well (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	3.2×10^{1}	4.6×10^{2}	6.4×10^{2}	5.8×10^{4}
		Time of maximum (years)	1155	105	5845	105
	South of Groundwater Divide	Maximum value (mrem/yr)	1.6×10^{1}	5.1×10^{1}	2.7×10^{2}	4.9×10^{3}
		Time of maximum (years)	1155	245	6405	105
Seepline (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	7.5×10^{-1}	4.5	2.3×10^{1}	4.9×10^{2}
		Time of maximum (years)	4515	385	6125	385
	South of Groundwater Divide	Maximum value (mrem/yr)	3.5×10^{-1}	8.4×10^{-1}	1.3×10^{1}	1.6×10^{2}
		Time of maximum (years)	4445	385	6895	1155
Surface water (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	4.2×10^{-3}	8.8×10^{-2}
		Time of maximum (years)	(a)	(a)	6195	385
	South of Groundwater Divide	Maximum value (mrem/yr)	1.2×10^{-3}	2.9×10^{-3}	4.6×10^{-2}	5.3×10^{-1}
		Time of maximum (years)	4515	385	6265	1155

TC

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

EC

TC

Table C.4.1-6. Radiological results for H-Area Tank Farm in the Congaree Aquifer (millirem per year).

			Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	1.1×10^{-2}	8.6×10^{-2}
		Time of maximum (years)	(a)	(a)	6825	805
	South of Groundwater Divide	Maximum value (mrem/yr)	1.6×10^{-3}	2.0×10^{-3}	6.6×10^{-2}	4.3×10^{-1}
		Time of maximum (years)	5285	3395	6755	1645
Child resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	1.0×10^{-2}	7.9×10^{-2}
		Time of maximum (years)	(a)	(a)	6825	805
	South of Groundwater Divide	Maximum value (mrem/yr)	1.4×10^{-3}	1.8×10^{-3}	6.1×10^{-2}	4.0×10^{-1}
		Time of maximum (years)	5285	3395	6755	1645
Seepline worker (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	1.2×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1645
Intruder (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
1-meter well (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	3.2×10^{1}	9.8×10^{1}	7.7×10^{2}	9.7×10^{3}
		Time of maximum (years)	5005	595	5145	595
	South of Groundwater Divide	Maximum value (mrem/yr)	1.2×10^{1}	1.6×10^{1}	2.0×10^{2}	3.2×10^{3}
		Time of maximum (years)	5215	3115	5355	1505
100-meter well (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	5.6	2.5×10^{1}	2.5×10^{2}	2.5×10^{3}
		Time of maximum (years)	4935	665	6475	595
	South of Groundwater Divide	Maximum value (mrem/yr)	1.7	2.3	6.4×10^{1}	4.6×10^{2}
		Time of maximum (years)	4935	3185	7105	1435
Seepline (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	9.8×10^{-2}	2.7×10^{-1}	3.2	2.5×10^{1}
		Time of maximum (years)	5005	805	6755	805
	South of Groundwater Divide	Maximum value (mrem/yr)	1.9×10^{-2}	2.3×10^{-2}	7.7×10^{-1}	4.8
		Time of maximum (years)	5285	3325	7665	1645
Surface water (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	4.0×10^{-3}	3.2×10^{-2}
		Time of maximum (years)	(a)	(a)	6825	805
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	2.4×10^{-2}	1.6×10^{-1}
		Time of maximum (years)	(a)	(a)	6755	1645

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

Table C.4.1-7. Alpha concentration for F-Area Tank Farm in the Water Table Aquifer (picocuries per liter).

		Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	Maximum value	5.2	5.3	5.2	7.6×10^{2}
	Time of maximum (yrs)	1855	945	1855	455
100-meter well	Maximum value	1.9	1.9	1.9	2.4×10^{2}
	Time of maximum (yrs)	1995	1085	1995	595
Seepline	Maximum value	2.6×10^{-2}	2.6×10^{-2}	2.6×10^{-2}	5.6
	Time of maximum (yrs)	3885	2905	3885	9555
Surface water	Maximum value	1.8×10^{-4}	1.8×10^{-4}	1.8×10^{-4}	4.1×10^{-2}
	Time of maximum (yrs)	3885	2975	3885	9555

TC

Table C.4.1-8. Alpha concentration for F-Area Tank Farm in the Barnwell-McBean Aquifer (picocuries per liter).

		Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	Maximum value	1.3×10^{1}	1.3×10^{1}	1.3×10^{1}	1.7×10^{3}
	Time of maximum (yrs)	2695	1785	2695	875
100-meter well	Maximum value	4.7	4.6	4.7	5.3×10^{2}
	Time of maximum (yrs)	2905	1995	2905	1085
Seepline	Maximum value	3.9×10^{-2}	3.9×10^{-2}	3.9×10^{-2}	9.2
	Time of maximum (yrs)	6405	5495	6405	9975
Surface water	Maximum value	2.2×10^{-4}	2.2×10^{-4}	2.2×10^{-4}	4.8×10^{-2}
	Time of maximum (yrs)	6265	5355	6265	9975

TC

Table C.4.1-9. Alpha concentration for F-Area Tank Farm in the Congaree Aquifer (picocuries per liter).

		Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	Maximum value	3.1×10^{-3}	3.1×10^{-3}	3.1×10^{-3}	1.7
	Time of maximum (yrs)	8295	7315	8295	9975
100-meter well	Maximum value	1.3×10^{-3}	1.2×10^{-3}	1.3×10^{-3}	3.6×10^{-1}
	Time of maximum (yrs)	8225	8225	8225	9975
Seepline	Maximum value	3.7×10^{-5}	3.7×10^{-5}	3.7×10^{-5}	9.4×10^{-3}
	Time of maximum (yrs)	9345	8435	9345	9975
Surface water	Maximum value	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	2.6×10^{-4}
	Time of maximum (yrs)	8365	7455	8365	9975

TC

Table C.4.1-10. Alpha concentration for H-Area Tank Farm in the Water Table Aquifer (picocuries per liter).

			Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	North of Groundwater Divide	Maximum value	2.4×10^{1}	2.9×10^{2}	2.4×10^{1}	1.3×10^{4}
		Time of maximum (years)	1925	175	1925	1715
	South of Groundwater Divide	Maximum value	8.6	8.6	8.6	1.1×10^{3}
		Time of maximum (years)	1855	945	1855	455
100-meter well	North of Groundwater Divide	Maximum value	7.0	3.8×10^{1}	7.0	3.8×10^{3}
		Time of maximum (years)	2205	455	2205	455
	South of Groundwater Divide	Maximum value	2.0	2.0	2.0	2.0×10^{2}
		Time of maximum (years)	2065	1155	2065	665
Seepline	North of Groundwater Divide	Maximum value	1.5×10^{-1}	3.3×10^{-1}	1.5×10^{-1}	3.4×10^{1}
		Time of maximum (years)	4655	2695	4655	2345
	South of Groundwater Divide	Maximum value	1.9×10^{-2}	1.9×10^{-2}	1.9×10^{-2}	4.9
		Time of maximum (years)	4585	3675	4585	8925
Surface water	North of Groundwater Divide	Maximum value	3.1×10^{-5}	6.1×10^{-5}	3.1×10^{-5}	6.2×10^{-3}
		Time of maximum (years)	4585	2765	4585	2695
	South of Groundwater Divide	Maximum value	7.9×10^{-5}	7.9×10^{-5}	7.9×10^{-5}	2.2×10^{-2}
		Time of maximum (years)	4655	3745	4655	8855

TC

Table C.4.1-11. Alpha concentration for H-Area Tank Farm in the Barnwell-McBean Aquifer (picocuries per liter).

TC

			Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	North of Groundwater Divide	Maximum value	3.8	2.1×10^{1}	3.8	2.2×10^{3}
		Time of maximum (years)	5355	3185	5355	2975
	South of Groundwater Divide	Maximum value	1.9	1.9	1.9	6.6×10^{2}
		Time of maximum (years)	5005	4095	5005	8435
100-meter well	North of Groundwater Divide	Maximum value	1.2	5.7	1.2	6.0×10^{2}
		Time of maximum (years)	5845	3605	5845	3325
	South of Groundwater Divide	Maximum value	5.2×10^{-1}	5.2×10^{-1}	5.2×10^{-1}	1.2×10^{2}
		Time of maximum (years)	5355	4445	5355	8785
Seepline	North of Groundwater Divide	Maximum value	1.0×10^{-2}	6.4×10^{-2}	1.0×10^{-2}	6.0
		Time of maximum (years)	9975	9975	9975	9625
	South of Groundwater Divide	Maximum value	1.0×10^{-2}	1.0×10^{-2}	1.0×10^{-2}	1.7
		Time of maximum (years)	9205	8295	9205	7875
Surface water	North of Groundwater Divide	Maximum value	2.0×10^{-6}	1.2×10^{-5}	2.0×10^{-6}	1.1×10^{-3}
		Time of maximum (years)	9975	9975	9975	9765
	South of Groundwater Divide	Maximum value	3.8×10^{-5}	3.8×10^{-5}	3.8×10^{-5}	6.4×10^{-3}
		Time of maximum (years)	9555	8645	9555	7735

Table C.4.1-12. Alpha concentration for H-Area Tank Farm in the Congaree Aquifer (picocuries per liter).

TC

			Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	North of Groundwater Divide	Maximum value	7.3×10^{-4}	7.2×10^{-2}	7.3×10^{-4}	9.5
		Time of maximum (years)	9975	9975	9975	9975
	South of Groundwater Divide	Maximum value	2.5×10^{-4}	1.2×10^{-3}	2.5×10^{-4}	4.0×10^{-1}
		Time of maximum (years)	9975	9975	9975	9975
100-meter well	North of Groundwater Divide	Maximum value	1.9×10^{-4}	1.6×10^{-2}	1.9×10^{-4}	2.1
		Time of maximum (years)	9975	9975	9975	9975
	South of Groundwater Divide	Maximum value	5.2×10^{-5}	2.8×10^{-4}	5.2×10^{-5}	1.0×10^{-1}
		Time of maximum (years)	9975	9975	9975	9975
Seepline	North of Groundwater Divide	Maximum value	6.7×10^{-9}	4.4×10^{-6}	6.7×10^{-9}	7.8×10^{-4}
		Time of maximum (years)	9975	9975	9975	9975
	South of Groundwater Divide	Maximum value	7.8×10^{-10}	1.6×10^{-8}	7.8×10^{-10}	1.8×10^{-5}
		Time of maximum (years)	9975	9975	9975	9975
Surface water	North of Groundwater Divide	Maximum value	2.6×10^{-11}	6.4×10^{-9}	2.6×10^{-11}	1.1×10^{-6}
		Time of maximum (years)	9975	9975	9975	9975
	South of Groundwater Divide	Maximum value	8.0×10^{-11}	9.3×10^{-10}	8.0×10^{-11}	8.8×10^{-7}
		Time of maximum (years)	9975	9975	9975	9975

Table C.4.1-13. Concentrations in groundwater and surface water of silver (milligrams per liter).

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	1.2×10^{-1}	7.9×10^{-2}	1.2×10^{-1}	8.2×10^{-1}	8.6×10^{-3}	6.3×10^{-3}	8.6×10^{-3}	5.3×10^{-1}	9.7×10^{-4}	7.2×10^{-4}	9.7×10^{-4}	4.9×10^{-2}
	Time (yr)	1015	245	1015	105	1015	245	1015	105	1015	245	1015	105
	Barnwell -McBean	3.2×10^{-1}	2.0×10^{-1}	3.2×10^{-1}	3.4	7.1×10^{-4}	9.4×10^{-4}	7.1×10^{-4}	9.3×10^{-2}	8.8×10^{-5}	8.9×10^{-5}	8.8×10^{-5}	9.0×10^{-3}
	Time (yr)	1155	385	1155	245	2695	1855	2695	1785	2765	1715	2765	1645
	Congaree	3.1×10^{-5}	3.1×10^{-5}	3.1×10^{-5}	3.3×10^{-4}	2.0×10^{-5}	2.4×10^{-5}	2.0×10^{-5}	2.3×10^{-3}	1.2×10^{-6}	1.2×10^{-6}	1.2×10^{-6}	1.2×10^{-4}
	Time (yr)	4165	3325	4165	3115	9975	9765	9975	9555	9975	9205	9975	9205
100-meter well	Water Table	2.3×10^{-2}	1.4×10^{-2}	2.3×10^{-2}	1.8×10^{-1}	1.5×10^{-3}	1.9×10^{-3}	1.5×10^{-3}	1.5×10^{-1}	2.0×10^{-4}	1.7×10^{-4}	2.0×10^{-4}	1.1×10^{-2}
	Time (yr)	1015	245	1015	105	1015	35	1015	35	1015	245	1015	175
	Barnwell -McBean	6.5×10^{-2}	3.9×10^{-2}	6.5×10^{-2}	9.0×10^{-1}	1.2×10^{-4}	1.9×10^{-4}	1.2×10^{-4}	1.8×10^{-2}	1.7×10^{-5}	1.6×10^{-5}	1.7×10^{-5}	1.7×10^{-3}
	Time (yr)	1155	385	1155	245	2625	1785	2625	1785	2765	1645	2765	1645
	Congaree	5.7×10^{-6}	5.7×10^{-6}	5.7×10^{-6}	6.7×10^{-5}	3.1×10^{-6}	4.0×10^{-6}	3.1×10^{-6}	3.7×10^{-4}	(a)	(a)	(a)	2.0×10^{-5}
	Time (yr)	4235	3325	4235	3115	9905	9695	9905	9835	(a)	(a)	(a)	9415
Seepline	Water Table	7.1×10^{-4}	5.8×10^{-4}	7.1×10^{-4}	1.1×10^{-2}	4.5×10^{-5}	5.8×10^{-5}	4.5×10^{-5}	6.0×10^{-3}	5.2×10^{-6}	5.1×10^{-6}	5.2×10^{-6}	5.5×10^{-4}
	Time (yr)	1085	315	1085	245	1155	175	1155	175	1155	385	1155	245
	Barnwell -McBean	1.7×10^{-3}	1.2×10^{-3}	1.7×10^{-3}	2.1×10^{-2}	3.9×10^{-6}	5.7×10^{-6}	3.9×10^{-6}	4.8×10^{-4}	(a)	(a)	(a)	6.7×10^{-5}
	Time (yr)	1365	525	1365	455	3115	2275	3115	2065	(a)	(a)	(a)	1925
	Congaree	(a)	(a)	(a)	1.9×10^{-6}	(a)	(a)	(a)	4.0×10^{-6}	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	3185	(a)	(a)	(a)	9835	(a)	(a)	(a)	(a)
Surface Water	Water Table	4.5×10^{-6}	3.8×10^{-6}	4.5×10^{-6}	7.8×10^{-5}	(a)	(a)	(a)	1.2×10^{-6}	(a)	(a)	(a)	2.4×10^{-6}
	Time (yr)	1085	315	1085	245	(a)	(a)	(a)	245	(a)	(a)	(a)	245
	Barnwell -McBean	8.8×10^{-6}	6.5×10^{-6}	8.8×10^{-6}	1.1×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	1365	595	1365	455	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

TC

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-14. Concentrations in groundwater and surface water of aluminum (milligrams per liter).

TC

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-15. Concentrations in groundwater and surface water of barium (milligrams per liter).

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	6.3×10^{-5}	(a)	6.3×10^{-5}	2.9×10^{-4}	1.9×10^{-4}	2.2×10^{-5}	1.9×10^{-4}	7.2×10^{-4}	(a)	(a)	(a)	(a)
	Time (yr)	9975	(a)	9975	9975	7945	8435	7945	6475	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	(a)	(a)	(a)	2.6×10^{-6}	(a)	(a)	(a)	4.0×10^{-6}	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

TC

TC

Table C.4.1-16. Concentrations in groundwater and surface water of fluoride (milligrams per liter).

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	1.1×10^{-2}	6.5×10^{-2}	1.1×10^{-2}	4.2×10^{-1}	1.2×10^{-2}	1.3×10^{-2}	1.2×10^{-2}	7.4×10^{-1}	2.6×10^{-3}	9.1×10^{-3}	2.6×10^{-3}	5.1×10^{-1}
	Time (yr)	105	105	105	105	35	35	35	35	105	105	105	105
	Barnwell-McBean	2.0×10^{-1}	2.1×10^{-1}	2.0×10^{-1}	1.9	1.2×10^{-2}	1.2×10^{-2}	1.2×10^{-2}	9.5×10^{-1}	1.0×10^{-2}	1.0×10^{-2}	1.0×10^{-2}	1.0
	Time (yr)	1015	105	1015	105	1015	105	1015	105	1015	105	1015	105
	Congaree	1.1×10^{-3}	1.2×10^{-3}	1.1×10^{-3}	1.0×10^{-2}	2.2×10^{-3}	3.1×10^{-3}	2.2×10^{-3}	2.7×10^{-1}	1.2×10^{-3}	1.3×10^{-3}	1.2×10^{-3}	1.4×10^{-1}
	Time (yr)	1085	175	1085	105	1155	245	1155	245	1155	245	1155	245
100-meter well	Water Table	3.8×10^{-3}	1.2×10^{-2}	3.8×10^{-3}	1.1×10^{-1}	3.2×10^{-3}	3.6×10^{-3}	3.2×10^{-3}	3.3×10^{-1}	6.0×10^{-4}	1.8×10^{-3}	6.0×10^{-4}	1.3×10^{-1}
	Time (yr)	105	105	105	105	35	35	35	35	105	105	105	105
	Barnwell-McBean	4.5×10^{-2}	4.7×10^{-2}	4.5×10^{-2}	5.0×10^{-1}	2.3×10^{-3}	2.4×10^{-3}	2.3×10^{-3}	2.2×10^{-1}	1.7×10^{-3}	1.7×10^{-3}	1.7×10^{-3}	1.7×10^{-1}
	Time (yr)	1015	105	1015	105	1015	35	1015	35	1015	105	1015	105
	Congaree	2.0×10^{-4}	2.2×10^{-4}	2.0×10^{-4}	2.1×10^{-3}	3.5×10^{-4}	6.0×10^{-4}	3.5×10^{-4}	4.8×10^{-2}	1.7×10^{-4}	2.0×10^{-4}	1.7×10^{-4}	2.1×10^{-2}
	Time (yr)	1085	175	1085	105	1155	245	1155	245	1155	245	1155	245
Seepline	Water Table	1.8×10^{-4}	7.0×10^{-4}	1.8×10^{-4}	8.4×10^{-3}	1.5×10^{-4}	1.7×10^{-4}	1.5×10^{-4}	1.6×10^{-2}	1.9×10^{-5}	8.4×10^{-5}	1.9×10^{-5}	7.8×10^{-3}
	Time (yr)	105	105	105	105	35	35	35	35	105	105	105	105
	Barnwell-McBean	1.1×10^{-3}	1.4×10^{-3}	1.1×10^{-3}	2.0×10^{-2}	6.3×10^{-5}	8.0×10^{-5}	6.3×10^{-5}	5.9×10^{-3}	5.5×10^{-5}	5.5×10^{-5}	5.5×10^{-5}	4.1×10^{-3}
	Time (yr)	1015	105	1015	105	1085	175	1085	175	1085	175	1085	105
	Congaree	5.8×10^{-6}	6.3×10^{-6}	5.8×10^{-6}	6.8×10^{-5}	5.6×10^{-6}	8.1×10^{-6}	5.6×10^{-6}	5.5×10^{-4}	1.6×10^{-6}	1.9×10^{-6}	1.6×10^{-6}	1.8×10^{-4}
	Time (yr)	1085	175	1085	175	1225	315	1225	315	1225	315	1225	315
Surface Water	Water Table	1.2×10^{-6}	4.8×10^{-6}	1.2×10^{-6}	6.1×10^{-5}	(a)	(a)	(a)	3.0×10^{-6}	(a)	(a)	(a)	3.5×10^{-5}
	Time (yr)	105	105	105	105	(a)	(a)	(a)	35	(a)	(a)	(a)	105
	Barnwell-McBean	5.7×10^{-6}	7.3×10^{-6}	5.7×10^{-6}	1.1×10^{-4}	(a)	(a)	(a)	1.1×10^{-6}	(a)	(a)	(a)	1.4×10^{-5}
	Time (yr)	1015	105	1015	105	(a)	(a)	(a)	175	(a)	(a)	(a)	105
	Congaree	(a)	(a)	(a)	1.8×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	5.8×10^{-6}
	Time (yr)	(a)	(a)	(a)	175	(a)	(a)	(a)	(a)	(a)	(a)	(a)	315

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-17. Concentrations in groundwater and surface water of chromium (milligrams per liter).

TC

		F-Area				H-Area: North of Groundwater Divide				H-Area: South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	2.1×10^{-2}	8.5×10^{-3}	2.1×10^{-2}	1.9×10^{-1}	5.4×10^{-3}	2.7×10^{-3}	5.4×10^{-3}	3.2×10^{-1}	3.6×10^{-3}	1.8×10^{-3}	3.6×10^{-3}	2.1×10^{-1}
	Time (yr)	1715	1925	1715	805	1645	1855	1645	805	1575	1785	1575	805
	Barnwell-McBean	2.3×10^{-2}	1.9×10^{-2}	2.3×10^{-2}	3.8×10^{-1}	2.9×10^{-6}	1.1×10^{-5}	2.9×10^{-6}	3.8×10^{-3}	1.4×10^{-6}	1.4×10^{-5}	1.4×10^{-6}	3.7×10^{-3}
	Time (yr)	3745	4025	3745	2065	9975	9975	9975	9975	9975	9975	9975	9975
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	2.7×10^{-3}	1.5×10^{-3}	2.7×10^{-3}	3.5×10^{-2}	7.6×10^{-4}	5.4×10^{-4}	7.6×10^{-4}	7.4×10^{-2}	5.2×10^{-4}	4.1×10^{-4}	5.2×10^{-4}	3.4×10^{-2}
	Time (yr)	1855	2065	1855	945	1995	2415	1995	1155	2065	2065	2065	1155
	Barnwell-McBean	4.4×10^{-3}	3.7×10^{-3}	4.4×10^{-3}	8.1×10^{-2}	(a)	1.2×10^{-6}	(a)	3.8×10^{-4}	(a)	1.4×10^{-6}	(a)	4.3×10^{-4}
	Time (yr)	4165	4305	4165	2485	(a)	9975	(a)	9975	(a)	9975	(a)	9975
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	3.1×10^{-5}	2.9×10^{-5}	3.1×10^{-5}	5.2×10^{-4}	1.5×10^{-5}	1.3×10^{-5}	1.5×10^{-5}	1.0×10^{-3}	9.2×10^{-6}	9.2×10^{-6}	9.2×10^{-6}	4.4×10^{-4}
	Time (yr)	4865	4865	4865	3955	5495	5565	5495	4235	6265	5775	6265	4935
	Barnwell-McBean	4.6×10^{-5}	4.5×10^{-5}	4.6×10^{-5}	8.0×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	9625	9625	9625	8015	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	3.7×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	2.0×10^{-6}
	Time (yr)	(a)	(a)	(a)	4095	(a)	(a)	(a)	(a)	(a)	(a)	(a)	4935
	Barnwell-McBean	(a)	(a)	(a)	4.2×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	7945	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-18. Concentrations in groundwater and surface water of copper (milligrams per liter).

TC

		F-Area				H-Area North of Groundwater Divide				H-Area South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	6.0×10^{-3}	4.6×10^{-3}	6.0×10^{-3}	6.2×10^{-2}	9.0×10^{-4}	7.1×10^{-4}	9.0×10^{-4}	6.6×10^{-2}	4.5×10^{-4}	3.4×10^{-4}	4.5×10^{-4}	2.9×10^{-2}
	Time (yr)	2765	2905	2765	1295	2695	2835	2695	1295	2555	2695	2555	1295
	Barnwell-McBean	9.4×10^{-3}	8.8×10^{-3}	9.4×10^{-3}	1.5×10^{-1}	(a)	(a)	(a)	8.0×10^{-4}	(a)	(a)	(a)	6.5×10^{-4}
	Time (yr)	6195	6405	6195	3115	(a)	(a)	(a)	9975	(a)	(a)	(a)	9975
	Congaree	(a)	(a)	(a)	5.2×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9835	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	7.6×10^{-4}	6.8×10^{-4}	7.6×10^{-4}	1.1×10^{-2}	1.2×10^{-4}	1.1×10^{-4}	1.2×10^{-4}	1.4×10^{-2}	4.5×10^{-5}	4.7×10^{-5}	4.5×10^{-5}	4.2×10^{-3}
	Time (yr)	3255	3465	3255	1785	3465	4025	3465	2135	3465	3745	3465	2345
	Barnwell-McBean	1.5×10^{-3}	1.6×10^{-3}	1.5×10^{-3}	2.7×10^{-2}	(a)	(a)	(a)	2.0×10^{-5}	(a)	(a)	(a)	2.4×10^{-5}
	Time (yr)	6895	7385	6895	4095	(a)	(a)	(a)	9975	(a)	(a)	(a)	9975
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	7.9×10^{-6}	8.1×10^{-6}	7.9×10^{-6}	1.2×10^{-4}	1.5×10^{-6}	1.6×10^{-6}	1.5×10^{-6}	1.6×10^{-4}	(a)	(a)	(a)	4.0×10^{-5}
	Time (yr)	9975	9975	9975	8505	9835	9975	9835	9835	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	1.1×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9905	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-19. Concentrations in groundwater and surface water of iron (milligrams per liter).

TC

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	2.6	2.7	2.6	3.0×10^{1}	1.1	1.1	1.1	8.2×10^{1}	4.8×10^{-1}	4.8×10^{-1}	4.8×10^{-1}	2.9×10^{1}
	Time (yr)	1575	735	1575	385	1575	665	1575	385	1505	665	1505	385
	Barnwell-McBean	4.7	4.7	4.7	7.4×10^{1}	4.5×10^{-1}	4.5×10^{-1}	4.5×10^{-1}	6.2×10^{1}	2.2×10^{-1}	2.1×10^{-1}	2.2×10^{-1}	2.6×10^{1}
	Time (yr)	2485	1645	2485	805	3605	2695	3605	1575	3465	2485	3465	1435
	Congaree	5.9×10^{-3}	6.0×10^{-3}	5.9×10^{-3}	7.6×10^{-2}	1.5×10^{-2}	2.5×10^{-2}	1.5×10^{-2}	2.6	4.1×10^{-3}	6.2×10^{-3}	4.1×10^{-3}	6.1×10^{-1}
	Time (yr)	4795	4095	4795	2695	9975	9905	9975	9345	9975	9975	9975	9835
100-meter well	Water Table	3.4×10^{-1}	3.3×10^{-1}	3.4×10^{-1}	4.7	1.3×10^{-1}	1.4×10^{-1}	1.3×10^{-1}	1.1×10^{1}	7.4×10^{-2}	7.6×10^{-2}	7.4×10^{-2}	4.6
	Time (yr)	1785	875	1785	595	1995	1085	1995	735	1925	1085	1925	875
	Barnwell-McBean	7.4×10^{-1}	7.2×10^{-1}	7.4×10^{-1}	1.3×10^{1}	6.2×10^{-2}	6.4×10^{-2}	6.2×10^{-2}	7.1	4.7×10^{-2}	4.5×10^{-2}	4.7×10^{-2}	3.7
	Time (yr)	2835	1925	2835	1225	4445	3535	4445	2275	4095	3185	4095	1995
	Congaree	1.1×10^{-3}	1.1×10^{-3}	1.1×10^{-3}	1.6×10^{-2}	2.1×10^{-3}	4.2×10^{-3}	2.1×10^{-3}	3.9×10^{-1}	9.2×10^{-4}	1.5×10^{-3}	9.2×10^{-4}	1.2×10^{-1}
	Time (yr)	4865	3955	4865	2695	9975	9975	9975	9695	9975	9905	9975	9345
Seepline	Water Table	3.9×10^{-3}	3.9×10^{-3}	3.9×10^{-3}	6.0×10^{-2}	2.3×10^{-3}	2.4×10^{-3}	2.3×10^{-3}	1.6×10^{-1}	1.4×10^{-3}	1.4×10^{-3}	1.4×10^{-3}	7.7×10^{-2}
	Time (yr)	4585	3605	4585	3255	5145	4165	5145	3675	5425	4585	5425	4305
	Barnwell-McBean	5.8×10^{-3}	5.8×10^{-3}	5.8×10^{-3}	9.2×10^{-2}	1.7×10^{-4}	3.3×10^{-4}	1.7×10^{-4}	3.1×10^{-2}	7.9×10^{-4}	7.9×10^{-4}	7.9×10^{-4}	4.6×10^{-2}
	Time (yr)	7665	6825	7665	6055	9975	9975	9975	9975	9065	8225	9065	6895
	Congaree	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	4.1×10^{-4}	(a)	(a)	(a)	2.8×10^{-4}	(a)	(a)	(a)	7.3×10^{-5}
	Time (yr)	6405	5495	6405	4445	(a)	(a)	(a)	9975	(a)	(a)	(a)	9975
Surface Water	Water Table	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	4.2×10^{-4}	(a)	(a)	(a)	3.7×10^{-5}	6.2×10^{-6}	6.2×10^{-6}	6.2×10^{-6}	3.5×10^{-4}
	Time (yr)	4445	3535	4445	3255	(a)	(a)	(a)	3815	5635	4725	5635	4235
	Barnwell-McBean	3.0×10^{-5}	3.0×10^{-5}	3.0×10^{-5}	4.9×10^{-4}	(a)	(a)	(a)	5.6×10^{-6}	3.0×10^{-6}	3.0×10^{-6}	3.0×10^{-6}	1.7×10^{-4}
	Time (yr)	7665	6825	7665	6195	(a)	(a)	(a)	9905	8785	7945	8785	6615
	Congaree	(a)	(a)	(a)	1.1×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	2.6×10^{-6}
	Time (yr)	(a)	(a)	(a)	4585	(a)	(a)	(a)	(a)	(a)	(a)	(a)	9975

(a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-20. Concentrations in groundwater and surface water of mercury (milligrams per liter).

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	2.6×10^{-5}	3.6×10^{-5}	2.6×10^{-5}	1.6×10^{-3}	1.4×10^{-3}	7.4×10^{-4}	1.4×10^{-3}	1.2×10^{-1}	(a)	(a)	(a)	1.2×10^{-1}
	Time (yr)	9975	9975	9975	9975	9835	5285	9835	9975	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	(a)	2.7×10^{-6}	(a)	1.3×10^{-4}	3.0×10^{-5}	5.3×10^{-5}	3.0×10^{-5}	5.3×10^{-3}	(a)	(a)	(a)	2.8×10^{-5}
	Time (yr)	(a)	9975	(a)	9905	9975	9975	9975	9975	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

TC

Table C.4.1-21. Concentrations in groundwater and surface water of nitrate (milligrams per liter).

TC

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	1.2×10^{-1}	6.7×10^{-1}	4.2×10^{3}	4.8	2.3×10^{-1}	2.7×10^{-1}	2.4×10^{4}	1.5×10^{1}	7.5×10^{-2}	2.5×10^{-1}	8.7×10^{3}	1.3×10^{1}
	Time (yr)	105	105	385	105	35	35	35	35	105	105	245	105
	Barnwell-McBean	2.1	2.2	4.4×10^{4}	2.2×10^{1}	2.8×10^{-1}	2.8×10^{-1}	3.5×10^{4}	2.3×10^{1}	2.9×10^{-1}	2.9×10^{-1}	3.4×10^{4}	2.7×10^{1}
	Time (yr)	1015	105	1015	105	1015	105	1015	105	1015	105	1015	105
	Congaree	1.2×10^{-2}	1.2×10^{-2}	4.2×10^{2}	1.2×10^{-1}	5.2×10^{-2}	7.2×10^{-2}	1.6×10^{4}	6.2	3.2×10^{-2}	3.7×10^{-2}	5.3×10^{3}	3.4
	Time (yr)	1085	175	1085	105	1155	245	1155	245	1155	245	1155	245
100-meter well	Water Table	3.9×10^{-2}	1.3×10^{-1}	1.0×10^{3}	1.3	6.5×10^{-2}	7.6×10^{-2}	6.8×10^{3}	6.9	2.1×10^{-2}	6.0×10^{-2}	2.3×10^{3}	3.6
	Time (yr)	105	105	1015	105	35	35	35	35	105	105	1015	105
	Barnwell-McBean	4.7×10^{-1}	4.9×10^{-1}	1.8×10^{4}	5.8	6.1×10^{-2}	6.1×10^{-2}	1.4×10^{4}	4.6	5.9×10^{-2}	5.9×10^{-2}	9.9×10^{3}	4.6
	Time (yr)	1015	105	1015	105	1015	105	1015	35	1015	105	1015	105
	Congaree	2.0×10^{-3}	2.3×10^{-3}	7.1×10^{1}	2.4×10^{-2}	8.9×10^{-3}	1.4×10^{-2}	2.1×10^{3}	1.1	5.6×10^{-3}	6.9×10^{-3}	9.3×10^{2}	5.6×10^{-1}
	Time (yr)	1085	175	1085	105	1155	245	1155	245	1155	245	1155	245
Seepline	Water Table	1.8×10^{-3}	7.4×10^{-3}	5.8×10^{1}	1.0×10^{-1}	3.1×10^{-3}	4.2×10^{-3}	3.0×10^{2}	3.4×10^{-1}	9.8×10^{-4}	3.5×10^{-3}	1.5×10^{2}	2.2×10^{-1}
	Time (yr)	105	105	1015	105	35	105	35	35	1015	105	1015	105
	Barnwell-McBean	1.2×10^{-2}	1.5×10^{-2}	4.2×10^{2}	2.4×10^{-1}	1.7×10^{-3}	2.1×10^{-3}	3.3×10^{2}	1.5×10^{-1}	2.5×10^{-3}	2.5×10^{-3}	4.2×10^{2}	1.1×10^{-1}
	Time (yr)	1015	105	1085	105	1085	175	1085	175	1085	175	1085	105
	Congaree	6.1×10^{-5}	6.5×10^{-5}	2.3	8.1×10^{-4}	1.5×10^{-4}	2.0×10^{-4}	3.0×10^{1}	1.3×10^{-2}	7.0×10^{-5}	8.5×10^{-5}	1.2×10^{1}	5.1×10^{-3}
	Time (yr)	1085	175	1085	175	1225	315	1225	315	1225	315	1225	315
Surface Water	Water Table	1.2×10^{-5}	5.0×10^{-5}	3.9×10^{-1}	7.3×10^{-4}	(a)	(a)	5.5×10^{-2}	6.5×10^{-5}	4.4×10^{-6}	1.5×10^{-5}	6.6×10^{-1}	9.9×10^{-4}
	Time (yr)	105	105	1015	105	(a)	(a)	35	35	1015	105	1015	105
	Barnwell-McBean	5.9×10^{-5}	7.7×10^{-5}	2.3	1.3×10^{-3}	(a)	(a)	6.0×10^{-2}	2.7×10^{-5}	9.3×10^{-6}	9.4×10^{-6}	1.6	4.1×10^{-4}
	Time (yr)	1015	105	1085	105	(a)	(a)	1085	175	1085	175	1085	105
	Congaree	1.6×10^{-6}	1.7×10^{-6}	5.9×10^{-2}	2.2×10^{-5}	(a)	(a)	3.8×10^{-2}	1.7×10^{-5}	2.3×10^{-6}	2.8×10^{-6}	3.8×10^{-1}	1.7×10^{-4}
	Time (yr)	1085	175	1085	175	(a)	(a)	1225	315	1225	315	1225	315

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-22. Concentrations in groundwater and surface water of manganese (milligrams per liter).

		F-Area				H-Area North of Groundwater Divide				H-Area South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	1.9×10^{-1}	2.2×10^{-1}	1.9×10^{-1}	2.2	2.9×10^{-1}	3.5×10^{-1}	2.9×10^{-1}	2.5×10^{1}	5.5×10^{-2}	6.2×10^{-2}	5.5×10^{-2}	4.0
	Time (yr)	1995	875	1995	455	1295	245	1295	245	1925	805	1925	455
	Barnwell-McBean	3.6×10^{-1}	3.8×10^{-1}	3.6×10^{-1}	5.5	2.2×10^{-2}	4.5×10^{-2}	2.2×10^{-2}	6.0	1.8×10^{-2}	2.0×10^{-2}	1.8×10^{-2}	2.2
	Time (yr)	3115	1925	3115	945	5145	2765	5145	2415	4445	3885	4445	2415
	Congaree	2.4×10^{-4}	2.4×10^{-4}	2.4×10^{-4}	3.6×10^{-3}	1.3×10^{-6}	1.6×10^{-4}	1.3×10^{-6}	3.1×10^{-2}	(a)	8.7×10^{-6}	(a)	4.9×10^{-3}
	Time (yr)	6405	5425	6405	4795	9975	9975	9975	9975	(a)	9975	(a)	9975
100-meter well	Water Table	2.8×10^{-2}	3.1×10^{-2}	2.8×10^{-2}	7.0×10^{-1}	4.3×10^{-2}	3.9×10^{-2}	4.3×10^{-2}	4.1	6.4×10^{-3}	6.5×10^{-3}	6.4×10^{-3}	5.6×10^{-1}
	Time (yr)	2205	1085	2205	805	1715	665	1715	665	2345	1155	2345	875
	Barnwell-McBean	6.2×10^{-2}	6.1×10^{-2}	6.2×10^{-2}	1.6	6.2×10^{-3}	1.1×10^{-2}	6.2×10^{-3}	1.3	2.8×10^{-3}	3.2×10^{-3}	2.8×10^{-3}	3.5×10^{-1}
	Time (yr)	3535	2345	3535	1505	6125	3675	6125	3045	5215	4445	5215	3115
	Congaree	4.6×10^{-5}	4.6×10^{-5}	4.6×10^{-5}	1.1×10^{-3}	(a)	3.0×10^{-5}	(a)	6.0×10^{-3}	(a)	(a)	(a)	6.3×10^{-4}
	Time (yr)	6755	5705	6755	4585	(a)	9975	(a)	9975	(a)	(a)	(a)	9975
Seepline	Water Table	3.8×10^{-4}	3.8×10^{-4}	3.8×10^{-4}	1.2×10^{-2}	5.4×10^{-4}	5.5×10^{-4}	5.4×10^{-4}	4.7×10^{-2}	6.8×10^{-5}	6.7×10^{-5}	6.8×10^{-5}	6.4×10^{-3}
	Time (yr)	5215	4165	5215	3535	5215	4305	5215	3815	6195	5005	6195	4585
	Barnwell-McBean	5.6×10^{-4}	5.6×10^{-4}	5.6×10^{-4}	1.8×10^{-2}	4.0×10^{-6}	4.2×10^{-5}	4.0×10^{-6}	5.4×10^{-3}	3.4×10^{-5}	3.7×10^{-5}	3.4×10^{-5}	3.7×10^{-3}
	Time (yr)	8855	7805	8855	6545	9975	9975	9975	9975	9905	9485	9905	8155
	Congaree	1.2×10^{-6}	1.2×10^{-6}	1.2×10^{-6}	4.1×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	8225	7175	8225	6335	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	2.5×10^{-6}	2.5×10^{-6}	2.5×10^{-6}	8.5×10^{-5}	(a)	(a)	(a)	9.5×10^{-6}	(a)	(a)	(a)	2.8×10^{-5}
	Time (yr)	5215	4165	5215	3745	(a)	(a)	(a)	4025	(a)	(a)	(a)	4515
	Barnwell-McBean	2.9×10^{-6}	2.9×10^{-6}	2.9×10^{-6}	9.8×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	1.3×10^{-5}
	Time (yr)	8785	7735	8785	7035	(a)	(a)	(a)	(a)	(a)	(a)	(a)	7875
	Congaree	(a)	(a)	(a)	1.1×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	6335	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L

TC

Table C.4.1-23. Concentrations in groundwater and surface water of nickel (milligrams per liter).

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	1.0×10^{-4}	2.2×10^{-5}	1.0×10^{-4}	1.1×10^{-1}	4.8×10^{-3}	4.7×10^{-3}	4.8×10^{-3}	2.9×10^{-1}	5.8×10^{-4}	2.4×10^{-4}	5.8×10^{-4}	5.9×10^{-2}
	Time (yr)	9975	9975	9975	6335	5495	4725	5495	5285	9975	9975	9975	6335
	Barnwell-McBean	(a)	(a)	(a)	6.7×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	(a)	(a)	(a)	1.9×10^{-2}	2.9×10^{-4}	3.4×10^{-4}	2.9×10^{-4}	3.4×10^{-2}	(a)	(a)	(a)	3.4×10^{-3}
	Time (yr)	(a)	(a)	(a)	9905	9975	9975	9975	9905	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

TC

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-24. Concentrations in groundwater and surface water of lead (milligrams per liter).

TC

		F-Area				H-Area: North of Groundwater Divide				H-Area: South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	5.2×10^{-4}	2.9×10^{-4}	5.2×10^{-4}	2.3×10^{-2}	7.3×10^{-4}	2.0×10^{-4}	7.3×10^{-4}	8.5×10^{-2}	3.9×10^{-4}	1.4×10^{-5}	3.9×10^{-4}	3.0×10^{-2}
	Time (yr)	9975	6055	9975	6475	9975	3745	9975	6965	9975	9975	9975	6545
	Barnwell-McBean	(a)	(a)	(a)	1.3×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	8.3×10^{-5}	8.0×10^{-5}	8.3×10^{-5}	4.2×10^{-3}	3.7×10^{-5}	3.4×10^{-5}	3.7×10^{-5}	8.1×10^{-3}	(a)	(a)	(a)	2.9×10^{-3}
	Time (yr)	8575	8505	8575	9765	9975	9765	9975	9975	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-25. Concentrations in groundwater and surface water of uranium (milligrams per liter).

TC

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	7.6×10^{-5}	4.0×10^{-5}	4.0×10^{-5}	4.0×10^{-5}	1.7×10^{-4}	3.7×10^{-5}	3.7×10^{-5}	3.7×10^{-5}	2.2×10^{-4}
	Time (yr)	8365	7035	8365	9975	9975	8925	9975	9695	9695	8785	9695	9345
	Barnwell-McBean	(a)	1.4×10^{-6}	(a)	1.5×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	9975	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	6.4×10^{-6}	6.5×10^{-6}	6.4×10^{-6}	4.5×10^{-5}	1.3×10^{-5}	1.3×10^{-5}	1.3×10^{-5}	1.0×10^{-4}	1.3×10^{-5}	1.3×10^{-5}	1.3×10^{-5}	1.3×10^{-4}
	Time (yr)	8995	8435	8995	9695	9485	8505	9485	9485	9975	9065	9975	9135
	Barnwell-McBean	(a)	(a)	(a)	6.1×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-26. Concentrations in groundwater and surface water of zinc (milligrams per liter).

		F-Area				H-Area: North of Groundwater Divide				H-Area: South of Groundwater Divide			
Location	Aquifer	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alter-native
1-meter well	Water Table	4.4×10^{-3}	4.4×10^{-3}	4.4×10^{-3}	8.7×10^{-2}	6.7×10^{-4}	4.8×10^{-4}	6.7×10^{-4}	5.4×10^{-2}	1.5×10^{-3}	1.5×10^{-3}	1.5×10^{-3}	2.4×10^{-2}
	Time (yr)	2135	1155	2135	595	2135	1225	2135	1925	2555	1645	2555	1015
	Barnwell-McBean	3.3×10^{-3}	5.7×10^{-3}	3.3×10^{-3}	1.3×10^{-1}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	9975	9975	9975	5425	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	1.5×10^{-3}	1.5×10^{-3}	1.5×10^{-3}	2.8×10^{-2}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.5×10^{-2}	7.4×10^{-4}	7.4×10^{-4}	7.4×10^{-4}	1.1×10^{-2}
	Time (yr)	2205	1295	2205	735	2345	1435	2345	2205	2975	2065	2975	1295
	Barnwell-McBean	1.2×10^{-3}	1.2×10^{-3}	1.2×10^{-3}	3.2×10^{-2}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	7315	6335	7315	5845	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	2.3×10^{-5}	2.3×10^{-5}	2.3×10^{-5}	5.5×10^{-4}	3.7×10^{-6}	3.7×10^{-6}	3.7×10^{-6}	5.3×10^{-4}	2.3×10^{-5}	2.3×10^{-5}	2.3×10^{-5}	3.1×10^{-4}
	Time (yr)	8855	7875	8855	4375	5005	4165	5005	4375	5775	4865	5775	4515
	Barnwell-McBean	9.3×10^{-6}	1.8×10^{-5}	9.3×10^{-6}	9.0×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	9975	9975	9975	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	3.9×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	1.4×10^{-6}
	Time (yr)	(a)	(a)	(a)	4375	(a)	(a)	(a)	(a)	(a)	(a)	(a)	4165
	Barnwell-McBean	(a)	(a)	(a)	4.7×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

TC

a. Concentration is less than 1×10^{-6} mg/L.

C.4.2 ECOLOGICAL RISK ASSESSMENT

C.4.2.1 Nonradiological Analysis

H-Area: Upper Three Runs – Barnwell-McBean, Congaree, and Water Table Aquifers

Aquatic Hazard Quotients (HQs) for each contaminant were summed to obtain an aquatic Hazard Index (HI). All HIs were less than 1.0 for all four alternatives. All terrestrial HQs for the shrew and the mink were less than 1.0 for all four scenarios: (Tables C.4.2-1 through C.4.2-4). Thus potential risks to ecological receptors at and downgradient of the Upper Three Runs seeps (from all aquifers under H Area) are negligible.

H-Area: Fourmile Branch – Barnwell-McBean and Water Table Aquifers, Upper Three Runs – Congaree Aquifers

Aquatic HQs for each contaminant were summed to obtain an HI. All HIs were less than 1.0 for the four scenarios. All terrestrial HQs for the shrew and the mink were less than 1.0 for these alternatives and options (Tables C.4.2-5 through C.4.2-8). Thus potential risks to ecological receptors at and downgradient of the Fourmile Branch seep (from the Barnwell-McBean and Water Table Aquifers and under H Area) are negligible, as are those for the Congaree at Upper Three Runs.

F-Area: Fourmile Branch – Barnwell-McBean and Water Table Aquifers; Upper Three Runs – Congaree Aquifer

Aquatic HQs for each contaminant were summed to obtain an HI. All aquatic HIs were less than 1.0 for the Fill with Sand and Fill with Saltstone Options. The maximum HI for the Fill with Grout Option with the Water Table Aquifer was 1.42. In addition, HIs for the No Action Alternative with the Barnwell-McBean and Water Table Aquifers were greater than 1.0: 2.0 and 1.42, respectively. This suggests some potential risks, although the relatively low HI values suggest that these risks are generally low. HQs for the shrew and the mink were less than 1.0 for all four scenarios (Tables C.4.2-9 through C.4.2-12). The exception was a silver HQ of 1.55 for the shrew under the No Action Alternative (Barnwell-McBean Aquifer). Although this indicates that risks are possible at the Fourmile Branch seep (via groundwater under F Area), the relatively low HQ suggests that these risks are somewhat low.

C.4.2.2 Radiological Analysis

Calculated absorbed doses to the referenced organisms are presented in Tables C.4-2-13 through C.4.2-21. All calculated doses are below the regulatory limit of 365,000 mrad per year (365 rad per year).

C.5 Ecological Risk Assessment Uncertainties

Most of the data and assumptions used in the exposure calculations (exclusive of the exposure concentrations, which were calculated by the groundwater model) are average or midpoint values. Uncertainty for these values is largely a question of precision in measurement or variability about these points. However, two assumptions are conservative, meaning that they are likely to overestimate risk.

The relationship between seep area and home range has already been mentioned; the lack of correction for home range is likely to overestimate risk to an individual shrew by a factor of two and to an individual mink by a factor greater than ten. The other assumption is that when contaminants in seepage adsorb to the soil, they are not removed from the water. In other words, the seepage concentration is used to predict soil concentrations and downstream water concentrations without adjustment for losses.

TC

Table C.4.2-1. Results of terrestrial risk assessment for H-Area/Upper Three Runs (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Grout Option.

Analyte	Barnwell-McBean Aquifer			Congaree Aquifer			Water Table Aquifer		
	Maximum HQ		Time of maximum HQ[a]	Maximum HQ		Time of maximum HQ	Maximum HQ		Time of maximum HQ
	Mink	Shrew		Mink	Shrew		Mink	Shrew	
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	b	NA	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	b	b	NA
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}. 1×10^{-2}
NA = Not applicable.

Table C.4.2-2. Results of terrestrial risk assessment for H-Area/Upper Three Runs (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Sand Option.

Analyte	Barnwell-McBean Aquifer			Congaree Aquifer			Water Table Aquifer		
	Maximum HQ		Time of maximum HQ[a]	Maximum HQ		Time of maximum HQ	Maximum HQ		Time of maximum HQ
	Mink	Shrew		Mink	Shrew		Mink	Shrew	
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	b	NA	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	b	b	NA
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
NA = Not applicable.

TC

Table C.4.2-3. Results of terrestrial risk assessment for H-Area/Upper Three Runs (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Saltstone Option.

	Barnwell-McBean Aquifer			Congaree Aquifer			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	b	NA	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	b	b	NA
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
NA = Not applicable.

Table C.4.2-4. Results of terrestrial risk assessment for H-Area/Upper Three Runs (Barnwell-McBean, Congaree, and Water Table Aquifers), No Action Alternative.

Analyte	Barnwell-McBean Aquifer			Congaree Aquifer			Water Table Aquifer		
	Maximum HQ		Time of maximum HQ[a]	Maximum HQ		Time of maximum HQ	Maximum HQ		Time of maximum HQ
	Mink	Shrew		Mink	Shrew		Mink	Shrew	
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	2.19×10^{-2}	3.94×10^{-2}	4,235
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	2.43×10^{-2}	5.76×10^{-2}	175	b	b	NA	6.6×10^{-2}	1.56×10^{-1}	35
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	1.93×10^{-2}	3.54×10^{-2}	2,065	b	b	NA	2.41×10^{-1}	4.43×10^{-1}	175
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
NA = Not applicable.

Table C.4.2-5. Results of terrestrial risk assessment for H-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Grout Option.

TC

Analyte	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of maximum HQ[a]	Maximum HQ		Time of maximum HQ	Maximum HQ		Time of maximum HQ
	Mink	Shrew		Mink	Shrew		Mink	Shrew	
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	b	NA	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	b	b	NA
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

TC

Table C.4.2-6. Results of terrestrial risk assessment for H-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Sand Option.

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	b	NA	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	b	b	NA
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

TC

Table C.4.2-7. Results of terrestrial risk assessment for H-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Saltstone Option.

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	b	NA	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	b	b	NA
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

Table C.4.2-8. Results of terrestrial risk assessment for H-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), No Action Alternative.

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	1.69×10^{-2}	4.0×10^{-2}	105	b	b	NA	3.22×10^{-2}	7.61×10^{-2}	105
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	2.21×10^{-2}	4.06×10^{-2}	245
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

TC

Table C.4.2-9. Results of terrestrial risk assessment for F-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Grout Option.

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	1.14×10^{-2}	2.05×10^{-2}	3,955
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	1.07×10^{-2}	1,015	b	b	NA	3.47×10^{-2}	8.2×10^{-2}	105
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	6.83×10^{-2}	1.25×10^{-1}	1,365	b	b	NA	4.42×10^{-1}	8.12×0^{-1}	245
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

Table C.4.2-10. Results of terrestrial risk assessment for F-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Sand Option.

TC

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	1.37×10^{-2}	105	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	4.82×10^{-2}	8.85×10^{-2}	525	b	b	NA	2.33×10^{-2}	4.28×10^{-2}	315
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

TC

Table C.4.2-11. Results of terrestrial risk assessment for F-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), Fill with Saltstone Option.

Analyte	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of maximum HQ[a]	Maximum HQ		Time of maximum HQ	Maximum HQ		Time of maximum HQ
	Mink	Shrew		Mink	Shrew		Mink	Shrew	
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	1.07×10^{-2}	1,105	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	6.83×10^{-2}	1.25×10^{-1}	1,365	b	b	NA	2.85×10^{-2}	5.24×10^{-2}	1,085
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

Table C.4.2-12. Results of terrestrial risk assessment for F-Area/Fourmile Branch (Barnwell-McBean, Congaree, and Water Table Aquifers), No Action Alternative.

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	1.76×10^{-2}	3.15×10^{-2}	8,015	b	b	NA	1.14×10^{-2}	2.05×10^{-2}	3,955
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	8.25×10^{-2}	1.95×10^{-1}	105	b	b	NA	3.47×10^{-2}	8.2×10^{-2}	105
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	8.44×10^{-1}	1.55	455	b	b	NA	4.42×10^{-1}	8.12×10^{-1}	245
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

Table C.4.2-13. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for F-Area Tank Farm – Water Table Aquifer.

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	0.0027	0.0016	0.025	0.49
Shrew dose	10.1	6.3	94.9	2,530
Mink dose	1.1	0.9	9.9	1,690

TC

Table C.4.2-14. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for F-Area Area Tank Farm – Barnwell-McBean Aquifer.

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	0.0038	0.0072	0.053	0.89
Shrew dose	18.7	34.5	372	4,320
Mink dose	2.0	3.6	265	452

TC

Table C.4.2-15. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for F-Area Tank Farm – Congaree Aquifer.

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	6.7×10^{-5}	8.9×10^{-5}	0.002	0.016
Shrew dose	0.1	0.1	1.9	15.8
Mink dose	0	0	0.2	1.7

TC

Table C.4.2-16. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Fourmile Branch – Water Table Aquifer.

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	0.0014	0.0023	0.027	0.35
Shrew dose	9.5	14.4	158.9	2,260
Mink dose	1.0	1.5	17.8	669.1

TC

Table C.4.2-17. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Fourmile Branch – Barnwell-McBean Aquifer.

TC

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	2.2×10^{-4}	0.0011	0.018	0.21
Shrew dose	0.2	8.3	126.6	1,580
Mink dose	0	0.9	13.3	165.7

Table C.4.2-18. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Fourmile Branch – Congaree Aquifer.

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	4.8×10^{-4}	2.8×10^{-4}	0.0095	0.061
Shrew dose	3.5	0.2	7.6	47.5
Mink dose	0.4	0	0.8	5.0

TC

Table C.4.2-19. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Upper Three Runs – Water Table Aquifer.

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	2.1×10^{-4}	0.0017	0.0037	0.039
Shrew dose	24.8	244.5	460.5	24,450
Mink dose	3.3	25.6	48.7	2,560

TC

Table C.4.2-20. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Upper Three Runs – Barnwell-McBean Aquifer.

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	5.4×10^{-5}	3.1×10^{-4}	0. 0016	0.014
Shrew dose	7.5	44.6	230.1	4,890
Mink dose	0.8	4.7	24.1	512

TC

Table C.4.2-21. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Upper Three Runs – Congaree Aquifer.

	Fill with Grout Option	Fill with Sand Option	Fill with Saltstone Option	No Action Alternative
Sunfish dose	4.8×10^{-5}	1.3×10^{-4}	0.0016	0.012
Shrew dose	1.0	2.7	31.6	244.5
Mink dose	0.1	0.3	3.3	25.6

TC

Uncertainty in the toxicity assessment includes the selection of a particular dose and the factors applied to ensure that it is protective. The fluoride dose selected as a threshold, a LOAEL of 5 milligram per kilogram per day associated with relatively less serious effects in rats and minks, could have been a higher dose based on effects more likely to cause decreased fitness. The data base available for silver toxicity is not good, and this is reflected in the high uncertainty factor (100X) used to lower the selected dose.

Because toxicity data is mostly limited to individual responses, a risk assessment is usually limited to the probability of risk to an individual. This makes the evaluation of risk to populations, communities, and ecosystems a speculative and uncertain undertaking, even though characterization of risks to populations is the typical goal of an ecological risk assessment. In the case of the seep, it is reasonable to assume that terrestrial effects will be limited to this area because the contaminants have not been shown to bioaccumulate in terrestrial systems. Surface water is the only likely pathway for contaminants to exit the seep area. [Mercury is known to accumulate in aquatic food chains, but only a minimal amount of mercury is transported to the seepline during the 10,000 year modeled time period.]

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APPENDIX D

PUBLIC COMMENTS AND DOE RESPONSES

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APPENDIX D. PUBLIC COMMENTS AND DOE RESPONSES

In November 2000, the Department of Energy (DOE) published the *Savannah River Site High-Level Waste Tank Closure Draft Environmental Impact Statement (DOE/EIS-0303D)* and invited public comment on the document. DOE held public hearings on the Draft Environmental Impact Statement (EIS) in North Augusta and Columbia, South Carolina, respectively, on January 9 and 11, 2001. The public comment period ended on January 23, 2001. DOE received written comments from 18 individuals and organizations and 8 people who spoke at the public hearings. DOE considered all comments in preparing this Final EIS.

This appendix provides the comments received and DOE's responses. Written comments and their responses are summarized in D.1. In Section D.2, each written comment letter is reproduced, with individual comments, questions, and suggestions labeled; responses to them are provided on the pages that follow each comment letter. If a comment prompted DOE to modify the EIS, the response describes the change and identifies its location in the Final EIS.

In Section D.3, comments made during the public hearings are summarized, followed by DOE's responses. Transcripts from the hearings are available at the DOE public reading rooms:

DOE Freedom of Information Reading Room
Forrestal Building, Room 1E-190
1000 Independence Ave., SW
Washington, DC 20585
Phone: 202-586-6020

and DOE Public Document Room
University of South Carolina, Aiken Campus
University Library, 2nd Floor
171 University Pkwy.
Aiken, SC 29801
Phone: 803-648-6851

D.1 Summary of Comments

Several of the major points made by commenters are summarized below, together with DOE's responses. More detailed responses are provided in Sections D.2 and D.3

Alternatives

Several comments questioned DOE's choice of alternatives for analysis or suggested additional alternatives that DOE should have considered. Specific topics included requests for clarification of the intent of the No Action Alternative, consideration of offsite disposal of tanks under the Clean and Remove Tanks Alternative, and a suggestion that DOE should cut up some of the tanks and place the components inside other intact tanks before grouting them. Several comments expressed concern or requested clarification about specific elements of the alternatives, including how transfer lines would be treated under the various alternatives and whether removed tank components would be disposed in the Savannah River Site (SRS) E-Area Vaults under the Clean and Remove Tanks Alternative.

Response:

DOE finds that the suggested new and modified alternatives either are not reasonable or were effectively addressed by the analysis presented in the EIS. Therefore, DOE did not change the alternatives considered in the EIS (other than modifying the Clean and Stabilize Tanks Alternative). However, clarifying information was added to the EIS as a result of several of these comments, as described in the responses to individual comments.

Use of Oxalic Acid

Several comments questioned the use of oxalic acid in cleaning tanks: whether other products could be used to remove residual material in the tanks, and whether DOE expects to use oxalic acid in view of technical concerns, particularly about the potential for nuclear criticality. Comments pointed out apparent contradictions between statements that oxalic acid cleaning would be used in the Clean and Stabilize Tanks Alternative and other statements that oxalic acid cleaning would not be practicable in the context of the Clean and Remove Tanks Alternative.

Response:

DOE revised the EIS to clarify DOE's position regarding the use of oxalic acid. 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. Concern about potential criticality would not preclude using oxalic acid for tank cleaning. However, a thorough, tank-specific evaluation for criticality would need to be done before using oxalic acid in any tank. The evaluation may result in the identification of additional tank-specific controls to ensure prevention of criticality. As discussed in the EIS, DOE identified oxalic acid as the preferred chemical cleaning agent after studying numerous other potential cleaning agents. Concerns about the effect of oxalic acid on the quality of the Defense Waste Processing Facility (DWPF) waste feed would be resolved by special handling of batches of waste feed that contained oxalates as a result of tank cleaning activities.

Cleaning of Tank Annulus

Several comments asked about the status of and plans for efforts to remove waste found in the annuli of some tanks, including the status of waste removal from the annulus of Tank 16.

Response:

In Chapter 2, a new paragraph was added on cleaning of the secondary containment, stating that waste would most likely be removed from the annulus using water and/or steam sprays, possibly combined with a chemical cleaning agent, such as oxalic acid. The Summary and Appendix A have been revised to clarify the status of waste removal from the Tank 16 annulus, specifically to state that some waste has been removed from the annulus, although some waste still remains.

Residual Waste

Several comments requested information on the residual waste inventories assumed for individual tanks or asked how DOE would measure or estimate the quantity and characteristics of residual waste remaining after tank cleaning is complete. Several comments requested additional discussion of the process by which the DOE determines that residual waste is "incidental to reprocessing."

Response:

In response to these comments, a table listing the assumed volume of residual waste if the tanks are cleaned remaining in each closed high-level waste (HLW) tank has been added to Appendix C. These volume estimates are based on previous experience with cleaning of Tanks 16, 17, and 20 and on judgments of the effectiveness of the cleaning method. Also, additional information on the approach used to estimate residual waste characteristics has been provided in Appendix A. For modeling purposes, the EIS assumes that the composition of the residual waste would be approximately the same as the sludge currently in the tanks. Before each tank is closed, DOE will collect and analyze samples of the residual waste remaining after tank closure and would conduct camera inspections to obtain visual evidence of the volume of residual waste in that tank. DOE has expanded the discussion of the three criteria for determining that waste is incidental to reprocessing, as specified in DOE Manual 435.1-1, Radioactive Waste Management.

Institutional Control and Future Land Use

Several questions addressed institutional control and future land use. Commenters said that DOE should not assume that institutional control would be retained for the entire duration of modeling analysis or that the land around the Tank Farms would remain in commercial/industrial use. Some expressed concern about whether the selected alternative for HLW tanks closure would restrict potential future land use.

Response:

No changes were made to the EIS as a result of these comments. DOE's *Savannah River Site Future Use Plan* calls for the land around the F and H Areas (i.e., between Upper Three Runs and Fourmile Branch) to remain in industrial use indefinitely. This future use designation would not be affected by the choice of a tank closure alternative. Although DOE does not envision relinquishing control of the area, it does recognize that there is uncertainty in projecting future land use and effectiveness of institutional controls. Therefore, in this EIS, DOE assumes direct physical control in the General Separations Area only for the next 100 years from the date of tank closure. In addition to reporting estimated human health impacts based at a regulatory point of compliance that is at the seepline (about a mile from the tank farms) DOE has provided estimates of human health implications of doses that would be received by persons obtaining drinking water from a well directly adjacent to the boundary of the tank farm.

<u>Regulatory Standard and Point of Compliance</u>

Several comments questioned the regulatory point of compliance (i.e., the seepline) or the application of the U.S. Environmental Protection Agency (EPA) drinking water standard of 4 mrem/year at that location. One viewpoint was that the seepline should not be used as the point of compliance unless institutional controls prevent groundwater use at locations closer to the tank farm. Another viewpoint was that the seepline point of compliance is overly conservative because people would obtain water from the nearby stream rather than at the seepline. Several commenters stated that the 4 mrem/year limit is overly conservative and suggested adopting a less stringent standard. Another concern expressed was that a more stringent standard might be applied under a future Resource Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulatory process.

Response:

The performance objective of 4 mrem/year at the seepline was established by South Carolina Department of Health and Environmental Control (SCDHEC), after discussions with DOE and EPA Region 4 and following an evaluation of all applicable or relevant and appropriate requirements.

<u>EIS Summary</u>

Several comments specifically addressed the EIS Summary, often requesting clarification on topics that were covered in the EIS text or appendices, but not in the EIS Summary. Some commenters suggested that the Summary should be made an integral part of the EIS instead of being published as a separate volume.

Response:

In response to several comments, DOE incorporated additional information from the EIS into the EIS Summary. As allowed and encouraged in the Council on Environmental Quality National Environmental Policy Act (NEPA) implementing regulations (40 Code of Federal Regulations (CFR) 1500.4), DOE publishes the Summary separately as a service to readers, many of whom only read the Summary.

D.2 Comment Letters and DOE Responses

In the following section, DOE has reproduced the written comments received and provides a response to each. Table D-1 lists the comment letters and provides the letter numbers and commenter names.

Table D-1. Written Comments on the SRS High-Level Waste Tank Closure Draft EIS.

Comment Source Number*	Commenter	Page Number
L-1	Mr. Wade Waters	D-5
L-2	Mr. William F. Lawless	D-11
L-3	Mr. R. P. Borsody	D-17
L-4	Mr. Heinz J. Mueller, U.S. Environmental Protection Agency	D-25
L-5	Mr. Peter French	D-34
L-6	Mr. Thomas H. Essig, U.S. Nuclear Regulatory Commission	D-37
L-7	Mr. W. Lee Poe	D-43
L-8	Mr. Jim Hardeman, Georgia Department of Natural Resources	D-65
L-9	Mr. Frank Watters	D-68
L-10	Mr. Ernest S. Chaput	D-70
L-11	Mr. Kenneth W. Holt, Centers for Disease Control and Prevention	D-73
L-12	Mr. Andreas Mager, Jr., National Marine Fisheries Service	D-78
L-13	Mr. Cliff Blackman, Georgia Department of Natural Resources	D-81
L-14	Mr. Cliff Blackman, Georgia Department of Natural Resources	D-85
L-15	Mr. Cliff Blackman, Georgia Department of Natural Resources	D-89
L-16	Mr. James H. Lee, U.S. Department of the Interior	D-92
L-17	Mr. Eric G. Hawk, National Marine Fisheries Service	D-94
L-18	Ms. Angela Stoner, South Carolina State Budget and Control Board	D-97

*Unique codes were given to each of the letters received. Individual comments are coded L-1-1, etc.

Rec.

FEB 14 2001

February 8, 2001

Andrew R. Grainger, NEPA Compliance Officer
U. S. Department of Energy
Savannah River Operations Office
Building 742A, Room 183
Aiken, South Carolina 29802

Subject: **Comments on the November 2000 Savannah River Site High-Level Waste Tank Closure Draft Environmental Impact Statement**

Dear Mr. Grainger:

At the request of the Savannah River Site (SRS) Citizens Advisory Board (CAB) Waste Management Committee, the Salt Team Focus Group (FG) has been asked to review and comment on the November 2000 High-Level Waste (HLW) Draft Environmental Impact Statement (DEIS). We are aware that the official public comment period ends on January 23, 2001 but DOE had stated during public meetings that comments received after this date would be, to the extent practicable, reviewed and addressed.

The primary point the Salt Team FG wishes to stress is the need to maintain the current HLW Tank closure schedule. Any deviation in the Federal Facility Agreement closure schedule is considered unacceptable. In addition, we offer the following comments for your review and consideration: L-1-1

1. Based upon a review of the data in this DEIS, the most logical proposed action is to Clean and Stabilize the Tanks. This action provides the best protection to human health and the environment at an acceptable cost. The Salt Team FG agrees with the tank stabilization preferred option to fill with grout and believes this alternative should be the action selected in the final Record of Decision. The Salt Team FG sees the other alternatives as unacceptable. L-1-2

2. The Salt Team FG believes the performance objective of 4 mrem/year at a seepline is overly conservative and not realistic. The Salt Team FG can not see how anyone could realistically drink from the seepline. A more realistic point of compliance would be the centerline of the stream receiving surface runoff from the seepline. The Salt Team FG requests a modification to the proposed point of compliance. Furthermore, consistent with DOE Order 435.1, the projected dose attributable to any single source, practice, or activity should be some fraction less than the applicable overall dose limit (e.g. 100 mrem/year criteria stated in the order DOE 5400.5). L-1-3

Feb 14 01 09:27a Linda and Wade Waters 912-748-9532 p.1

Andrew R. Grainger, NEPA Compliance Officer
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To provide a realistic protection of human health and the environment, the Salt Team FG believes the composite analysis limit of 30 mrem/year should be used at the centerline of the stream receiving water from the seepline. This limit is normally applied at the site boundary but by using it at a location far within the site boundary a more than adequate level of protection will be provided. In addition, a greater level of protection will be utilized as the SRS begins to use institutional controls as part of its long-term stewardship program. By using this higher, but very protective, limit, tank closures will meet the performance objective at considerable cost savings to DOE and the taxpayer. L-1-4

3. One of the most important aspects of modeling the long-term closure scenarios is an accurate radioactive material source term. The DEIS appears to use process knowledge and reliance on past performance activities to assume a source term. No actual sampling data is used. The Salt Team FG believes representative sampling should be performed to verify the predicted levels and the approach should be documented in the DEIS. L-1-5

4. As individual private citizens, several members of the Salt Team FG submitted comments on the DEIS. Many of these comments address the Summary, which is a separate publication from the DEIS. The Salt Team FG believes that the Summary is considered to be part of the DEIS and merely pulls from specific sections of the DEIS to make a more condense version for the general public to read. However, neither the Foreword nor the Table Of Contents specifically address the Summary as being part of the DEIS. The Salt Team FG suggests that the Summary be listed and incorporated as an integral part of the DEIS. L-1-6

5. In the DEIS, DOE estimates that oxalic acid cleaning could be required on as many as three-quarters of the tanks to meet performance objectives and DOE plans to use the acid wash as part of the Clean and Stabilize Alternative. However, under the Clean and Remove Alternative, oxalic acid cleaning is considered not to be "technically and economically practical" because of critically safety concerns, potential interference with DWPF, and high cost. The Salt Team FG believes that safety and process uncertainties should be resolved and the results included in the DEIS. Additional discussion is needed to clarify the conflicts between using oxalic acid cleaning in one case and then discounting it in another. L-1-7

6. The Salt Team FG believes further explanation is required to address potential generation of HLW from new missions at SRS. Currently, the DEIS has a blanket statement suggesting that new missions targeted for SRS will not add HLW to the current SRS inventory. DOE has previously identified new waste streams resulting from the Pit Disassembly & Conversion Facility (PDCF), the MOX facility (including a liquid "polishing" process), and SNF treatment and storage facility. All of these waste streams have the potential for including high level L-1-8

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liquid waste. The final EIS should discuss this apparent inconsistency. If some high level liquid wastes are expected to be received by the SRS tank farms from these new facilities, the amounts and constituents should be identified in the final EIS. L-1-8

7. Under the long-term closure modeling, one aspect not discussed nor explored is the potential for the No Action Alternative to release contaminated media from the filling and overflowing of the failed tanks from rainfall events. The DEIS only assumes that rainfall will fill the tanks and infiltrate to the groundwater, which understates the potential health and environmental impacts from this scenario. The Salt Team FG suggest that the potential for the failed tanks to release contaminated media to surface run-off be addressed. L-1-9

8. During its review, the Salt Team FG noted several inconsistencies between the body of the DEIS and the Appendices. Some of these were specifically addressed in individual comments from the FG members. The Salt Team FG requests the inconsistencies be corrected and a thorough review be performed to removed any errors. One such error noted was the description of HLW as a "highly corrosive and radioactive waste" in the Summary and in the DEIS. Highly radioactive is correct but highly corrosive is not and the word should be deleted. L-1-10

The Salt Team FG requests clarification on these comments whether they are incorporated in the High-Level Waste Draft Environmental Impact Statement or not. Thank you for the opportunity to offer our comments.

Sincerely,

Wade Waters

Mr. Wade Waters, Chair
Waste Management Committee
308 Pinewood Drive
Pooler, GA 31322

Response to comment L-1-1 and L-1-2: Comment noted.

Response to comment L-1-3: The comment is correct in that it is not probable that someone would drink 2 liters per day from the seepline; rather, they would drink from the free-flowing waters of the creek. However, this conservative point of compliance and the 4 mrem/year standard were established by the State regulators and DOE does not have a need to change the point of compliance. Use of the 4 mrem/year performance objective also helps ensure that the 100 mrem/year all-pathways dose limit would be met. Also see response to comment L-5-4 (first paragraph).

Response to comment L-1-4: See response to comment L-1-3.

Response to comment L-1-5: The inventory that is needed for modeling is the inventory of the residual left after waste removal. For tanks that have not undergone waste removal, this residual does not yet exist. If spray water washing was used, the residual would be lower in soluble components than the salt solution because water washing removes most soluble components, but would be higher in insoluble components. For the purposes of the modeling in the EIS, it was assumed that the composition of the residual would be approximately the same as the sludge currently in the tanks, which DOE believes is conservative. Section A.4.3 has been revised to provide more information on residual waste sampling/characterization. "To determine the characteristics of the residual material that would remain in the closed HLW tanks, DOE obtained and analyzed sludge samples from waste tanks containing each of the major waste streams that have gone to the tank farms. These samples were washed in the laboratory, approximating what might remain after waste removal, and the concentrations of various components in the washed sludge were measured. DOE used the results of these samples in developing the process knowledge database that was used for the modeling described in Appendix C. Samples of the actual residuals that would remain in each tank after waste removal would be collected and analyzed after the completion of waste removal in that tank."

Response to comment L-1-6: The Foreword and the Table of Contents in the Final EIS indicate that the Summary is published as a separate volume. DOE publishes the Summary separately as a service to readers, many of whom only read the Summary. Publication of an EIS in several volumes is a common practice consistent with the Council on Environmental Quality guidelines on the content of an EIS.

Response to comment L-1-7: See response to comment L-4-23.

Response to comment L-1-8: DOE believes that the facilities listed in the last paragraph of Section S-3 on page S-13 of the Draft EIS would not substantially affect the current SRS HLW inventory. This EIS considers alternatives for closure of empty HLW tanks; therefore, impacts of new HLW generation are not within the scope of this document.

The HLW program utilizes a "High-Level Waste System Plan" to help plan and manage the operation of the tank farms, DWPF, and associated systems. This plan is updated annually and whenever there are major perturbations to the system. Included in this plan are the known influents to the HLW system. Potential impacts from new missions will be included in this planning document.

Response to comment L-1-9: As discussed in Section C.1.1, the performance assessment modeling presented in the EIS assumes that, at some point in the future, degradation associated with the aging of the tanks would destroy the tanks. The contaminants are then assumed to reside at the bottom of a hole equal to the depth of the tank (generally 30 to 40 feet). Because of the lack of structural support, the tanks and concrete basemat are assumed to fail completely at 100 years, exposing the contaminated media to rain-fall with subsequent infiltration to groundwater. At 100 years, the tanks and concrete basemat are assumed to have the same hydraulic conductivity and infiltration rate as the surrounding soil. DOE does not believe the tanks would fill with rainwater and overflow, releasing contaminants to the land surface.

However, if the top of the tanks fail before the base of the tanks fail or before the concrete basemats disintegrate, water from precipitation could leak into the tanks and cause them to overflow at the ground surface. In response to similar public comments on the analysis of the No Action Alternative in the Salt Processing Alternatives Supplemental EIS (DOE/EIS-0082-S2), DOE modeled the potential impacts of a scenario in which the tanks overflow and spill their contents onto the ground surface, from which contaminants flow overland to nearby streams. The potential consequences of this type of event would be smaller for the No Action Alternative in this EIS than for the No Action Alternative in the Salt Processing SEIS, because the residual sludge that would remain in the tanks following bulk waste removal is largely insoluble, in contrast to the salt solution, which would contain a large inventory of dissolved radioactivity. It is unlikely that rainwater overflowing from the tanks could transport appreciable quantities of radioactivity from the sludge phase.

Nevertheless, the scenario addressed in the Salt Processing Alternatives Supplemental EIS places a conservative upper bound on the potential consequences of this scenario to persons who might consume water from SRS streams for the No Action Alternative considered in this EIS. To conservatively estimate the consequences of this scenario for water users, DOE modeled the eventual release of the salt waste to surface water at SRS, assuming no loss of contaminants during overland flow. This modeling was performed for both onsite streams that flow near the tank farm areas (Fourmile Branch and Upper Three Runs), as well as the Savannah River, into which these streams flow. The modeling showed that an individual consuming 2 liters per day of water from Fourmile Branch would receive a dose of 640 millirem per year. This dose is more than 160 times the drinking water regulatory limit of 4 millirem per year and would result in an increased probability of contracting a latent cancer fatality from a 70-year lifetime exposure of 0.022. The probability of contracting a latent cancer fatality under the No Action Alternative would be about 13,000 times greater than that of any of the action alternatives. Similarly, an individual consuming the same amount of water from Upper Three Runs would receive a dose of 295 millirem per year, and an individual consuming the same amount of water from the Savannah River would receive a dose of 14.5 millirem per year. These doses also exceed the drinking water limit and would incrementally increase the probability of contracting a latent cancer fatality from a 70-year lifetime exposure by 0.01 and 5.1×10^{-4}, respectively.

For the No Action Alternative in the Final Salt Processing Alternatives SEIS, DOE also considered potential external radiation exposure from the tank overflow scenario described above for a resident in the tank farm area, conservatively assuming that all contamination is deposited on the ground surface rather than flowing to streams or entering the underlying soil. The modeling showed that an individual living in the tank farm would receive an external direct gamma irradiation) dose of about 2,320 rem in the first year following the event, which would result in a prompt fatality.

<u>Response to comment L-1-10</u>: The word “corrosive” has been deleted in Sections S.1 and 1.1.

1

Rec. JAN 25 2001

PAINE COLLEGE

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January 22, 2001

Andrew R. Grainger, NEPA Compliance Officer
U. S. Department of Energy
Savannah River Operations Office
Building 742A, Room 183
Aiken, South Carolina 29802

Subject: Comments on the November 2000 Savannah River Site High-Level Waste Tank Closure Draft Environmental Impact Statement

Dear Mr. Grainger:

I would like to take this opportunity to offer my comments on the November 2000 High-Level Waste Draft Environmental Impact Statement (DEIS). As a citizen living near the Savannah River Site (SRS), I have been active in monitoring the waste management activities of SRS and in past years, I have volunteered my time on the Savannah River Site (SRS) Citizens Advisory Board (CAB). Currently, I am a volunteer member of several Focus Groups formed by the SRS CAB.

One of those groups is the Salt Team Focus Group (FG), which has been tasked to review and comment on the DEIS. Comments from the FG will not be available until after the official period ends. DOE assured this group that its comments would be reviewed and addressed to the extent possible if they are received after January 23, 2001; that has encouraged me to provide my comments as a private citizen now, and again later when the group submits its formal comments. I have reviewed the DEIS and I attended the public meeting held in North Augusta, South Carolina on January 9, 2001. My general comments and specific comments are provided as an attachment to this letter.

First, I do not want to see additional delays in the publication of a Final EIS or the Record of Decision. I believe that the HLW Tanks need to be closed to meet the current schedule as agreed to by the three agencies (DOE, EPA, and South Carolina-DHEC) in the Federal Facilities Agreement (FFA) for the Savannah River Site. However, I offer the following general comments and attached specific comments to provide clarification and identify deficiencies:

1. Where relevant, correlating the text with CAB motions will convey to the average reader that some of the ideas in the DEIS have already been reviewed by stakeholders. It will provide some level of assurance to readers unfamiliar with SRS and tank closure that L-2-1

A College of The United Methodist Church and the Christian Methodist Episcopal Church citizens with a stake in the outcome for tank closure have reviewed many of the issues underlying this document. L-2-1

2. Considering the performance time span of 10,000 years, the closure criteria of 4 millirem is overly conservative. Given a background of around 300 mrem, the 4 mrem standard amounts to 4/300 or 1/75th of background. The DEIS should make this point in the very beginning and throughout the DEIS. Comparisons with common radioactive doses should be made so that the reader understands the conservative nature of this standard. L-2-2

3. The DEIS should include a fuller discussion of the importance to stakeholders of the resolution of the issue of tank closure. As it stands, tank closure comes across as a technical benefit with little or no health or environmental consequences. But tank closure is much more. Closing the tanks establishes the social and political precedent of closing the fuel cycle from the point of view of SRS stakeholders. This point was made in the DEIS, but it was buried in the text and not very clear; it should be placed front and center. From my perspective as a professional engineer, the tank closures at SRS have served as an example of an excellent engineering practice to all sites across the DOE complex. L-2-3

4. The No Action alternative as discussed during the January 9, 2001 Public Meeting would lead to tank collapse, subsidence, and inflows of water and animal intrusion. This scenario could potentially result in the widespread dispersion of radioactivity across the surface. L-2-4

5. The No Action alternative as discussed during the January 9, 2001 Public Meeting assumes nearly complete removal of radioactive high-level wastes from the tanks. Has a safety analysis considered whether this alternative may leave uncovered sufficient waste residues in the annuli to generate hydrogen gas and pose a dispersion hazard? L-2-5

I respectfully request that DOE consider these general comments and the attached specific comments in the final High-Level Waste Draft Environmental Impact Statement. Thank you for the opportunity to offer my comments.

Sincerely,

William F. Lawless, Ph.D., P.E.
Technical Lead, CIF Focus Group
Paine College, Departments of Mathematics and Psychology
Augusta, GA 30901-3182

3

Attachment

cc: Salt Team Focus Group

HIGH-LEVEL WASTE DRAFT ENVIRONMENTAL IMPACT STATEMENT
SPECIFIC COMMENTS

HLW Tank Closure DEIS-Summary

1. Page S-8: If it is the case, add no known leaks have occurred in the Type III tanks. L-2-6
2. Page S-9: The goal "to remove as much waste as can reasonably be removed" seems insufficiently rigorous. It would be better to add "consistent with the approved closure criteria in the General Closure Plan". Also, on page S-10, last paragraph, to the phrase "constitutes the limit of what is economically and technically practicable for waste removal", add "consistent with the approved closure criteria in the General Closure Plan". L-2-7
3. Page S-10: Please provide estimated curies per gallon for the gallons to be left as residue. L-2-8
4. Page S-12, last paragraph: Failed tanks could lead to surface subsidence, which would open the tanks to water, plant, and animal intrusion. L-2-9
5. Page S-16: The likelihood of the State of SC allowing removed HLW tanks to buried in the waste management facility seems unlikely. A more likely arrangement would be to transport the removed tanks for disposal to an offsite facility, which would substantially increase the costs of the removal alternative, exposure to workers and the public, and increase the possibility of transportation accidents. L-2-10
6. Page S-18: The assumption of zero cancer fatalities for the No Action alternative appears to assume that discontinued tanks containing uncovered residue wastes, especially in their annuli, will not generate hydrogen gas. L-2-11
7. Table S-2: In addition to the utility and energy costs, please provide the convenience of listing the average and total costs for each option; e.g., on page S-21, the total costs for the removal alternative is stated in the text, but the others are not. L-2-12
8. Figure S-7: To assist the reader in being able to quickly see when the closure criteria is estimated to become exceeded and by how much, please draw a horizontal line in the figure at 4 mrem to represent the closure criteria. L-2-13
9. Page S-25: It would help readers to know that stakeholders reviewed the composite analyses method and the zoning processes (i.e., cite the relevant CAB motions). L-2-14

HLW Tank Closure DEIS Text

1. Page D-5, Figure A-5: The possibility of reusing HLW tanks formerly considered to be retired should be noted. L-2-15
2. Figure A-5: The illustration of the tanks that have already been closed (Numbers 20 and 17) is not clear from the figure. Maybe drawing a line through them or separating them from the pack would be clearer. L-2-16
3. Page 1-7: The discussion states that much of the leaked waste was removed from the annulus of Tank 16; however, page A-5 states that waste in the annulus of Tank 16 has not been removed. If page 1-7 is correct, the discrepancy on page A-5 needs to be corrected. L-2-17

4. Page 1-10: It might help for the reader to know that the CAB conducted a cursory ISPR (Ratib Karam from ERDA visited the site for the closure of Tank 17; and Tom Pigford reviewed the Closure Plan). L-2-18
5. Page 1-11: It might be helpful for the reader to know that the CAB reviewed DOE Order 435.1 while it was in draft. L-2-19
6. Page 1-13: Section 1.4.3 would be an ideal location to review the CAB's participation in the tank closure process. L-2-20
7. Page A-21: While helpful, Figure A-7 seems unclear. Describe the different elements inside of the tanks (viz., currently, the tanks are divided into four unnamed sections; contrast this figure with the clearer Figure 2.1-1). L-2-21
8. Table 2-5, p. 2-25: the percent of MCL is confusing. It would help the reader to give an example from the data presented; e.g., 320 under Cr means 320%, or 3.2 times greater than the MCL. L-2-22
9. Table 3.3-5 uses Becquerels in a footnote and curies in the table. It might be more helpful to include becquerels and curies in the relevant tables. Conversions should be provided. Also, other tables use rem instead of sieverts. Both should be provided along with convenient conversions. L-2-23

Response to comment L-2-1: Chapter 1 of the EIS (Section 1.4.3) has been revised to present a more comprehensive discussion of stakeholder involvement in the SRS High-Level Waste Tank Closure Program. The following text has been added: "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 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."

As an example, 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.

Response to comment L-2-2: Section 3.8.1 explains background radiation exposure and Section 4.2.5 presents a comparison of the calculated radiation doses to the average U.S. background radiation exposure.

Response to comment L-2-3: Comment noted. Comparing the impacts of no action to those with the action alternatives shows the beneficial consequences.

Response to comment L-2-4: The Summary (Section S.4) and Chapter 1 (Section 1.2) have been modified to acknowledge the possibility of intrusion and releases from failed tanks in the long term. The long-term impacts of the No Action Alternative are discussed in Section 4.2 of the EIS, and the modeling basis for the results is presented in Appendix C (Section C.1.1). For purposes of the analysis DOE assumed that structural failure of the tanks and subsidence would not result in atmospheric releases, because of the depth of the tanks below grade and the likelihood that water and debris in the tanks would tend to reduce the potential for atmospheric releases. The groundwater release pathway is dominant in the calculation of doses, which are described in Section 4.2. See response to L-1-9 regarding surface dispersion of radioactivity under the no action alternative.

Response to comment L-2-5: Because DOE has not selected an alternative for tank closure at this time, the safety analysis the commenter suggests has not been performed. However, current safety analyses and surveillance programs account for the presence of waste in some of the tank annuli. Following selection of an alternative, and approval of a tank specific closure module (in the case of all alternatives except no action), DOE would perform the appropriate safety analyses based on the selected closure method.

In-tank generation of hydrogen may be an issue in the highly concentrated radioactive waste contained in the tanks prior to bulk waste removal; however, that condition is not in the scope of this EIS. The impacts from each alternative are evaluated assuming bulk removal has already been done. Under these conditions, the amount of hydrogen that could be generated internally would be insufficient to support combustion.

Response to comment L-2-6: At the end of the last paragraph before S.2.4, the text, "No leaks have been observed in the Type III tanks" has been added.

Response to comment L-2-7: The text boxes in Section S.2.4 of the Summary and Section 1.1.4.2 of the EIS have been revised to include all of waste incidental to reprocessing criteria. Section S.2.4 of the Summary and Section 2.1 of the EIS have been revised to more completely address meeting DOE Order 435.1 requirements relative to the waste incidental to reprocessing determination - specifically additional discussion of economic and technical considerations for removal of waste. The section labeled "Performance Objective" does refer to the overall performance standard in the General Closure Plan, and states that closure of individual tanks must occur in such a way that overall performance objectives can be met.

Response to comment L-2-8: Appendix C has been revised to present a new table, as Table C.3.1-2, which lists the assumed volume of residual waste if the tanks are cleaned remaining in each closed HLW tank. Table C.3.1-1 has been revised to present the average concentration in each tank farm for each listed radionuclide (curies/gallon).

Response to comment L-2-9: See response to comment L-2-4.

Response to comment L-2-10: DOE would follow the permitting procedures of the SCDHEC for disposal of the removed HLW tanks if the Clean and Remove Tanks Alternative were selected and implemented. The residual material would meet the criteria for low level waste and would be managed as such. It is DOE's practice that LLW generated at SRS is disposed of at SRS. Therefore, transportation and disposal of this material at an offsite location was not considered to be a reasonable alternative. DOE acknowledges the commenter's conclusions regarding increased cost, exposure to workers, and increased risk of transportation accidents if removed HLW tanks were transported offsite for disposal.

Response to comment L-2-11: Under the No Action Alternative during the short term DOE would continue to manage the tank farms but not close any tanks. This means that normal operations would be conducted in accordance with approved safety analyses. During this period of time the tanks would not be abandoned but actively managed to ensure worker and public health and safety. See response to comment L-7-82 regarding hydrogen generation.

Response to comment L-2-12: Further information on the costs of each alternative (that presented in Section 2.3 of the Final EIS) has been added to the Summary in Section S.8.1.

Response to comment L-2-13: Both figures S-7 and 4.2.2-1 have been modified accordingly.

Response to comment L-2-14, L-2-18, L-2-19, and L-2-20: See response to L-2-1.

Response to comment L-2-15: 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. Figure E-4 (which was Figure A-5 in the Draft EIS) has been modified to account for the future storage use of some Type I tanks.

Response to comment L-2-16: Figure E-4 (which was Figure A-5 in the Draft EIS) has been revised to show an "X" through Tanks 17 and 20.

Response to comment L-2-17: Section 1.1.3 is correct. Sections A.3.1 and E.2, third paragraph, second-to-last line, have been revised to read, "DOE removed some waste from the annulus at that time, but some dry waste still remains in the annulus."

Response to comment L-2-21: Figure A-6 is provided to present an environmental restoration concept with backfill material and a RCRA/CERCLA type cap shown over the closed tanks. See Figure A-5, Section A.4.4 (which is the same base figure as Figure 2.1-1) for more detail.

Response to comment L-2-22: DOE believes that the existing note at the bottom of the table provides sufficient guidance for interpreting "percent of MCL." There are many tables in the EIS that contain a similar construct.

Response to comment L-2-23: The purpose of footnote "B" was to provide a conversion from curies to becquerels. DOE believes that using dual sets of units would make this table (and other tables in the EIS) less reader-friendly and understandable.

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Rec.
JAN 16 2001

To: Andrew R. Grainger - NEPA Compliance Officer
Savannah River Site, Building 742-A, Room 185
Aiken, SC 29802

1/10/2001

Sir:

After lightly reading the High-Level Waste Tank Closure (F + H Areas) Draft Environmental Impact Statement over a series of weeks, I was impressed by the depth and presentation of the information. However, I was left with questions, comments, and suggestions, some of which are contained below. I was going to follow the order of the text sent, but quickly found many areas overlapped if using that format, therefore, I will start off with the most deeply related data and then proceed to broader, less focused (on this one work) info.

A - TANK OPERATIONS

I must agree with the basic plans for tank closure by filling the emptied tanks with a grout-mixture, however, several points relating to this procedure deserve some consideration. First and foremost, filling the tanks with grout limits future activities should a new plan of action be decided as preferable to the current options. Any new process would find the tanks themselves to be a nearly insurmountable problem as any method to handle the waste would require the structures be cut up which would spread the now-solid masses of contaminated materials into the air, land, and water. Some other areas of worry are... L-3-1

A1 - 1: Grout Rather then worrying about fully emptying the tanks, could only sufficient material, likely LLW, be removed so the tanks could be grout-filled with much of the HLW in place? Not only would this require processing less of the waste products, but would prevent the collapse of the tanks as mentioned as a problem in the No Action proposition. However, how dangerous the remaining structures radioactivity would be was not discussed in the text, especially as regard to the heat buildup within the tanks, should this in-place method be used. L-3-2

A1 - 2 Will the grout contain a neutron modifier as part of its composition to help limit possible radioactive processes that will continue in wastes that are left in the tanks? Also, does the grout have an expansion factor as it hardens? If not, will it settle allowing the tank to crack wherever the grout has pulled away from the wall? If so, could the expansion factor exert enough pressure to crack the tank or push existing defects apart even as the grout fills them? L-3-3

A1 - 3 The heat generation of the grout was discussed in regards to it hardening without layers, but will the residual heat in the materials coating the wall (or the walls themselves) be sufficient to set-up the grout touching the walls quicker than the rest of the mass, thus forming layers which would diminish the overall strength of the structure? L-3-4

A1 - 4 Rather than use "new" water, once the water from the tanks is treated, can it not be mixed with the grout thus preventing the tank water from being released into the environment? And would the water have to be as cleaned as much if it was planned to be reused in this manner? Would one holding tank to hold the water from existing tanks until it can be used be enough or would there have to be many tanks due to multiple cleaning projects? L-3-5

A2 -1 Water (also see A1 - 4) The evaporators generate a lot of pressure in the system prior to filtering the mist so could this cause an explosion? What is the heat source for these units and will their failure to continue to evaporate (such as in an accident) cause the radioactive material in suspension to fall back over the equipment thus rendering it useless? How micro-fine are the filters as the smaller the "mesh", the quicker the holes become plugged, and will these HEPA filters become HLW? L-3-6

A2 - 2 As direct boring to water supplies in the aquifer could contaminate them via reverse pressure or other accidents, what precautions are being taken to protect this direct link? Equally importantly, should drought conditions continue, will the removal of millions of gallons of ground water create sink holes that could undermine the tanks? L-3-7

A3 - 1: Cleaning In the tanks, under the pump-able fluids and surreys, the materials coating the walls may be a sludge or solid mass due to the heat and pressure generated by the wastes, and normal settling factors in an gravity field.. Has there been any wall scrapings or cores taken to determine how thick the settled materials are? L-3-8

A3 -2 As water is removed and cleaned, some of it will remain radioactive. Has anyone suggested using electric currents to separate the molecules of the water into their component atoms, which if then processed through gaseous diffusion, could separate out the abnormal atoms that contain extra mass prior to the now-gaseous materials release? L-3-9

A3 - 3 The chemicals to be used for cleaning are to be adjusted so they will not directly react with the linings of the tanks, however, as the tank walls have been in contact with radioactive materials over a long period, are tests planed to see if the composition of the surface (or deeper) layers of the stainless steel walls has changed and will be able to resist the chemicals and/or pressure effects from the spray itself? (A degrading of metals used in nuclear reactors, in a similar environment with heat, radiation, and pressure, often renders the metals brittle or otherwise susceptible to failure.) Under the assumption the walls will withstand cleaning, the contaminated materials coating them may peel away from the walls interface layer (as the solution undermines the contaminates) in large masses. Can the filtration system and pumping pipes handle chunks and plates of the waste material without blockages? Can the cleaning materials themselves be cleaned and used in more than one tank or will the acidic action dissolve the contaminates so the wastes are locked in the cleaning agents? L-3-10

A4 -1: Cooling Many tanks have, and so are presumed to need, cooling units. As the fluid is withdrawn for processing, will the temperature in the tanks so equipped become dangerously high? Indeed, as the circulation fluid grows less, will the cooling system become permanently inoperative? How high will the temperature in these tanks rise and will this reach a level which would boil water thus increasing tank pressure or create the need for atmospheric releases that may not be treated first? L-3-11

B - LONG TERM STORAGE

If the first tanks were left empty after processing, subsequent tanks could be cut up and stored within these repository tanks before grout is poured in them.. This would limit the number of sites left as well as provide a volume reduction in the total capacity of all the tanks. L-3-12

C - BIOLOGICAL:

Viruses have simple genetic structures and mutate rather easily, as demonstrated by the swamps in Canada which have been shown to be the breeding ground of diseases that are carried world-wide by nesting birds. Has there been any tests to see if SRS, with all the possible radiation sources, could be a similar breeding area? Are fish, fowl, and animals taken within or that exit the SRS grounds safely consumable for humans? L-3-13

D - GEOPHYSICAL

D1 - 1: Atmosphere: The prevailing winds of the coastal plain in the area of SRS is toward the east and the ocean, however, a weather condition called "the wedge" seems to be a more current phenomena then in the recent past. This condition occurs when a high pressure system in New England forces surface winds down the eastern slope of the Appalachians toward Atlanta. Are monitoring stations setup to monitor possible atmospheric radionuclides releases that travel in directions other than are considered norm and for what distance? The possibility of a tornado hitting SRS was considered very low in the text, as was hurricane damage, however, as tornados are often spawned by hurricanes, have these weather problems been considered as a unit situation rather than always separately? L-3-14

D2: Earthquakes Although this topic was touched upon in the text, much of the true picture of this problem was ignored. The eastern half of the USA, due to the subsurface structure, has a tendency for even minor quakes to travel to distant points, unlike the Pacific coast where major quakes affect relatively limited areas. The last 100-year quake (now overdue) near Charleston, SC rang church bells in Atlanta, and the last major New Madrid fault (Kansas) quake broke walls in Atlanta. Due to these conditions, the odds of a major quake anywhere from Eastern Canada to the Mississippi River to the Gulf Coast could cause destruction at SRS, especially with the unstable upper land structures of clay and dirt over bedrock as found at SRS. This issue deserves much more consideration to prevent accidents during critical operations. Recently, the collapse of the Atlantic submerged coastal plain wall, along the junction of it with the deeper ocean depths, is suspected to create massive land slides that could trigger seismic events, and has been determined to be a greater threat than previously thought. Has this potential problem been calculated for its affects on SRS? L-3-15

D3: Ocean: With the greenhouse effect now somewhat shown to be affecting the polar caps, not to mention the other changes possible, the submersion of coastal lands may bring the waters within miles of SRS if not covering parts of SRS altogether sometime in the not-so-distant future. Due to this, the 10,000-year proposed safety by current plans is nowhere near long enough. In whatever form the tanks are left, sealing the structures with liquid glass and then coating them with concrete into giant heavily shielded egg-shaped structures may prove reasonably safe for may more years. L-3-16

EXPECTATIONS

First, clean and process all LLW + HLW from above grade tanks that are in the best condition. Keeping temperatures from raising in the tanks without introducing materials that would stabilize the temperature without damaging the tanks may be difficult. Presuming the tanks are easily cleanable, removing the presumed coatings on the inner walls of the tanks should be treated off-site and placed in glass for repositories. This combined product could then be replaced in the tanks for long term storage. If the coating proves as difficult to remove as the temperatures and pressures seem likely to have caused, the coating should be left in place rather than risk damage to the tank walls. These walls then should be coated with liquid glass materials to completely seal them before anything else is placed in the tanks. L-3-17

Tanks below grade should be decommissioned next and after processing, these tanks should be disassembled and the first tanks used as repositories for them. After all possible materials are loosely stored in a tank, it should be filled with grout that contains a neutron modifier and that is mixed with LLW waster - presuming the possible expansion and temperature rise of a grout can be introduced that will not adversely effect the tanks. L-3-17

After this, the tanks need to be steel reenforced all over, including the lower surfaces, and then mounds of concrete be poured all over the remaining structures, including tunnels to coat the lower surfaces. These mega-mounds would keep water from all sources from penetration as well as making 25,000 year storage facilities that could resist major earth shifts, being covered by oceans, or other local major factors. New submergence of earth masses, space related collusions, and such planet wide catastrophes are capable of causing destructions at such a level that radioactive areas and storage will be the least of humanity's problems and are beyond coping with at our current level of technology.. L-3-18

CLOSING

Thank you for the opportunity to comment of a problem that is a long way from being solved. Because of my schedule in the close of the year, I was unable to devote the time I wished to the text, and due to frequent interruptions, some of the points I have raised may have been addressed, however, I hope those situations were few if at all. I look forward to hearing the results of the public comments and if any of my questions and the like prove useful.

Response to comment L-3-1: Comment noted.

Response to comment L-3-2: The waste is somewhat homogeneous during waste removal operations and is not amenable to segregation. Therefore, DOE cannot consider selectively removing only some of the residual waste. Heat of hydration would be managed during grout placement. Upon completion of grout placement heat of hydration would not be an issue.

Response to comment L-3-3: The grout would not be formulated to contain a neutron modifier. Concentrations in the waste are at levels that criticality should not be a concern though it is evaluated. Minimal shrinkage and cracking is expected but is not anticipated to have adverse effects on the tank wall.

Response to comment L-3-4: The residual decay heat from any residual material on the tank wall would be insignificant and would not impact grout placement or strength.

Response to comment L-3-5: Contaminated water would be reused during the tank waste slurry and waste removal activities. It may be necessary to process the water through existing evaporators to maintain adequate tank space and reduce the risk of leaks to the environment until the grout is placed in the tank. Additional storage/holding tanks would not be needed. Any water released to the environment must satisfy strict permit requirements and criteria.

Response to comment L-3-6: Operation of the HLW evaporators is outside the scope of the EIS. This type of information is addressed in the Safety Analysis Report for the tank farms, which is referenced in Appendix B of the EIS.

Response to comment L-3-7: Production wells are placed into the deep aquifers of Cretaceous age in locations away from known contaminant plumes. The deep aquifer and the upper aquifers are isolated by the thick Meyers Branch Confining system. This same hydrologic isolation along with the great thickness of the Cretaceous aquifer limits the impact of water withdrawal from the deep aquifer on the shallow aquifers and sediments, which would ensure that the integrity of the tanks is not compromised (i.e., sinkholes would not be created).

Response to comment L-3-8: Samples of the residual material in the tanks are collected and analyzed to characterize the waste residuals. SRS would use camera inspections of the interior surfaces of the tanks to verify that the tank walls are clean. In the two tanks that DOE closed (Tanks 17 and 20), the residual material was about one-half to one-inch thick.

Response to comment L-3-9: The water generated from tank cleaning activities is managed as HLW (e.g., sent through evaporators for volume reduction). Treatment of the high level waste is outside the scope of this EIS (see DOE/EIS-0082S, DOE/EIS-0082S-2, and DOE/EIS-0217). This EIS addresses stabilizing the tank and remaining residual material after removal of as much of the residual waste as possible.

Response to comment L-3-10: As noted in Section 2.1, DOE selected oxalic acid as the preferred chemical cleaning agent after examining several cleaning agents that would not aggressively attack carbon steel and would be compatible with HLW processes. These studies included tests with waste simulants and also actual Tank 16 sludge. In tanks for which DOE has performed spray water washing, DOE has not noted any negative effects from the pressure of the water washing. The waste removal equipment would be designed to be robust enough to remove the waste in each particular tank. If situations arise such that blockages occur, then steps would be taken to remedy the situation. Typically waste removal equipment would remain in the tank. DOE would recycle tank cleaning materials to the maximum extent practicable.

Response to comment L-3-11: Waste and tank temperatures would be monitored and managed during waste removal from the tank to prevent abnormal emissions from the tank. The tank cooling system would be isolated within the tank following waste removal and the cooling coils would be filled/entombed with grout. Temperature and pressure within the tank would be managed during grout placement (using a ventilation system).

Response to comment L-3-12: Cutting up and storing tanks within other tanks would not be allowable under the current operating permit for the tanks. However, the EIS analyzes two alternatives that include aspects of the alternative proposed in the comment. The Clean and Remove Tanks Alternative includes the cutting and removal of the tanks while the Fill with Saltstone Option of the Stabilize Tanks Alternative includes the disposal of waste in the closed HLW tanks. As shown in the EIS, the radiation dose received by SRS workers performing the tank removal activities under the Remove Tanks Alternative would be substantially higher than for any of the other alternatives analyzed in the EIS.

Response to comment L-3-13: There have been no tests for viruses in birds nesting at SRS. A radionuclide monitoring surveillance program is in place to monitor animals that are taken offsite for consumption (primarily deer and feral hogs). Any animals that exceed the DOE radioactivity limit would be confiscated.

Response to comment L-3-14: Thirteen radionuclide air surveillance stations are continuously monitored at SRS. There are 12 stations located around the site perimeter and one station located between F and H areas. Releases resulting from tank closure activities would be adequately characterized from information from these monitoring stations. As discussed in Section B.2.2 of the EIS, the consequences from postulated accidents were assessed using average measured meteorological values for the Savannah River Site.

The postulated accidents analyzed in Appendix B include consideration of a tornado as an initiating event. Since the wind velocity during a tornado would be larger than a hurricane, its impacts would bound those from a hurricane. The changes in accident frequency if hurricane initiated tornadoes were also included would be so small that it would not alter the conclusions in the EIS.

Response to comment L-3-15: The probable consequences of an earthquake are assessed as part of the accident analysis in Appendix B. Additional information and analysis are found in the Safety Analysis Report for the tank farms.

Response to comment L-3-16: The accuracy of projections decreases with the length of the projection into the future. The value of projecting beyond 10,000 years is low. The 10,000-year period of analysis was selected to conform to relevant regulatory guidance. Current projections of a sea level rise associated with greenhouse warming do not indicate a potential for submergence of the SRS area.

Response to comment L-3-17: Waste removed from the tanks will be treated at DWPF. The walls would be cleaned and verified by visual inspections using cameras. All HLW tanks are below grade. DOE does not believe that coating the interior tank walls with liquid glass material as suggested in the comment is technically practicable, nor would its use be necessary for the closed HLW tanks to meet the performance objectives. See response to comment L-3-12 regarding the use of tanks to dispose of structural material scrap from other tanks.

Response to comment L-3-18: As discussed in Section A.4.5 of the EIS, decisions regarding the need for a cap over the closed HLW tanks would be made as part of the Environmental Restoration Program.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

February 6, 2001

4EAD

Rec.
FEB 12 2001

Mr. Andrew R. Grainger, NEPA Compliance Officer
U.S. Department of Energy
Building 742 A, Room 183
Aiken, SC 29802
ATTN: Tank Closure EIS

RE: EPA Review of
Draft Environmental Impact Statement (DEIS) for
High-Level Waste Tank Closure (DOE/EIS-0303D)
CEQ No. 000401

Dear Mr. Grainger:

Thank you for submitting the above-referenced Draft Environmental Impact Statement (DEIS) for our review. Pursuant to Section 102(2)(C) of the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, the U.S. Environmental Protection Agency (EPA) reviewed the subject DEIS. The document provides information to educate the public regarding general and project-specific environmental impacts and analysis procedures. The purpose of this letter is to provide you with our comments on the project, based on our review of the document.

Overall, the document is detailed and clearly written. EPA evaluated the information in the DEIS, with regard to potential impacts of the proposed mission to close additional high-level waste (HLW) tanks at the Savannah River Site near Aiken, South Carolina. Alternatives presented in the DEIS include the following: (1) Clean and stabilize the tanks; (2) Clean and remove the tanks; and the (3) No Action Alternative. Under the Clean and Stabilize the tanks alternative, DOE is considering three options for tank stabilization: Fill with grout (preferred alternative); fill with sand; and fill with saltstone. As a result of this review, our comments regarding potential project impacts are attached.

Based on our review, the DEIS received a rating of "EC-2," that is, there are environmental concerns, and more information is needed to clarify the potential impacts. Our concerns focus on how all the project elements will ultimately function together, and the number of refinements that will be necessary to accomplish all the desired purposes. In particular, clarification of potential impacts, tank closure procedures, and schedule for tank closure warrant further discussion in the Final EIS. L-4-1

Please note that, while we are fully supportive of the overall goals of the project, we are concerned that the preferred alternative has long-term ramifications which will prevent redevelopment of the land at a later date. However, in order to make the land available for future use or redevelopment, the tanks would need to be removed and disposed of at an appropriate facility off-site. We realize that, at the current time, safety issues, cost and transportation issues, and disposal issues prevent this from being a viable alternative. L-4-2

Conversely, filling the tanks with grout will make their removal more difficult in the future, when this land could be needed for redevelopment, and removal of the tanks may be more feasible and desirable. At a minimum, the current project should include an interim plan for removing the tanks to an appropriate alternate location, such as a high level waste repository, if Maximum Contaminant Levels (MCLs) of radionuclides are exceeded by a predetermined amount. L-4-3

As additional details become available, they should be shared with the involved parties. A list of information which we believe would help clarify the document is attached. We appreciate the opportunity to review this project. If you have any questions or require technical assistance, you may contact Ramona McConney of my staff at (404)562-9615.

Sincerely,

Heinz J. Mueller, Chief
Office of Environmental Assessment

EPA Comments on
Draft Environmental Impact Statement (DEIS) for
High-Level Waste Tank Closure (DOE/EIS-0303D)

1. Page 2-4, Column 1, Tank Stabilization, 1st paragraph, 7th line: text states that each tank would be filled with a self-leveling material. Sand, in the sand fill option, is not self-leveling. Please clarify. L-4-4

2. Page 2-5, Column 1, 3rd section, 1st line: text states that the amount of saltstone required would exceed 160 million gallons. Page A-19, Column 2, 1st line mentions saltstone made would be greater than 160 million gallons. If the amount required to fill the tanks and the amount planned to be made exceeds tank capacity, then requirements should be reconsidered. L-4-5

3. Page 2-7, Column 1, 3rd line from top: this section compares the number of workers under the No Action alternative with only one of the other alternatives, the Stabilize Tank alternative, leaving out the Tank Removal alternative comparison. L-4-6

4. Page 2-11, Table 2-2, Saltstone Option for Particulate Matter and Carbon Monoxide: values in this chart 1.7 and 8.0 do not match the Table S-2 values of 3.6 and 16.0 in the Executive Summary, page S-19. L-4-7

5. Page 4-16, Column 2, 2nd section, 1st line: the text references the post-closure activities in Table 4.1.8-2. Table 4.1.8-2 on page 4-18 does not mention post-closure activities impacts to workers. The text on page 4-16 states that the collective dose of the other alternatives is less than the No Action alternative. Table 4.1.8-2 does not show this (if the reference is to footnote "d", even 1.2 mrem/year x 1000 years is still less than the other alternatives). Please clarify. L-4-8

6. Page 5-3, Column 1, CEQ Cumulative Effects Guidance, 3rd section, last line: text mentions five identified resources of concern. This does not match the paragraph above which lists <u>six</u> areas (see numbered resources in CEQ Cumulative Effects Guidance, 2nd section, lines 6-9). L-4-9

7. Page 6-1, Column 1, line 14: text mentions minimal short-term adverse impact to cultural resources. However, chapter 4, page 4-14 does not list any further cultural resources being impacted by any of the alternatives. See page 4-14, Column 1, 1st section, last line and Column 1, 2nd section, last line. L-4-10

8. Page C-7, Column 1,1st section, line 14: letter '<u>n</u>' stands alone. Typo? L-4-11

9. Page S-1, Column 2, section S.1, 2nd to last sentence: text mentions 'issues that remain to be resolved,' but this is not separately addressed in the Executive Summary (as listed). If it is included within other sections, a separate breakout of pending actions and/or outstanding issues (i.e. pending EIS's and Environmental Restoration Programs) would help the reader. L-4-12

10. Page S-2, Column 1, 3rd section, 4th line: The text mentions a geologic repository but no estimated time frame for approval of the geologic repository is given. This may give the reader a misleading L-4-13

impression of the disposal process. A mention of this issue earlier in the text, (along with page S-2 information), or in a separate section of unresolved issues, (see #1 above), would help. L-4-13

11. Page S-2, Column 2, 1st section, 8th line: DOE is preparing an EIS for the HLW Salt Disposition procedure. However, there is no mention of potential impact(s), if any, if the proposed action gets approved. L-4-14

12. Pages S19-S20, Table S-2 & page 2-11, Table 2-2: Please explain why cost is not included in these charts (cost is mentioned on page S-18, Column 2 last section, lines 3-5; page 2-6, Column 2, last section, 3rd to last sentence; and page 2-9, Column 2). L-4-15

13. Page 3-45, Column 2, last section, first line: DOE committed to close 24 tanks by 2022 (leaving 25 tanks for the next 8 years). Please show a schedule of closure plans in the Final EIS. L-4-16

14. Page 4-25, Column 2, 3rd line: 'the tank closure plan may need to be extended if the salt disposition process start-up is delayed'. Please show a schedule, and issues to be resolved, that may impact the tank closure. L-4-17

15. Page C-4, Column 1, last section, line 4: Please show a graphic depiction of the model mentioned in this section, which delineates the referenced zones. L-4-18

16. Page C-3, Column 2, last section, last two lines: Please explain why tanks (under all alternatives) are not capped to prevent water from entering, thus allowing contaminants to spread out. With the understanding that engineered caps may be a major undertaking (page S-25, Column 2, 2nd section, line 14 and page C-1, Column 1, 2nd section, line 9), it is still not apparent why a simple impermeable layer was not considered to help keep water out of the tanks. If there is a reason why the top of the tanks cannot be sealed, please explain this. L-4-19

17. Page S-24, Column 1, 2nd section, lines 4-7: The text states the probability of limited contamination under the No Action Alternative, but on same page, Column 2, 1st section, line 3-4, it states that contamination would be very large under the No Action alternative. Please clarify. L-4-20

18. Page S-24, Column 1, 2nd section, lines 4-6: The text states there would be limited movement of contaminants to groundwater under the No Action alternative (long-term). This does not match page 2-7, Column 1, section 2, lines 5-7, which states that movement of contaminants would be rapid under the No Action alternative. If time is the factor, then compare each to page S-18, Column 1, last section, which states the No Action alternative has the least impact in the short term. L-4-21

19. Page 2-19, Column 2, 2nd section, lines 6-9: text states all options are better than the No Action alternative for contamination into groundwater. Page S-24, Column 1, 2nd section lists the No Action alternative as 'limited movement', grout option as 'almost no' movement and 'intermediate amount' under the sand and saltstone alternatives. Please clarify. L-4-22

20. Page 2-10, Column 1, last section, lines 17-19: text mentions each alternative, and includes oxalic acid cleaning (which is only to be used "if needed"). Page 4-24, Column 2, 1st line mentions the L-4-23

oxalic acid cleaning solutions from all the alternatives (again, not a part of all cleaning options if hot water rinse is sufficient). Page 6-3, Column 2, 2nd section, lines 16-19: text again mentions oxalic acid cleaning for each alternative. Please add modifying text to each of these places to show oxalic acid will be used only as needed (still not an approved option). L-4-23

21. Page C-3, Column 1, last section, 1st line: Please clarify whether the Clean and Remove alternative would also potentially expose individuals, via the atmospheric pathway from the tank area, during destruction. L-4-24

22. Page C-6, Column 2, middle (inhalation of contaminated soils from banks of streams): if this pathway is feasible for the residents, then why couldn't we assume the same for the workers? Page C-3, Column 1, middle, states that exposure from inhalation of suspended soils was not evaluated. This appears to be the same pathway. L-4-25

23. Page C-10, Figure C-2, Terrestrial Wildlife Column: When eating, the animals selected could also ingest sediment as well as soils. As a result, clarification is needed on page C-11, Column 2, last section regarding exposure routes. L-4-26

24. Page D-3, Column 2, subsistence sportsmen: Fish consumption for residents is addressed, but please clarify the source of the data regarding the amount of fish consumed. Are warning signs posted as Institutional Controls? L-4-27

Response to comment L-4-1: Portions of this EIS have been rewritten or expanded concerning potential impacts, closure procedures, and schedule. Please refer to the specific DOE responses to the other EPA comments, dealing with these topics.

Response to comment L-4-2: As described in Section 4.2.4, the SRS Future Use Plan does not envision releasing the area from federal control. The tank farms are located in an area that will be zoned "industrial" as described by the Land Use Plan, and as such, any proposed redevelopment of the area would need to consider the closed tanks. The EIS, under the Clean and Remove Tanks Alternative, analyzed the impacts of removing the tanks and transporting the tank components to an onsite disposal facility.

Response to comment L-4-3: The SRS Future Use Plan and Section 4.2.4 of the EIS state that the integrity of site security shall be maintained, SRS boundaries shall remain unchanged, land will remain under ownership of the Federal Government, and residential uses of all SRS land shall be prohibited. Filling the tanks would not preclude tank removal in the future, if found to be necessary, but would make tank removal more difficult than removing an empty tank. The EIS, under the Clean and Remove Tanks Alternative, analyzed the impacts of removing empty tanks and transporting the tank components to an onsite disposal facility.

Response to comment L-4-4: The last sentence in the first paragraph of the Section "Tank Stabilization" in Section 2.1.1 has been revised to say"…material (grout or saltstone), or sand."

Response to comment L-4-5: The volume of saltstone generated from salt processing will occur regardless of what decision is made concerning tank closure. If tanks were to be filled with saltstone from salt processing, the excess saltstone, beyond tank capacity, would be disposed of in the Saltstone Disposal Facility.

Response to comment L-4-6: The third paragraph of Section 2.1.3 has been revised to include a comparison to the number of workers under the Clean and Remove Tanks Alternative.

Response to comment L-4-7: The values in the Summary (Table S-2) have been corrected.

Response to comment L-4-8: The second to last paragraph of Section 4.1.8.1 of the Draft EIS has been deleted as it refers to post-closure impacts that are not presented in Table 4.1.8-2. Those impacts are presented in Tables C.4.1-1 through C.4.1-6.

Response to comment L-4-9: The third paragraph of the CEQ Cumulative Effects Guidance Section has been changed to "six" areas of concern.

Response to comment L-4-10: In the first paragraph of Section 6.1, the phrase "cultural resources" has been removed from the sentence and a new sentence has been added: "These actions are not expected to impact cultural resources."

Response to comment L-4-11: In the second to last paragraph of Section C.2.1.2, the "n" has been changed to the word "no."

Response to comment L-4-12: This paragraph has been added after the second paragraph in Section S.2.4 and at the end of Section 1.1.4.1: "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 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/ CERCLA processes as part of its environmental restoration program.)"

Response to comment L-4-13: The following text has been added in the Summary (Section S.2.2) and Section 1.1.2 of the EIS: "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 EIS. As part of that process, DOE issued a Draft EIS for a geologic repository at Yucca Mountain, Nevada, in August 1999 (64 FR 156), and a Supplement to the Draft EIS in May 2001 (66 FR 22540). The Final EIS was 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."

Response to comment L-4-14: Sections S.2.2 and 1.1.2 were updated to reflect the current status of the Salt Processing Alternatives EIS and its Record of Decision. In addition, the following sentence was added to those sections: "Selecting a salt processing technology was necessary in order to empty the tanks and allow tank closure to proceed."

Response to comment L-4-15: Further information on the costs of each alternative (that presented in Section 2.3 of the Final EIS) has been added to the Summary (Section S.8.1).

Response to comment L-4-16: Schedule is included in the EIS in Section 3.9.1.3.

Response to comment L-4-17: The Salt Processing Alternatives project is currently on schedule. As shown in Figure 3.9-1 of the EIS, a technology needs to be on-line by 2010 in order to support the FFA schedule for tank closure. As with any large project, there are technical and budget issues that may arise that would have to be successfully managed to achieve operation by 2010.

Response to comment L-4-18: DOE agrees and has added a figure (Figure C-1) to improve the explanation of the conceptual model.

Response to comment L-4-19: DOE would make decisions regarding the need for a cap over the closed HLW tanks as part of the Environmental Restoration Program, as described in Section A.4.5. An engineered cap might reduce or delay the long-term impacts that are presented in this EIS. However, because decisions on capping could not be made until after all of the tanks in a group were closed, it would be premature to assume that an engineered cap would help reduce or delay long-term impacts from tank closure. Therefore, for the long-term contaminant transport modeling presented in the EIS, DOE conservatively assumed that there would be no cap over the closed tanks. As described in Appendix C, for the Stabilize Tanks Alternative, DOE assumed that the tank top, fill material, and basemat fail simultaneously at 1,000 years, with a corresponding increase in the hydraulic conductivity and infiltration rates. Prior to 1,000 years, the rate of infiltration of water is assumed to be controlled by the hydraulic conductivity of the intact concrete. For the No Action Alternative, the tank top and basemat are assumed to fail at 100 years.

Response to comment L-4-20, L-4-21, and L-4-22: Section S.8.2 has been revised as follows: "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 tank stabilization options, as far as minimizing long-term movement of residual radiological contaminants."

Response to comment L-4-23: 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.

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. On a tank-by-tank basis, DOE will evaluate the long-term human health impacts of further waste removal versus the additional economic costs.

Tank cleaning by spray water washing involves washing each tank, using hot water in rotary spray jets. 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 out of the tank. This process has been demonstrated on Tanks 16 (which has not been closed) and 17 (which has been closed). 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. If oxalic acid cleaning were chosen, hot oxalic acid would be sprayed through the spray nozzles that were used for spray water washing. Oxalic acid has been demonstrated in Tank 16 only and shown to provide cleaning that is much more effective than spray water washing for removal of radioactivity (See Table S-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 successfully demonstrating that dissolution of HLW sludge solids by the acid would not create a potential for a nuclear criticality.

The potential for nuclear criticality is one significant technical constraint on the practicality of chemical cleaning (such as with oxalic acid). Concern about potential criticality would not preclude using chemical cleaning. However, a thorough, tank-specific evaluation for criticality would need to be done before using chemical cleaning in any tank and may result in the identification of additional tank-specific controls to ensure prevention of criticality.

Response to comment L-4-24: Section 4.1.3.2 describes the airborne emissions attributable to tank closure activities for each alternative. The phrase "after tank closure" has been added to the third paragraph of Section C.1.1 to clarify this point. A reference to Section 4.1.3.2 was also added to Section C.1.1.

Response to comment L-4-25: The exposure points for the worker and the resident receptors are different. The worker is assumed to be present at the seepline, where the soil is very damp, which would make resuspension and inhalation of soil very unlikely. The resident is assumed to reside on the opposite side of the stream, at a downstream location that ensures complete mixing of the seep water with the surface water. At this hypothetical resident location, the soil moisture characteristics cannot be accurately defined, therefore, it was conservatively assumed that resuspension and inhalation of soil could occur.

Response to comment L-4-26: As discussed in the first paragraph of Section C.2.2.2, sediment as an exposure medium for terrestrial wildlife was not quantitatively evaluated. This is because estimating sediment contamination from surface water inputs would be highly speculative. Seepage into sediment is not considered in the groundwater model; however, because exposure to chemicals in sediments is theoretically possible, the first paragraph of Section C.2.2.2, has been revised to clarify this point.

Response to comment L-4-27: The fish consumption rate used in the long-term dose assessment modeling was derived from SRS-specific studies. DOE would use all appropriate institutional control measures, including the possibility of using warning signs related to fish consumption. The specific details of these measures over the long term are speculative and cannot be accurately predicted at this time. The states of South Carolina and Georgia have programs in place to assess the quality of water in the Savannah River and other surface water bodies in their states and post fish consumption advisories which they deem necessary. There is no public fishing access to the on-site streams assessed in this EIS.

"French, Peter/COR" <pfrench@ch2m.com>

To: drew.grainger@mailhub.srs.gov
cc: esandc@prodigy.net, CrescentEMC@aol.com, kpatrson@home.ifx.net, lawless@mail.paine.edu, leepoe@mindspring.com, Mcdonell@ttnus.com, wwaters256@aol.com
Subject: Tank Closure EIS

01/26/01 12:11 PM

Drew,

Greetings; Please find attached my comments on the HLW Tank Closure draft EIS. If you have any questions or comments, please do not hesitate to contact me.

Regards,

Mike French
(803)642-0735
<<COMMENTS ON DRAFT TANK CLOSURE EIS.doc>>

COMMENTS ON DRAFT TANK CLOSURE EIS.doc

Rec.
JAN 26 2001

COMMENTS ON DRAFT TANK CLOSURE EIS.

1. Various CAB Committees have stated that they believe that Salt Processing and HLW Tank Closure to be the most important activity at SRS. Consequently, we believe that it is imperative get on with Tank Closure activities as expeditiously as possible, and under no circumstances allow this EIS – or any other item – to interfere with the closure schedule negotiated with the Site regulators. L-5-1

2. The statement "... Highly Corrosive Waste ..." is not correct. The word "corrosive should be deleted, as the waste is not corrosive to its containment system. Leaks into the annulus are as a result of stress corrosion cracking because the lower tank weld was not annealed prior to use. L-5-2

3. On P. S8 you state that waste that leaked into the annulus of Tank 16 has not been removed. However, on P.S11 it states that the annulus cleaning operation was "only 70% completed". These 2 statements are not consistent. Also on P. S11, we believe that you are seriously underestimating the annulus cleaning problem as indicated in several CAB committee meetings. Emphasizing this issue, the CAB is in process of submitting recommendations to DOE/SR that state that 1. "SRS develop, test and have a method for annuli cleaning for use no later than 2007" & 2. " SRS develop a HLW tank-annulus cleaning plan .... and submit it to Salt Team Focus Group before the end of 2001! L-5-3

4. I believe that the 4mrem/yr dose consequence regulatory limit at the seep is too low & unrealistic. You emphasize that the contaminants from all tanks should not exceed this limit! Once again, it should be emphasized that the 4mrem/yr is municipal water drinking standard, & as such is hardly applicable. Furthermore, if I interpret Table S-2 correctly, only the "clean & grout" option stands a chance of meeting this limit. Consequently, as this 4mrem/yr limit poses no health risk in this case, a higher, more realistic limit should be evaluated in this EIS & negotiated with the regulators as soon as possible. L-5-4

5. On Pages S10 & 11, you talk about the potential for a nuclear criticality when using oxalic acid cleaning. I would question that statement. As a minimum, I believe that a detailed explanation of these statements would be appropriate & useful. This also ties in with the CAB recommendation discussed in #3 above. L-5-5

6. On Page S12, the potential impact of new missions at SRS are discussed re additional HLW generation. In particular you refer to the 3 new Pu disposition facilities, & state that "these will not add to the current HLW waste inventory at SRS". I do not believe that this statement is true. Specifically, in the Pit Disassembly & Conversion Facility, DOE has approved the addition of a "Polishing Capability" to the front end of the unit, whose sole function is to remove Americium & other "nasty materials" from the Pu. Surely these impurities constitute HLW & should be treated as such just like the Pu residues from RFETS. As you indicate, treating the latter at SRS is expected to result in an additional 5 DWPF canisters. I believe this needs to be checked out. L-5-6

7. Per #6, how can you guarantee that additional new programs that might come to SRS will not be HLW generators? Don't let yourself get "boxed in" & allow for contingencies. L-5-7

Response to comment L-5-1: DOE agrees that HLW tank closure is important and that undertaking tank closure activities expeditiously is an important objective.

Response to comment L-5-2: The word "corrosive" has been deleted in Sections S.1 and 1.1.

Response to comment L-5-3: The last sentence of the third paragraph of Section S.2.3 has been revised as follows: "Waste removal from the Tank 16 primary vessel was completed in 1980. DOE removed some waste from the annulus at that time, but some dry waste still remains in the annulus."

The following new paragraph concerning DOE's response to the CAB recommendations has been added to Sections S.2.3 and 1.4.3: "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."

Response to comment L-5-4: Chapter 7 of the EIS describes the process DOE used in reviewing requirements and guidance to identify environmental protection standards. Since application of the 4 mrem/year drinking water standard at the seepline was established by SCDHEC, DOE does not consider looking at a higher regulatory limit to be useful as this requirement is not likely to be relaxed. Sections 2.4.2 and 4.2.2.2 have been revised to state that the contaminant level at the seepline is specified in the General Closure Plan for the tanks as the regulatory compliance point for groundwater, and would be compared with the 4 mrem/year standard.

Additionally, your observation is correct relative to the options and this is one of the main reasons DOE prefers the Fill with Grout Option of the Stabilize Tanks Alternative.

Response to comment L-5-5: The detailed discussion requested exceeds the level of detail appropriate for an EIS summary. Criticality and other concerns associated with the use of oxalic acid are discussed in Sections 2.1, A.4.3, and B.3.1. Also, see the response to comment L-7-32.

Response to comment L-5-6: This EIS considers alternatives for closure of empty HLW tanks; therefore, impacts of new HLW generation are not within the scope of this document.

The HLW program utilizes a "High-Level Waste System Plan" to help plan and manage the operation of the tank farms, DWPF, and associated systems. This plan is updated annually and whenever there are major perturbations to the system. Included in this plan are the known influents to the HLW system. Potential impacts from new missions will be included in this planning document.

Response to comment L-5-7: The HLW program utilizes a "High-Level Waste System Plan" to help plan and manage the operation of the tank farms, DWPF, and associated systems. This plan is updated annually and whenever there are major perturbations to the system. Included in this plan are the known influents to the HLW system. Potential impacts from new missions will be included in this planning document.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 22, 2001

Rec.
JAN 24 2001

Andrew R. Grainger
NEPA Compliance Officer
Savannah River Site
Building 742-A, Room 185
Aiken, SC 29802

Dear Mr. Grainger:

NRC staff have reviewed the U.S. Department of Energy's (DOE) "Savannah River [SR] Site High-Level Waste [HLW] Tank Closure Draft Environmental Impact Statement [EIS]," and have prepared the following list of comments on the document.

1. **Comment:**

   None of the NRC recommendations from its review appear to have been incorporated.

   Basis:

   NRC staff performed a review of the DOE-SR methodology for determining that residual tank waste met the incidental waste criteria. The results of the review are summarized in the June 30, 2000 letter and associated technical evaluation report (TER) (letter from W. Kane/NRC to R. Schepens/ DOE-SR, June 30, 2000). Staff recognizes that the Draft EIS was in preparation at the same time as the NRC review was being performed. L-6-1

   Recommendation:

   NRC staff suggests incorporation of its recommendations in the Final EIS and supporting performance assessment(s).

2. **Comment:**

   There is no cost-benefit analysis provided for the alternatives.

   Basis:

   No cost-benefit analysis has been provided. Only order of magnitude estimates are provided on page 2-9. A cost-benefit analysis (including rad-worker exposure) for the various alternatives would be useful for comparison. It would prove particularly useful in comparing the "Fill with Grout" and "Fill with Saltstone" alternatives. If the "Fill with Saltstone" alternative were selected, normal saltstone activities at the Saltstone Manufacturing and Disposal Facility in Z-Area would be decreased. It is not apparent in the Draft EIS that the cost analysis (discussion on pages S-10, 2-5) for the "Fill with Saltstone" alternative takes into consideration the cost-savings from decreased usage of the Saltstone Manufacturing and Disposal Facility in Z-Area and construction of fewer disposal vaults, nor L-6-2

A. Grainger -2-

does it appear to balance worker exposure from filling tanks with saltstone against the worker exposures that would have occurred at the Z-Area facility. L-6-2

Recommendation:

Provide a thorough cost-benefit analysis in the Final EIS to aid in comparison of alternatives.

3. **Comment:**

There is no discussion of the waste form meeting Class C concentration limits as required by DOE G435.1, Section II.B, "Waste Incidental to Reprocessing." (See also comment 5.)

Basis:

The third criterion in DOE G435.1 for Waste Incidental to Reprocessing is that, "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." Not only is this requirement never discussed, it is also conspicuously absent from direct quotations of DOE G435.1 (Text Box page S-9, page S-17, Text Box page 1-11, page 2-2, page 7-5 etc.). L-6-3

Recommendation:

Provide an analysis of the residual tank waste with respect to this criterion, or provide a rationale for alternative waste classification as discussed in DOE G435.1, Section II.B(2)(a)3.

4. **Comment:**

The Waste Incidental to Reprocessing analysis provided in the Draft EIS is inconclusive.

Basis:

There are three incidental waste criteria in DOE G435.1. The second requires "the waste meet safety requirements comparable to the performance objectives set out in 10 CFR Part 61...." One of the performance objectives is protection of an inadvertent intruder. The Part 61 intruder is a resident farmer (with a well), which would place the farmer near the tank farms (i.e., the 1m or 100m wells). The dose limit for an inadvertent intruder is 500 mrem/year. It appears from the information provided in this Draft EIS, that a resident farmer on H-tank farm would receive ~ 100 rem/yr from 1m well (+20% for other sources (pages 4-47 and C-24)). Pages 2-28 and 4-34 state that the 1m and 100m well doses are extremely conservative due to modeling assumptions. In addition, there is a complete absence of any discussion in the Draft EIS of the third criterion, which requires that the waste be "incorporated in a solid physical form at a concentration that does not exceed the applicable L-6-4

A. Grainger -3-

concentration limits for Class C low-level waste as set out in 10 CFR 61.55." The Class C concentration limits were developed to protect an inadvertent intruder, which is particularly important because the intruder performance objective is the one that is not met.

When NRC staff reviewed the DOE-SR methodology for meeting the incidental waste criteria, the information we were provided indicated that a resident farmer intruder would be protected at F-tank farm. The methodology also indicated that Class C concentration limits could not be met for all tanks, however, a rationale similar to the provisions in 10 CFR 61.58 was provided. (10 CFR 61.58 states that, "[t]he Commission may... authorize other provisions for the classification... of waste on a specific basis, if, after evaluation, or the specific characteristics of the waste, disposal site, and method of disposal, it finds reasonable assurance of compliance with the performance objectives in subpart C of this part.") Based on the information provided, NRC staff concluded that "the methodology for tank closure at SRS appears to reasonably analyse the relevant considerations for Criterion One and Criterion Three of the incidental waste criteria. DOE would undertake cleanup to the maximum extent that is technically and economically practical, and would demonstrate it can meet performance objectives consistent with those required for disposal of low-level waste. These commitments, if satisfied, should serve to provide adequate protection of public health and safety (June 30, 2000 letter)." In addition, staff recommended that DOE-SR develop site-specific concentration limits. L-6-4

The information currently provided in the Draft EIS does not conclusively support the Waste Incidental to Reprocessing determination, for two of the three criteria listed in DOE G435.1.

Recommendation:

(1) Perform an updated performance assessment which does not artificially skew the 1m and 100m well results (i.e., provides a more realistic analysis). However, if these results show a drinking water dose greater than 416 mrem/year (500 mrem/year ÷ 120%), the 10 CFR Part 61 resident farmer intruder may not be sufficiently protected.

OR

(2) Provide sufficient rationale for extended institutional controls, and explain how they would provide protection to an inadvertent intruder comparable to that provided by the performance objectives in 10 CFR Part 61.

5. **Editorial Comment:**

This document needs more technical editing.

Basis: L-6-5

There are many mistakes in the document, including spelling, grammar and misuse of terms, for example:

A. Grainger -4-

On page 3-5, it states that, "[t]he mineralogy of the sands and pebbles primarily consists of quarts and feldspars."

On page 1-10, the document abbreviates the National Research Council as "NRC;" however, the list of Abbreviations (and later sections of the document) use "NRC" to mean the U.S. Nuclear Regulatory Commission. L-6-5

Recommendation:

The Final EIS should be more closely edited.

If you have any questions on this letter, please contact Jennifer Davis, of my staff, at (301) 415-5874, or bjd1@nrc.gov.

Sincerely,

Thomas H. Essig

Thomas H. Essig, Chief
Environmental and Performance
Assessment Branch
Division of Waste Management
Office of Nuclear Materials Safety
and Safeguards

Response to comment L-6-1: DOE expects to make waste incidental to reprocessing determinations tank by tank, based on analyses that will be provided in future tank-specific Closure Modules. The NRC recommendations, which included such items as additional sensitivity analyses and calculations for the long-term performance evaluation, will be incorporated in these analyses. The level of detail requested is not appropriate for the EIS.

Response to comment L-6-2: The Draft EIS presented data on both the costs and impacts of each alternative. Further details regarding quantitative cost-benefit analysis are not required by NEPA regulations and would not be appropriate for the EIS. The Final EIS Summary (Section S.8.1) has been revised to more clearly present the cost information from Chapter 2 of the EIS.

Response to comment L-6-3: The text in the referenced text boxes was not intended to be a direct quotation from DOE Manual 435.1-1. The text included in Criterion 3 the fact that DOE will manage the waste in accordance with AEA and 435.1-1 requirements. 10 CFR 61.55 Class C requirements are addressed in 435.1-1. These text boxes were intended to address instances where the residual material would be managed as low-level waste or as transuranic waste, depending on the concentration of alpha-emitting radionuclides in the residual. The text in the referenced text boxes has been revised to include all of Criterion 3. As a result of several comments, the text in Section 2.1 of the Final EIS has been revised to provide a more comprehensive discussion of DOE's Waste Incidental to Reprocessing determination process, including the requirement to meet Class C limits (if the residual material was considered low-level waste).

Response to comment L-6-4: Identification of standards for the long-term performance of the SRS HLW tank closure process was the result of a series of interactions between DOE, SCDHEC, and EPA Region 4. The South Carolina regulations on closure of facilities permitted as industrial wastewater treatment systems (R.61-82, "Proper Closeout of Wastewater Treatment Facilities") require that such closures 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. As a result of these interactions, it was determined that the point of compliance for SRS HLW tank closure impacts would be the point at which the groundwater potentially impacted by contaminants from closed HLW tanks enters the accessible environment (i.e., the seepline).

This location is also in accordance with DOE policy on the long-term performance of closed HLW tanks. DOE Manual 435.1-1, Section IV.P.(2)(b) states, "The point of compliance shall correspond to the point of highest projected dose or concentration beyond a 100-meter buffer zone surrounding the disposed waste. A larger or smaller buffer zone may be used if adequate justification is provided." As discussed in DOE Guidance 435.1-1 (Page IV-193), this requirement provides flexibility in establishing the extent of the buffer zone considering site-specific issues. For example, in cases where the disposal facility is located far from the DOE site boundary, and the site's land-use planning does not envision relinquishing control of the site, a larger buffer zone could be considered. The justification for the selection of the point of compliance and size of the buffer zone is based on land use plans and commitments that have been negotiated during consent agreements or other regulatory actions. The justification could also be based on the proximity of already existing contaminated areas or nearby operational facilities that establish a boundary, or which would render the 100-meter point of compliance as unreasonable.

Therefore, the long-term fate and transport modeling for HLW tank closure is optimized to provide the most accurate (while still conservative) results at the seepline. In doing so, DOE's assumption that the tank farms are nearly a point source is reasonable for a seepline that is nearly one mile downgradient.

Calculated doses at both the 1-meter and 100-meter wells for the H-Area Tank Farm north of the groundwater divide (the highest location) are dominated by a single tank group, Tanks 9-12, because of its vertical location within the water table. Since the 1-meter and 100-meter well locations are determined from the downgradient edge of the tank farm, and are therefore more than 1 meter and 100 meters from the edge of the tank group, the dose resulting from summing the doses from all tank groups within H-Area Tank Farm north of the groundwater divide is a close approximation to the maximum dose from that tank group. The results reported in the EIS indicate that the 100-meter well drinking water dose would comply with the cited criterion under the Fill with Grout Option (the highest dose under this option is 300 mrem/year for the H-Area Tank Farm, north of the groundwater divide), but not under the other options of the Stabilize Tanks Alternative, nor under the No Action Alternative. Under the Fill with Grout Option, the dose at the seepline is within the 4 mrem/year performance objective for both F-and H-Area Tank Farms.

Meeting all three criteria under the waste incidental to reprocessing requirement is a condition for closure of the tanks. For closure of a specific tank, DOE must demonstrate that all three criteria are satisfied before the tank can be closed. For example, if the residual material remaining in the HLW tank did not conform to the definition of Class C Waste from 10 CFR 61.55, DOE could apply the methodology presented in the NRC's Branch Technical Position on Concentration Averaging to demonstrate that the configuration of the resulting closed tank conforms with this concentration criterion. DOE's determination of how a closed tank conforms to the waste incidental to reprocessing criteria will be included in Tank Specific Closure Modules.

Response to comment L-6-5: The Final EIS was subjected to a thorough technical edit prior to publication.

Drew Grainger

To: L Ling/DOE/Srs@Srs, George Hannah@Srs, John Knox/DOE/Srs@Srs
cc:
Subject: Comments on Tank Closure EIS

01/24/01 01:16 PM

----- Forwarded by Drew Grainger/DOE/Srs on 01/24/01 01:18 PM -----

Lee Poe <leepoe@springmail.com>
Sent by: leepoe@springmail.com

To: Drew Grainger <drew.grainger@mailhub.srs.gov>, NEPA Compliance <nepa@mailhub.srs.gov>
cc: Rick McLeod <CrescentEMC@aol.com>, Bill Lawless <lawlessw@mail.paine.edu>, Ernie Chaput <esandc@prodigy.net>, Mike French <pfrench@ch2m.com>, Karen Patterson <kpatrson@home.ifx.net>, Kelly Dean <kelly.dean@mailhub.srs.gov>, Donna Martin <donna.martin@mailhub.srs.gov>, Wade Waters <wwaters258@aol.com>, Larry Ling <l.ling@mailhub.srs.gov>
Subject: Comments on Tank Closure EIS

01/24/01 01:09 PM
Please respond to leepoe

Attached are my comments on the Tank Closure EIS.

Please respond telling me you recieved them. I will mail you a copy if you desire a signed copy.

Thanks Lee

Comments on Tk Closure EIS.doc

January 23, 2001
807 E. Rollingwood Rd
Aiken, SC 29801

Mr. Andrew R. Grainger
NEPA Compliance Officer
U. S. Department of Energy
Savannah River Operations Office
Building 742-A, Room 183
Aiken, SC 29801

Comments on Tank Closure EIS
DOE/EIS-0303D, November 2000

I would like to provide the following comments on DOE/EIS-0303D.

General Comments:

1. **Get on with the closure of HLW Tanks.** Do not allow this EIS or anything else interfere with the closure schedule that has been negotiated with SRS regulators. Tank 19F closure schedule is 2003 but the plan for closure is 2002. Meet the planned schedule. Closure of the remaining tank in the four-pack is scheduled for 2004. Meet these and all other HLW Tank closure schedules. L-7-1

2. **Select the "Clean and Stabilize Tanks Alternative" with the "Fill with Grout" option.** It is the only long-term alternative/option that provides sufficient long term environmental protection. The option "Fill with Sand" allows water to freely flow through the sand (after tank failure) hastening release of radionuclides. The "Fill with Saltstone" requires three saltstone manufacture plants at unnecessary expense. The "Clean and Remove the Tank" does not provide the environmental impacts of long-term storage of the steel and concrete rubble. Of course the "No Action" is an incomplete cleanup of the SRS. L-7-2

3. I suggest the site look at and include a higher regulatory limit than the 4 mrem/yr dose consequence at the seep. Based on my knowledge of the HLW System, I doubt that the inventories of radionuclides postulated to be left in the tank system can be met, in reality. To achieve the projected inventories may be impossible or very difficult and require much more water washing and tank cleaning. **A higher regulatory limit should be considered in the EIS.** The 4 mrem/yr limit poses no health consequence and a higher limit should be evaluated in this EIS and appropriate administrative controls (but not another EIS) should be specified now in this EIS to allow its use if needed. L-7-3

Page 1

4. **The 20% additional inventory, allowed for piping, equipment, etc, should be given a more prominent position in the EIS.** I was able to find it only in Appendix C. L-7-4

5. **Information should be included in the EIS on how waste and waste residues, left in the HLW Tanks, will be measured and how well the residual quantities will be known.** This issue is a paramount issue in establishing cleanliness before closure can be initiated. At this time, it is not dealt with in this EIS. L-7-5

6. **The environmental impacts of all alternatives should be included in this EIS.** If those impacts have been previously determined in other EIS's, the impacts should be included here also. Only in this manner can the decision-maker compare and evaluate the various alternatives. L-7-6

7. **Include a section on Institutional Controls (IC) planned to ensure both near-term and long-term safety of the public.** For example, if IC do not prevent intrusion to the water table and use of the groundwater, adoption of the seep line limit makes no sense. L-7-7

8. **The summary should be included in the large EIS book.** Or at the very least, the big book should say this is only a partial EIS. L-7-8

Specific Comments:

Summary:

1. The Summary is well written and includes much of the pertinent findings of the EIS. L-7-9

2. In the second paragraph of S-1, delete the word corrosive when describing the waste. The waste is not corrosive to the system it is contained in. This also makes this section consistent with other sections in the EIS that describe the waste as highly radioactive. L-7-10

3. Add to section S.2.3 a short paragraph on the basis for HLW Tank cracking and its present status. L-7-11

4. On Page S-8, in the second paragraph, add a short sentence stating why Tanks 17 and 20 cracks are thought to be groundwater corrosion. Does this infer that the tanks components exposed to groundwater are severely corroded? L-7-12

5. In the last paragraph in Section S.2.3 (page S-8), add a sentence or two on why the primary of Type III tanks have not leaked. L-7-13

Page 2

6. The second paragraph of Section S.2.4 states DOE has reviewed several EIS for waste removal. The section should summarize what DOE found in this review. L-7-14

7. The Performance Objective paragraph, on Page S-9, should be expanded to provide the CAB the opportunity to review of the tank specific Closure Modules at the same time as the regulator's review. L-7-15

8. The cumulative curies removed in Table S-1 are shown to be 10^{-6}. The minus sign is a typographical error. L-7-16

9. I consider the last sentence is Section S.2.4, on Page S-11, to be wrong. SRS documentation of the waste in the annulus of Tank 16 show it contains 30,000 curies of Cs-137. That amount of waste exceeds the entire inventory in F- or H-Areas used in calculating the dose rates in Table S-3. Other examples can also be given to show the inventory is large compared to the values given in Table C.3.1-1. L-7-17

10. The middle paragraph in Page S-12 says that in response to comments DOE has included total volumes of waste remaining in the tanks as residual waste. I have been unable to locate this. It is obviously used in the analysis that went into the EIS. L-7-18

11. If I assume the 4 mrem/yr seepline limit, Table S-3 (page S-22) shows that two of the alternatives examined will exceed the limit and the third will be essentially at the limit. Only "Clean and Fill with Grout" is acceptable. See General Comment number 3 above that proposes a higher limit than the 4 mrem/yr. L-7-19

12. Please check the "No Action" seepline dose rate to Upper Three Runs Creek. Table S-3 shows it to be 2,500 mrem/yr. That value seems high when compared with other values given and is probably a typographical error. L-7-20

13. Figure S-7 shows a plot of predicted drinking water dose over the 10,000-year analysis period. Add information to the text to show why the curves appear as they do and what are the principal radionuclides reaching the creeks. It is my understanding that the dose rate is primarily due to Tc^{99}. L-7-21

Chapter 1:

1. In the second paragraph, delete the word corrosive when describing the waste. The waste is not corrosive to the system it is contained in. This also makes this section consistent with other sections in the EIS that describe the waste as highly radioactive. L-7-22

2. On page 1-7, in the Section on Tanks, and in the third paragraph; change the wording of the fourth sentence. As written it infers all of the waste has been contained in the concrete encasement; it has not as mentioned for Tank 16. Suggest the sentence read "Most of the waste was contained in the concrete encasement……" L-7-23

Page 3

3. On page 1-7, in the Section on Tanks, and in the fourth paragraph; add a statement on Type III HLW Tank leakage or lack of it. This keeps section parallel to other sections. L-7-24

4. On page 1-7, in the Section on Evaporator Systems; aren't there three evaporators operating? Use care when you say words like "at present" because your reader thinks it is a statement of the condition at the time the EIS was published or when he is reading it and it is probably neither. L-7-25

5. On page 1-11, in the Section on Decisions to be based on this EIS, and in the first paragraph; the third sentence is not technically correct. Some of the environmental impacts are not included in the EIS but referenced to other NEPA documents. L-7-26

6. On page 1-12, in the second paragraph; the EIS states a tank-specific Closure Module is required. This specific Module should contain the measured inventory of residual waste after water washing and estimated inventory before tank stabilization with grout. (This EIS should specify what the type of information that will be contained in these tank-specific Closure Modules. L-7-27

7. The last full paragraph on page 1-12 should be expanded to describe the process in reference DOE-1996. This paragraph should describe the coordination and interactions between HLW and ER. L-7-28

8. The top paragraph on Page 1-13 say the ER activities will be governed by CERCLA/RCRA. Will the 4 mrem/yr at the seepline be rescinded and the DWS imposed at the HLW fence post as is currently being required for other CERCLA/RCRA sites? This last paragraph should be more informative. L-7-29

9. Include CAB/WM Committee/Salt FG interactions with SRS and the regulators in Section 1.4.3. L-7-30

<u>Chapter 2:</u>

1. On page 2-1, in the Section on HLW Tank Cleaning; the volume of waste left after spray washing was given for Tank 16 & 17, add similar information for Tank 20. Also add for the three tanks the amount of waste (probably expressed in curies) to the paragraph. L-7-31

2. The second paragraph on Page 2-2 states that a nuclear criticality evaluation is required before oxalic acid will be allowed. The EIS, by discussing it, gives the impression it is not a criticality contributor. If the EIS discussed oxalic acid washing as a possible mode of cleaning the tanks, it should be known to be acceptable. After reading this information, I am left with a significant question on its use. Please clarify. L-7-32

3. Table 2-1 on page 2-3 and associated text, SRS needs to include information to show the amount of waste left in the tank after oxalic acid cleaning. Otherwise the % removed and the cumulative columns are incomplete and do not tell the appropriate story. L-7-33

4. On page 2-3, in the second paragraph, add discussion on dissolution of salts from the annulus. L-7-34

5. Page 2-5 says that the saltstone alternative has "a large quantity of nitrates". This statement should be quantified to identify what the concern or point is. L-7-35

6. Section 2.1.4.2 should discuss the environmental impacts of delayed closure of the tanks. L-7-36

7. In Section 2.3 on page 2-9, in the middle paragraph; in addition to new technologies add demonstration of old technologies to the section. L-7-37

8. In Section 2.3 on page 2-9, the statement is made that "for the period of delay, the impact of this approach would be the same as the No-Action Alternative". Without additional information, I do not understand why it is true. If fact, I doubt that it is correct. L-7-38

9. Environmental Impacts of Clean and Remove Alternative are stated not to be included in the EIS because they are included in another EIS. This EIS should summarize the impacts, not leave them out. L-7-39

10. Section 2 should include discussion of accidents during the long-term. If the EIS doesn't determine them, a clear rational must be given. L-7-40

11. Section 2.4.2 on page 2-27 states "the principal source of potential impacts to the public health is leaching and groundwater transport of contaminants". With the analysis presented, I conclude that falling into an unfilled HLW tank with a high probability of death is a much larger public health consequence and risk. Contaminant transport will not kill members of the public. L-7-41

12. I consider the discussion on page 2-27 in the last paragraph comparing lifetime dose commitment and the single year limit to be weak. L-7-42

<u>Chapter 3:</u>

No comments are provided on this section. It contains lots of information in its 58 pages that is required by NEPA but does not impact the conclusions of this EIS. A better way of implementing the NEPA requirements should be developed for the many SRS EISs that essentially have the same type of information. L-7-43

Page 5

Chapter 4:

1. Page 4-10 in Section 4.1.3.2, the EIS makes the assumption for Clean and Remove Tanks Alternative that HEPA Filtered enclosures are used during removal of metal from the tank enclosures. I question this assumption. It is not clear to me that the safety improvement justifies this requirement after the tank has been decontaminated and while the steel is being removed. L-7-44

2. Table 4.1.8-1 et al includes partial environmental impacts. The long-term impacts of disposal of the steel should be included. L-7-45

3. On page 4-25, the No Action Alternative environmental impacts are shown as zeros. That alternative will have impacts. L-7-46

4. Table 4.1.12-1 on page 4-29 does not include accident consequences for the No Action Alternative. It seems to me that the time duration of these type activities is 10,000 years not 30 as assumed for other alternatives resulting in probabilities of one for the various accidents. L-7-47

5. The long-term impacts for the Clean and Remove Tank alternative should be given in Section 4.2 (page 2-30). If the impacts are given in other EISs, they should be summarized here, as I stated under the General Comments. L-7-48

6. Table 4.2.2-6 (page 4-37) doesn't seem to include iron from the steel of the tanks. What are the impacts of this iron? L-7-49

7. Text associated with Figure 4.2.2-1, should describe when the plutonium is expected to arrive at the seep line and what impact it may have on dose rate. I expect it is beyond the 10,000 year analysis period but still should be given in the EIS. L-7-50

8. The Public Health (Section 4.2.5 on page 4-44) seems to be long-term effects. The title of the section should provide this information since there are other public impacts as well. L-7-51

Chapter 5:

1. Modify the section title on page 5-3 (Spacial and Temporal Boundaries), it is unclear. What is being covered here? L-7-52

2. Delete reference to a specific company (Bridgestone Tire) or use other company names. This usage is on page 5-3.) L-7-53

Page 6

3. Table 5-2 (page 5-8) should include the impacts of the Composite Analysis for the 200-Areas (it includes the long-term impacts of other discharges to the SRS streams impacted by this EIS). L-7-54

Chapter 6:

No comments.

Chapter 7:

1. The example given on page 7-3 in Section 7.1.2, doesn't seem to be the most stringent requirement. Expand to ensure your reader understands the point you are making. L-7-55

Appendix A:

1. Add the basis for that statement made on Page A-5 "there is no evidence that he waste has leaked from the secondary containment". L-7-56
2. Section A.3 on page A-5, add a reference for Tank 16 "the 10s of gallons leakage that migrated to the surrounding soil" L-7-57
3. Page A-5 also contains the statement about Type IV tanks "small amounts of groundwater have leaked into these tanks". Also add a reference for the statement. L-7-58
4. Section A.3 needs a paragraph that describes when the cracks occurred and what is projected for the future. It is my understanding they occurred early in the Tank Farm life and cracking has decreased materially or stopped. Describe why. Tank 15 cracking may be the exception. Reader needs to feel the cracking is under control or has been eliminated. L-7-59
5. Last line on page A-5 has a spelling error. L-7-60
6. Change the work "complete" in Table A-1 on page A-7 as used in Tank 16 current usage. The work says the annulus cleaning is complete. I doubt that it is complete with 30,000 Ci of Cs-137 still in the annulus. It may have meant to state cleaning was stopped in the past. L-7-61
7. The first full paragraph on page A-9 describes 17 RCRA/CERCLA contaminations. Add a Table with this information showing the location and quantity of waste that leaked and what is still there. L-7-62

Page 7

8. Add the basis for the last statement in that first full paragraph on Page A-9. The one that states these leak sources probably will not contribute to the tank closure performance. L-7-63

9. Reference the source of the information in the second full paragraph on page A-9. In particular the leakage stated to be a few gallons but the date (and presumably other pertinent information on the leak) is unknown. This certainly raises questions on validity of what is being stated. L-7-64

10. Reference the Tank 16 leak statement in the top paragraph on page A-9. L-7-65

11. Expand the first sentence of the second paragraph in the right hand column of Page A-9. Why is it unlikely that waste has not leaked from other tanks? L-7-66

12. What is the basis for the last statement in the second paragraph in the right hand column of Page A-9? L-7-67

13. In Section A.3.2 on page A-9, the same comment as given earlier. Use care in using "recently" in an EIS. It won't be read the same way by all readers. I thought that there were three operating evaporators. L-7-68

14. Add a paragraph to Section A.3.2 describing how HLW evaporators are contained and shielded. L-7-69

15. At the top of page A-12, evaporator rated capacity is expressed as volume. The normal way to describe capacity of an evaporator is throughput rate (volume per unit time). L-7-70

16. Suggest rewording the last sentence of Section A.3.2. In the sentence supernate probably means evaporator feed. The volume is reduced to 25% of its original volume and it freezes as crystallized salt (perhaps that is the immobilize term used). Perhaps a better way to say this is that the concentrated waste crystallizes into a solid salt cake reducing its mobility. L-7-71

17. Add a paragraph describing the expected inventory of radionuclides after flushing and prior to closure. Is the inventory significant? Why is that judgment made? L-7-72

18. Section A.3.5 starts off saying that the HLW produced in the canyons contains insoluble and highly radioactive metal hydroxides. When initially produced, these hydroxides are in a meta-stable solution and require weeks for form the insoluble metal hydroxides. Thus the insoluble form occurs in the waste tanks not in the canyons. L-7-73

19. Section A.4.1 references earlier EISs. It is OK to reference them but also the key conclusions applicable to this EIS should be summarized here. I consider the waste L-7-74

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removal heel to be one of the principal issues of uncertainty for success of this Tank Closure activity. | L-7-74

20. In Section A.4, add several paragraphs on waste removal from tank annulus and from between the primary tank bottom and the annulus tank bottom. | L-7-75

21. On page A-14, in Section A.4.3; the fourth paragraph states that only salt is in the annulus and it should be easily removed with water. Provide referencable support for the first point and basis for the second. It is my understanding there is very little information on dissolvability of salts in the annulus. We know Tank 16 salt did not dissolve and I understand the only other sample available also shows that the salt is difficult to dissolve. | L-7-76

22. On page A-15, the last paragraph of Section A.4.3; it would be beneficial to the EIS to have descriptive information on what is known about how clean the primary Tank is based on the inspections made. | L-7-77

23. Page A-19 &20, add more conceptual description on how the Clean and Remove Alternative would be accomplished. Will the removal and packaging be done remotely or hands on, etc.? | L-7-78

24. The soil cover described in the last sentence on Page A-20 should also include prevention of deep-rooted plants so they will not add a new dispersion pathway. | L-7-79

Appendix B:

1. As I read Section B.2 and looked at Table B-1; I concluded that 10,000 year analytical period made all of the accident frequencies greater than one. I later found that the accident analysis was performed for 30 years. It is very important to set the stage for this analysis. I do not understand why accident (particularly naturally occurring events) should not be looked at for the full 10,000 years. At the very least tell your reader that you are only examining 30 year tank closure period and not the decay and release time period. | L-7-80

2. Section B.2.2 writes off surface runoff and underground releases by saying mitigative actions would be taken, again applies to the period of active institutional control. Why is this appropriate? | L-7-81

3. Section B.3.1.1 on page B-5, needs to also consider in-tank-generated hydrogen. The analysis seems only to look at flammable chemicals that are accidentally introduced into the tanks. | L-7-82

4. Section B.3 (Pages B.4 – B.7) should be expanded to consider loss of containment. The CAB is concerned about this with the numerous changes of equipment that | L-7-83

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require opening and closing containment during sludge and salt removal and the same issues exist during tank cleaning. L-7-83

5. Section B.3.1.3 on Page B-6; add a paragraph to show why underground releases are not considered for seismic events. The only seismic event considered is one that releases the content of the above ground waste being pumped. I also do not consider mitigation appropriate for a severe seismic event of sufficient strength to breach HLW piping or tankage since off-site damage to essential infrastructure will also be sever and require immediate correction. This will dilute the priority that will be placed on SRS damage. L-7-84

6. Section B.3.1.7 (Page B-7) doesn't seem to include liquid release. Why not? L-7-85

7. Section B.3.2.1 states that flooding after 200 years is not considered. It is stated to be a long-term impacts and is not considered in Appendix B. Where is it included? In a 10,000 year analysis, this logic seems questionable. L-7-86

Appendix C:

1. The assumption in the third paragraph that DOE intends that the area immediately surrounding the tank farms would remain in commercial/industrial use for the entire 10,000 year period of analysis seems unlikely. There may be deed restrictions on these areas but the area will probably not look like commercial/industrial use that we currently recognize. L-7-87

2. The intruder on page C-1 is defined as a teenager. Why and did all of the parameters associated with dose commitment use teenager parameters? L-7-88

3. Section C.1.1 on Page C-3, in the bottom paragraph in the left column, the logic given for atmospheric releases seem unlikely but the conclusion seems reasonable. L-7-89

4. Does the nearby resident and the child resident, decribed on Pages C-6 & C-7 drink contaminated water? I am not able to tell if they do or do not from the write up given. L-7-90

5. Discussion on page C-9 says that the inventory is increased by 20% to account for tank-specific systems outside of the Waste Tanks. This is the only place I saw this and could find no calculated results from this assumption. One questions the validity of this assumption. Environmental impacts for the outside systems need to be given. L-7-91

6. Table C.3.1-1 provides the entire inventory for F-Area Tank Farm that results in 1.9 mrem/yr seepline dose rate for F-Area. The 4,300 Ci of Cs^{137} is the equivalent of 860 gallons of HLW left in the entire tank farm or on the average 39 gallons/tank. (This conversion of curies to gallons assumes HLW contains 1 to 20 curies of Cs^{137}/gallon HLW. I used 5 Ci/gallon for this conversion.) This small volume of waste raises the issue discussed in General Comment # 3. Similar calculation for H-Area Tank Farm L-7-92

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give similar small volumes. It should be noted that the principal dose in the seeps are from Tc^{99} left in the tanks. Tc^{99} is more mobile than cesium. L-7-92

Appendix D:

Reading the comment and DOE Response then reading the EIS to ensure that the response was truly implemented, I found several that are inconsistent. DOE should reconsider the responses to the comments and the body of the EIS to be sure they are consistent. A couple of examples are listed below where the response did not seem to be carried through into the EIS.

- The response to the top comment-response given on Page D-3 in the right hand columns seems inconsistent with the text of the EIS. L-7-93
- The response (listed at the top of the left columns on Page D-4) says that lessons learned from closing tanks 17 and 20 will be used for closing other tanks. In general this was done, in that the experience from those tanks is the total experience to date on tank closure. I found no section that explicitly listed those lessons learned that were considered to be important.

I hope these comments are useful in reaching a decision that allows tank closure to continue on schedule. The process should recognize the potential that waste removal will be more difficult than planned and provide a preplanned process that accepts larger quantities of waste while not impacting safety of future generations downstream from SRS.

If I can answer questions or shed additional light on these issues, please call me.

Sincerely

W. Lee Poe, Jr.

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Response to comment L-7-1: Comment noted.

Response to comment L-7-2: Comment noted.

Response to comment L-7-3: See response to comment L-5-4, first paragraph.

Response to comment L-7-4: As stated in Section 4.2.2.2, Appendix C presents the major assumptions and inputs used in the long-term fate and transport modeling, including the assumption regarding the contaminant inventory in piping and ancillary equipment. Section 1.4.1 describes the overall HLW tank closure process. Section 4.2.2.2 has been revised to more clearly state the assumptions regarding residual material in piping and ancillary equipment.

Response to comment L-7-5: DOE agrees that accurately measuring the residual is an important task. However, the EIS is a decision-making tool to determine the preferred closure alternative, which is independent of the method used to determine tank residuals. Only a summary description of residual characterization is possible now, until a closure method is chosen and tank-specific procedures are established. Two paragraphs were added to Section 4.2.2.2 and are included below.

"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.

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 solids remaining after aggressive cleaning may be too small to accurately measure visually, so some other technique may need to be employed."

Response to comment L-7-6: Section 2.1.2, has been revised to present a more detailed summary of impacts from the 1995 Waste Management EIS (DOE 1995) in indicating that impacts from low-level waste disposal of tank components in the vaults would be well below impacts expected from tank closure.

Response to comment L-7-7: See response to comment L-8-3. The specific details of the implementation of DOE's Institutional Controls would be developed as part of the Environmental Restoration Program.

Response to comment L-7-8: The Foreword and the Table of Contents in the EIS indicate that the Summary is published as a separate volume. DOE publishes the Summary separately as a service to the reader, many of whom only read the Summary. Publication of an EIS in several volumes is a common practice consistent with the Council on Environmental Quality NEPA regulations on the content of an EIS.

Response to comment L-7-9: Comment noted.

Response to comment L-7-10: The word "corrosive" has been deleted in Section S.1.

Response to comment L-7-11: Section S.2.3 is a summary section, so the level of detail suggested in the comment is not appropriate. However, the following additional technical information on tank cracking mechanisms and current tank status was added to Section 1.1.3: "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 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 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."

Response to comment L-7-12: There is no evidence to support a generalization that tank components in groundwater experience severe corrosion. Sections S.2.3 and 1.1.3 have been changed to read, "Interior photographic inspections have indicated that small amounts of groundwater have leaked into…"

Response to comment L-7-13: The following sentence has been added to the last paragraph in Section S.2.3: "During construction, 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 stress corrosion cracking."

Response to comment L-7-14: The intent of this paragraph was to illustrate that the environmental impacts of bulk waste removal have been previously analyzed in several EISs. In preparing this HLW Tank Closure EISs, DOE did not "review" these previous EISs, other than to confirm that they addressed the activities associated with bulk waste removal. Therefore, the first sentence of the second paragraph of Section S.2.4 has been revised to state: "DOE has analyzed the environmental impacts of bulk waste removal from the HLW tanks…."

Response to comment L-7-15: The CAB will be provided with the opportunity to review Closure Modules as a matter of regular interaction between DOE and the CAB. Also, see the response to comment L-2-1.

Response to comment L-7-16: The values for curies remaining in the tanks in the "Cumulative Curies Removed" column have been changed to "10^6" in Table S-1 and Table 2-1.

Response to comment L-7-17: The values for curies remaining in the tanks in Table C.3.1-1 represent the values after all waste removal has been completed. The SRS High-Level Waste Tank Closure program is designed such that DOE must remove enough waste from the HLW tank systems so the performance objectives would be met. This is true whether the residual waste is in the tank, the annulus, or piping and ancillary equipment. Therefore, DOE would be obligated to clean the tank annuli to a level at which the performance objectives for a tank would be met. In the case of Tank 16, DOE would remove Cs-137 from the annulus until modeling demonstrated that the performance objectives could be met. For other tanks that have annuli, as part of the tank closure process, DOE would be required to fully characterize any residual material remaining in the annulus. The last sentence of Sections S.2.4 and 2.1 have been revised to clarify this point.

Response to comment L-7-18: Appendix C has been revised to present Table C.3.1-2, which lists the assumed volume of residual waste remaining in each closed HLW tank if the tanks are cleaned.

Response to comment L-7-19: True. This is one of the main reasons DOE prefers the Fill with Grout Option of the Stabilize Tanks Alternative.

Response to comment L-7-20: The value of 2,500 mrem/year is correct for the No Action seepline dose rate at Upper Three Runs Creek. The No Action Alternative assumes that the tank contents are removed but residual waste is available for transport after the tank containment fails. This residual waste results in the high dose observed for this alternative.

Response to comment L-7-21: Further information describing Figure S-7 has been added to Section S.8.2.

Response to comment L-7-22: The word "corrosive" has been deleted in Section 1.1.

Response to comment L-7-23: Section 1.1.3 has been revised as suggested in the comment.

Response to comment L-7-24: The fifth paragraph of the section labeled "tanks" (which discusses the Type III tanks) contains the sentence "None of them has known leak sites." Therefore, no change to the EIS in required.

Response to comment L-7-25: True. The wording in the "Evaporator Systems" sections of Chapter 1, Appendix A and Appendix E were changed to reflect two evaporators in F-Area and three evaporators in H-Area, and indicate that three evaporators are operational.

Response to comment L-7-26: This EIS provides the decision maker with an assessment of the environmental impacts that would provide a discrimination between alternatives. Details of certain impacts are provided by summarizing information from other EISs and providing reference to these other documents. This approach is allowed, in fact recommended in the CEQ regulations at 40 CFR 1502.21.

Response to comment L-7-27: The second paragraph of Section 1.3 has been revised to state that 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.

Response to comment L-7-28: Section 7.1.4 of the EIS presents a discussion of the Environmental Restoration Program and its interactions with the HLW tank closure program.

Response to comment L-7-29: The performance objectives for the HLW tank closure program were developed through an evaluation of all applicable or relevant and appropriate requirements, which is the same process required under CERCLA and RCRA. Therefore, it is unlikely that the performance objectives would be revised during the performance of Environmental Restoration activities.

Response to comment L-7-30: See response to comment L-2-1.

Response to comment L-7-31: The assumed volume of residual waste remaining in each closed HLW tank if the tanks are cleaned is presented in Table C.3.1-2 of Appendix C. The volume of waste in Tank 20 after spray washing was about 1,000 gallons (P. D. d'Entremont and J. R. Hester, "Characterization of Tank 20 Residual Waste," WSRC-TR-96-0267, March 17, 1997) which also presents the measured radiological and non-radiological composition of the residual material. In each tank, an inventory has been estimated for over 30 radionuclides and many non-radioactive constituents (also in Tables C.3.1-1 and C.3.1-3 of Appendix C). These estimates were compared to the results of analysis of the samples of the residual material and the results showed that the estimates were in good agreement with the sampling results. Section 2.1 of the EIS has been revised to include this reference. Table C.3.1 has been revised to present the average concentration for each listed radionuclide (curies/gallon).

Response to comment L-7-32: Concerns about potential criticality would not preclude using oxalic acid for tank cleaning. However, any use of oxalic acid must be thoroughly evaluated for criticality concerns. This evaluation must be done on a tank-by-tank basis to account for variations in waste characteristics, tank internal geometry, and waste removal technology. The evaluation may result in the identification of additional tank specific controls and/or compensatory measures to ensure prevention of criticality. DOE expects that it would be possible to use oxalic acid safely if it is determined to be necessary, but it is premature to do the detailed analysis necessary to define measures needed to allow its use for specific tanks. A bounding evaluation covering all tanks would not be meaningful and is not necessary to ensure safety. In summary, it is not inconsistent to state that the use of oxalic acid is restricted, yet to assume that it could be used to further clean the tanks.

Response to comment L-7-33: See response to comments L-2-8 and L-14-4 regarding DOE's estimates of the volume and characteristics of the residual material remaining in the closed HLW tanks. As noted in that response, DOE has added Table C.3.1-2, which lists the assumed volume of residual waste in each closed HLW tank if the tanks are cleaned (actual measured volume for Tanks 16, 17, and 20) to Appendix C of the EIS. This new table provides the information requested in the comment and is a more appropriate location for this information than Table 2-1 as suggested in the comment.

Response to comment L-7-34: A new paragraph was inserted at the end of Section 2.1 starting with the sentence "Cleaning of the secondary containment…" It states that: "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."

Response to comment L-7-35: The sentence that follows the one referred to by the commenter explains that, "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," indicating the environmental concern.

Response to comment L-7-36: The environmental impacts of delayed tank closure would be the same as the No Action Alternative impacts in the short term for the duration of the delay. These impacts are described in Section 2.1.4.2. See also response to comment L-7-38.

Response to comment L-7-37: DOE does not intend to conduct demonstrations of known technologies at this time.

Response to comment L-7-38: In the short term, No Action would be equivalent to delayed closure because in both cases the tanks would be managed to protect human health and safety for a period of institutional control, at least during the active operations of other missions at the SRS. The impacts of structural failure of the tanks at 100 years and consequent release of residual waste to the groundwater are described in Section 2.4.2 of this EIS.

Response to comment L-7-39: See response to comment L-7-6. Also, note that these impacts (from the low-activity waste vaults) would occur at the E-Area Vaults Facility, not the tank farm areas.

Response to comment L-7-40: Accidents are described in Section 2.4.1. Additional details are provided in Section 4.1.12 and Appendix B. Those accidents involving natural phenomena, such as a design basis seismic event during cleaning, are assumed to occur during the period of tank closure activities (i.e., at times of active handling of contaminated material). These short-term seismic or other natural phenomena events would not result in higher releases if modeled as part of the long-term impacts. In addition, no credit is given for the structural integrity of the tanks after 100 years (Scenarios 1 and 3) or 1,000 years (Scenario 2 and 4). A seismic event that would be severe enough to fail the tank top, grout and basemat before the postulated failure after 1,000 years would have a very small probability of occurrence (and would be even lower for the 100-year period). Therefore, the risk associated with this accident would be very small compared to the risk from a release that is assumed to occur (probability of 1) after either 100 or 1,000 years.

Response to comment L-7-41: For clarity, the phrase, "with the exception of the safety hazard of collapsed tanks under the No Action Alternative," has been added to the sentence after the word "therefore" in Section 2.4.2.

Response to comment L-7-42: The cited paragraph in Section 2.4.2 has been revised to present the average annual dose that is equivalent to the calculated maximum lifetime dose. This annual dose is then compared to regulatory standards and natural background radiation dose.

Response to comment L-7-43: Comment noted.

Response to comment L-7-44: The existing HEPA-filtered ventilation system would be utilized to the extent practicable during closure activities. This practice would provide an extra margin of safety at minimal extra cost, regardless of the level of internal contamination detected.

Response to comment L-7-45: Long term impacts of the alternatives are described in Section 4.2 of the EIS; in Section 4.1, Short-Term Impacts, only impacts in the short term are discussed. In Section 4.2, impacts of the Clean and Remove alternative in regard to disposal of the tank systems as low-level waste are given by reference to the SRS Waste Management EIS. They are summarized in the third paragraph of Section 4.2 of the EIS.

Response to comment L-7-46: Tables 4.1.10-1 and 10-2 estimate waste generated in the short term by implementation of each of the alternatives. No wastes would be generated because no cleaning would take place under the no action alternative in the short term.

Response to comment L-7-47: Consequences of accidents involving the No Action Alternative have been postulated over the 30-year period covered by short term impacts. Under the No Action Alternative, after bulk removal of waste has occurred (a process that is common to all alternatives and outside the scope of the EIS) the tanks would not be actively managed and an accident involving a natural phenomenon, such as a seismic event, could possibly result in failure of the tank, with concurrent release of contaminants to soil below the tank. Also see the response to comments L-7-40 and L-7-80.

The long-term impacts analysis for No Action assumes that the tanks fail after the 100-year institutional control period, a failure which is not assumed to require an accident initiator. To affect the estimated risk from No Action, any accident that would accelerate such failure would have to be assumed to occur before 100 years. Such an early failure would not contribute significantly to long term risks due to the long transport times in groundwater relative to the assumed 100-year pre-failure period.

Response to comment L-7-48: See the response to comment L-7-45.

Response to comment L-7-49: DOE analyzed the long-term impacts of transport of iron from the HLW tanks in Appendix C of the EIS (see Table C.4.1-19). Tables 4.2.2-6, 4.2.2-7, and 4.2.2-8 present a summary of the detailed analyses in Appendix C.

Response to comment L-7-50: The commenter is correct in that plutonium (and other radionuclides) may not reach the seepline within the 10,000-year period of analysis. As indicated in the response to comment L-3-16 regarding the basis for the 10,000-year period of analysis, this period was chosen to conform to regulatory guidance, and because the value of projecting beyond it is low.

Response to comment L-7-51: Section 4.2.5, "Public Health" is contained within the larger Section 4.2, which is entitled "Long-Term Impacts." Therefore, no change to the title of Section 4.2.5 is necessary.

Response to comment L-7-52: The following new introductory text regarding the scope and purpose of this section has been added: "The purpose of this section is to identify the boundaries (both in space and time) of DOE's cumulative impacts analysis."

Response to comment L-7-53: The reference to the specific company in the Section "Spatial and Temporal Boundaries" of Chapter 5 has been deleted.

Response to comment L-7-54: Table 5-2 presents the offsite impacts of atmospheric emissions. The Composite Analysis presents long-term impacts from releases to groundwater and surface water and is presented in Section 5.7 of the EIS.

Response to comment L-7-55: As described in Section 7.1.1, DOE undertook a comprehensive review of requirements and guidance to identify environmental protection standards. That review is documented in Appendix B of the General Closure Plan (DOE 1996), which was updated in 2000 (DOE 2000). DOE will define tank-specific performance objectives that are consistent with these environmental protection standards. DOE expects the groundwater protection standards to be the most limiting performance objectives for HLW tank system closures. The example cited in Section 7.1.2 (the 4 mrem/year dose limit for beta-gamma radioactivity) is one of these groundwater protection standards (see Table 7-3 of the EIS for other examples). Section 7.1.2 uses the groundwater protection standards to illustrate how the environmental protection standards are used to establish tank-specific performance objectives. Table 7-4 illustrates how the performance objectives would be allocated to individual tanks to ensure that the impacts from all sources affecting a particular media (e.g., groundwater) would comply with the relevant standards. Section 7.1.2 has been revised to present compliance with drinking water standards at the seepline as the example.

Response to comment L-7-56: The second sentence of the second paragraph under Sections A.3.1 and E.2 have been revised to read "The leaked waste is kept dry by air circulation, and, based upon groundwater monitoring results, there is no evidence…."

Response to comment L-7-57: The reference was added to Sections A.3.1 and E.2, and to the list of references for these appendices. See response to comment L-7-65.

Response to comment L-7-58: A reference to the Annual Radioactive Waste Tank Inspection Program has been added.

Response to comment L-7-59: In response to comment L-7-11, a new paragraph describing tank cracking has been added to Section 1.1.3.

Response to comment L-7-60: The word "thee" has been changed to "these."

Response to comment L-7-61: Sections A.3.1 and E.2 have been revised to read, "DOE removed some waste from the annulus at that time, but some dry waste still remains in the annulus."

Response to comment L-7-62: Rather than add a table to the EIS, a reference to the Federal Facility Agreement for the Savannah River Site (EPA 1993) has been added.

Response to comment L-7-63: DOE believes that these sources external to the tanks would not contribute significantly to the dose reported in this EIS for tank closure for the following reasons:

(1) The sizes of these spills are small, compared to the residual tank contents.

(2) The contamination is outside the tanks and would thus transport through the soil and groundwater much more rapidly than those contaminants bound inside the tanks. This would cause their impacts to be noncoincident in time with those from tank closure.

(3) Contamination outside the tanks would be addressed in the CERCLA closure of the tank farm areas. Tank closure and CERCLA closure are being coordinated so that cumulative impacts

are within limits established with SRS regulators through the risk-based closure process. Therefore, if any spill appears to produce a large contribution, it would be remediated until it produces a small contribution.

DOE has revised Sections A.3.1 and E.2 to incorporate this text.

Response to comment L-7-64: As noted in the EIS, the source of information for the first leak was Odum 1976. The source of information for the second is P. D. d'Entremont, "Written Report on Contingency Plan Activation," WSRC-RP-89-259, May 17, 1989. Based on a radiation survey of the soil surrounding the leak site, the leaked mass was estimated to be about 50 pounds, or about 5 gallons. The survey was conducted on April 27, 1989. A reference to this latter study has been added to this paragraph.

Response to comment L-7-65: The reference is W. L. Poe, "Leakage from Waste Tank 16: Amount, Fate, and Impact," DP-1358, 11/74, and was inserted after the sentence ending" . . . Tens of gallons of waste leaked into the soil."

Response to comment L-7-66: The intent of the sentence was not to indicate leaks were unlikely but to indicate that it was unlikely that leaks would be undetected. The paragraph has been expanded as follows: "Because all tanks at SRS have leak detection, it is unlikely that any large leaks have occurred that have not been detected. In eight tanks other than Tank 16, observable amounts of waste have leaked from primary containment into secondary containment. These tanks are managed to ensure that the leaked waste remains dry and immobile. The waste in the annuli of these tanks has been observed carefully over a period of years and minimal movement of the waste has been observed. Other than Tank 16, there is no evidence that waste has leaked from a tank into the soil."

Response to comment L-7-67: See response to L-7-66.

Response to comment L-7-68: True. See response to comment L-7-25.

Response to comment L-7-69: Sections A.3.2, 1.1.3, and E.3 now state "Because of the radioactivity emitted from the waste, the evaporator systems are either shielded (i.e., lead, steel, or concrete vaults) or placed underground."

Response to comment L-7-70: Production capacity can be expressed in overheads production per unit time, feed rate, throughput rate, etc. The EIS was merely giving a sense of the size of the evaporator and thus the volume of the evaporator vessel was used. Section A.3.2 has been extensively revised to provide an updated description of the SRS HLW evaporator systems and no longer presents a specific evaporator capacity.

Response to comment L-7-71: The last sentence of Sections A.3.2 and E.3 have been revised as follows: "…volume by successive evaporation of liquid supernate. This concentrated waste crystallizes into a solid salt cake, which reduces its mobility."

Response to comment L-7-72: The expected inventory of radionuclides after waste removal is shown in Tables C.3.1-1 (total radioactivity) and C.3.1-2 (volume). Table C.3.1-2 was added to the Final EIS to help address concerns such as those expressed in this comment.

Response to comment L-7-73: The first sentence of Sections A.3.5 and E.6 have been revised to state: "The waste streams generated by the F- and H-Area Canyons form insoluble and highly radioactive metal hydroxides (manganese, iron, and aluminum) that settle to the bottom of the waste tanks to form a sludge layer."

Response to comment L-7-74: Section A.4.1 references other EISs that have addressed waste removal from the HLW tanks, the subject of this section. Section A.4.1 then goes on to describe waste removal priorities and techniques. The other EISs do not address heel removal.

Response to comment L-7-75: See response to comment L-5-3.

Response to comment L-7-76: In the third paragraph of A.4.3, reference is made to the Annual Radioactive Waste Tank Inspection Program - 1999 (to support the presence of salt deposits). Past demonstrations have shown that these salts are relatively easily dissolved with water.

As noted in Section A.4.3 of the EIS, the Tank 16 annulus waste contains sand and compounds that formed when the sand mixed with the salt. This mixture makes the waste more difficult to dissolve than if it were purely salt.

Response to comment L-7-77: The following two sentences have been added after the second sentence: "More than 99.9 percent of the original volume of sludge was removed during cleaning (approximately 10 kilograms of solid material was left). Based upon sample results, approximately 830 curies of strontium-90 (the predominant radionuclide) remained."

Response to comment L-7-78: The conceptual design for the Clean and Remove Tanks Alternative is not developed and a definitive description cannot be provided. Because of the high radiation levels, any removal and packaging activities would have to be accomplished remotely. What is provided are advantages and disadvantages inherent to the scope of work that would be required to carry out this alternative so that impacts can be understood.

Response to comment L-7-79: Comment noted. Detailed discussions of specific environmental restoration activities are beyond the scope of this EIS.

Response to comment L-7-80: The different treatment of short-term and long-term impacts of accidents is clarified in the Final EIS in Section 4.1.12 and Section C.1.5 in Appendix C.

The following text was added to Section 4.1.12: "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. 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."

Also, the following explanation was added to Appendix C as Section C.1.5: "Because the tanks are assumed to fail after either 100 (Scenarios 1 and 3) or 1,000 years (Scenarios 2 and 4), the probability of a release from the tanks is one (i.e., it is assumed that the tank will fail). If an accident severe enough to cause tank failure were to occur before the 100- to 1,000-year post-closure periods, the impacts would not be significantly different than the calculated long-term impacts for the following reasons. First, the probability of such an accident occurring in the first 100 or 1,000 years post-closure would be much smaller than one. Therefore, any impacts from accidents that cause tank failures to occur prior to 100 or 1,000 years would have to be multiplied by this small probability of premature failure. Second, due to the long transport times of the contaminants in groundwater, the difference between the impacts from an early release would be insignificant compared to the calculated impacts based on releases occurring at 100 or 1,000 years."

Response to comment L-7-81: The statements in Section B.2.2 apply to both surface runoff and underground releases only in that accidental releases during operation (30 years) and the subsequent period of active institutional control (100 years) would not result in radiological impacts offsite. Section B.2.2 explains why this is the case. Mitigation actions would prevent offsite human exposures from releases to the surface, and any materials released to subsurface waters during the period of active institutional control would take a long period to reach the potential human receptors. As stated in the last sentence of the first paragraph in this section, the potential long-term consequences of subsurface releases are considered in the EIS assessment of long-term impacts (i.e., in Appendix C). The response to comment L-1-9 discusses the potential long-term impacts of releases to the surface environment under the No Action Alternative. For the action alternatives, surface releases over the long term are not a potential source of impacts because the tanks would be isolated from the surface environment following their closure.

Response to comment L-7-82: Under the No Action Alternative, during the short term, DOE would continue to manage the tank farms, but not close any tanks. This means that normal operations would be conducted in accordance with approved safety analyses. During this period of time, the tanks would not be abandoned, but actively managed to ensure worker and public health and safety. In-tank generation of hydrogen may be an issue in the highly concentrated radioactive waste contained in the tanks prior to bulk waste removal; however, that condition would not exist for the actions in the scope of this EIS. The impacts from each alternative are evaluated assuming bulk removal has already been done. Under these conditions, the amount of hydrogen that could be generated internally would be insufficient to support combustion.

Response to comment L-7-83: For short-term impacts analysis, the impacts of accidents involving temporary losses of containment can be classified as either leaks or spills. The impacts of loss of containment would be bounded by the transfer error scenario (Section B.3.1.2), which would result in a large release of liquid to the environment with subsequent airborne release by evaporation. The last sentence in the first paragraph of Section B.3.1.2 has been revised to state "This scenario would bound all leak/spill events, including loss of containment."

Response to comment L-7-84: Section B.3.1.3 actually addresses vehicle impact. The comment would more appropriately apply to Section B.3.1.5, Seismic Event. Underground releases resulting from seismic events are not separately analyzed because their impacts would be similar to the long-term impacts from tank failures that are considered in Appendix C. Short-term impacts from seismic events are limited to those that cause releases of material to the surface. The fact that it may be unlikely that immediate action would be taken to mitigate the release following a seismic event due to competing priorities is also taken into consideration in the analysis. The last sentence in Section B.3.1.5 starts by stating, "If mitigation measures are not taken..." Also, see the response to comment L-7-80.

Response to comment L-7-85: The failure of the salt solution hold tank would be in fact a liquid release. However, the only pathway for short-term off-site exposure would be through the evaporation of this liquid, as postulated in the scenario. Any portions of the liquid spill that are not cleaned up would contribute to the long-term impacts addressed in Appendix C. There could be some exposure of SRS workers to this spilled salt solution. However, DOE anticipates that the human health consequences would be minimal because of the application of standard radiological control practices, such as posting, monitoring, and access control.

Response to comment L-7-86: Section B.3.2.1 addresses flooding as a potential contributing factor to long-term impacts and directs the reader to the analysis of long-term impacts (contained in Appendix C). While flooding is not explicitly mentioned in Appendix C, it is one of several potential mechanisms that may cause the tanks to fail after 100 years. The tanks are assumed to fail after 100 years (No Action Alternative) or 1,000 years (Stabilize Tanks Alternative) regardless of the initiating event (whether it be seismic, flooding, corrosion, or other mechanism). The analysis of long-term impacts following a tank failure will bound the impacts from tank failures caused by flooding.

Response to comment L-7-87: This paragraph (the third paragraph in Appendix C) has been deleted.

While DOE does not envision relinquishing control of the area in or near the Tank Farms, it recognizes that there is uncertainty in projecting future land use and 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 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. Section 4.2.4 of the EIS describes the long-term land use impacts of the residual radioactive and non-radioactive material in the closed HLW tanks.

Response to comment L-7-88: The intruder was assumed to be a teenager for consistency with EPA Region 4 assessment guidance. All parameter values used in the long-term dose assessment modeling presented in Appendix C are consistent with this assumption.

Response to comment L-7-89: DOE believes that its rationale for not performing analysis for the atmospheric release pathway is valid and appropriate.

Response to comment L-7-90: As described in Section C.2.1.2, the Nearby Adult Resident/Nearby Child Resident are assumed to ingest surface water. To clarify this point, the word "incidental" has been deleted from the sixth bullet in the discussion of receptors.

Response to comment L-7-91: Based on engineering judgement, DOE believes that the assumption of 20% of the inventory in ancillary equipment is conservative. The impacts presented in the EIS include the 20 percent inventory as part of the analysis. Presenting the impacts of the ancillary equipment separately is not appropriate because the tank closure process would close the tank with its ancillary equipment. Section 4.2.2.2 has been revised to more clearly state the assumptions regarding residual material in piping and ancillary equipment.

Response to comment L-7-92: The doses were calculated based on 1,000 gallons of sludge in second-cycle tanks and 100 gallons of sludge in first-cycle tanks. The residual left behind after waste removal is primarily sludge. For example, Tank 20 was a salt receiver that never received sludge, but the residual after waste removal was about 1,000 gallons of a sludge-like material. The 5 curies/gallon number quoted by the Commenter is characteristic of Cs-137 in supernate. Sludge levels of Cs-137 are lower.

Response to comment L-7-93: The Draft EIS Appendix D, Public Scoping summary, has been replaced in the Final EIS with Appendix D, Response to Public Comments (on the Draft EIS). However, as indicated in the Comment Response referred to by the commenter, the EIS discusses potential impacts to a hypothetical resident who consumes fish exposed to contaminants from the tanks in Section 4.1.8 of the EIS. The assumptions regarding the calculations are described in Appendix C.

As the comment response indicated, and the commenter acknowledged, DOE used available information from the closure of Tanks 17 and 20 in preparing the EIS. The information is relevant to several sections of the EIS. Therefore DOE did not consolidate the information in a single section of the EIS. Lessons learned included grout emplacement methods, tank system isolation, and occupational radiation protection.

Drew Grainger

01/23/01 09:53 AM

To: L Ling/DOE/Srs@Srs, John Knox/DOE/Srs@Srs, Howard Gnann/DOE/Srs@Srs
cc: Jeffrey Allison/DOE/Srs@srs
Subject: Comments on DOE/EIS-0303

fyi
----- Forwarded by Drew Grainger/DOE/Srs on 01/23/01 09:54 AM -----

Jim Hardeman
<Jim_Hardeman@mail.dnr.state.ga.us>

01/23/01 09:23 AM

To: nepa@mailhub.srs.gov
cc: andrew.grainger@mailhub.srs.gov
Subject: Comments on DOE/EIS-0303

Rec.
JAN 23 2001

Thank you for the opportunity to comment on "The Savannah River Site (SRS) High-Level Waste Tank Closure Draft Environmental Impact Statement (EIS), Aiken, South Carolina (DOE/EIS-0303)". Mr. Cliff Blackman of this office has already submitted comments; these comments are supplemental to Mr. Blackman's.

The referenced document, in its current form, is inadequate to determine the acceptability of DOE's proposed action or any of the alternatives. The document does not contain information sufficient to confirm DOE's estimate of residual activity (i.e. "source term"), and independent estimates by this Department indicate that DOE's estimate of residual radioactivity may be low by a factor of 20 or more. For example, a residual of 3,000 gallons of sludge in each tank which currently has a sludge inventory (consistent with tank washing results from Tanks 16 and 17) would result in residual radioactivity some 20 times greater than the estimate presented in the DEIS in Table C.3.1-1 (the only estimate of residual activity presented in the DEIS). This increased source term would result in increased dose to members of the general public, and would call DOE's ability to meet tank closure performance standards into question. L-8-1

The use of oxalic acid to clean waste tanks is treated in an inconsistent manner in the DEIS. On one hand, DOE states that "oxalic acid cleaning of any waste tank is prohibited." (p. 2-2). On the other hand, the DEIS states that "DOE expects that oxalic acid cleaning would be required on tanks that contain first-cycle wastes, the most highly radioactive waste in the tanks". The DEIS should present on a tank-by-tank basis, DOE's estimate of residual radioactivity after bulk removal, bulk removal plus spray water wash, and after oxalic acid spray wash, and long-term dose modeling should be performed for each case. DOE should also include in this analysis significant radionuclides not included in Table C.3.1-1, such as Pu-240, Am-241 and Cm-244, which may increase doses to the general public even further, perhaps by a factor of 100 or more, as indicated in Mr. Blackman's comments. L-8-2

In addition to questioning the source term presented in the DEIS, we question DOE's long term modeling analyses themselves, particularly the assumption that the point of compliance for radionuclides in groundwater is the seepline (i.e. where groundwater seeps out of the ground and into surface streams). By measuring compliance at this point, DOE would de facto preclude the direct use of groundwater for drinking water purposes. The graphic presented in Figure C.1, by not presenting the direct ingestion of contaminated groundwater as a "potential exposure pathway for human receptors" tends to confirm this conclusion. It is unreasonable to conclude that DOE can and will maintain institutional control of the site for the 10,000 year duration of the modeling analysis, and likewise it is unreasonable to exclude direct use of groundwater as an exposure pathway during the 10,000 year modeling timeframe. DOE's proposal for tank closure appears, by using groundwater as a "buffer", to be simply a larger, longer-term version of the use of seepage basins for low-level radioactive waste disposal. That practice is now universally viewed as unacceptable. L-8-3

We welcome the opportunity to review a revised draft EIS which addresses the issues itemized above.

Jim Hardeman, Manager
Environmental Radiation Program
Environmental Protection Division
Georgia Department of Natural Resources
4244 International Parkway, Suite 114
Atlanta, GA 30354
(404) 362-2675 fax: (404) 362-2653
Jim_Hardeman@mail.dnr.state.ga.us

Response to comment L-8-1: DOE believes that the assumed source term values are appropriate for use in this EIS. As discussed in the response to comment L-7-18, Appendix C has been revised to present a table listing the assumed volume of residual waste remaining in each closed HLW tank if the tanks are cleaned. These assumed volume estimates are based on previous experience with closure of Tanks 17 and 20 and on judgments of the effectiveness of the waste removal method. For example, 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.

The characteristics of this residual sludge were based on knowledge of the processes that generated the waste. It was assumed that the residuals left behind after waste removal would have approximately the same composition as the sludge currently in the tanks. Before each tank is closed, the residual in that tank will be estimated and modeled to ensure that the closure is within requirements. In Tanks 17 and 20, the two tanks that were 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 species of interest. A similar procedure will be followed in the future for waste residual in each tank.

Response to comment L-8-2: For use of oxalic acid, see response to comment L-4-23. For residual radioactivity, see response to comment L-8-1.

The radionuclides listed in the comment were included in DOE's long-term fate and transport modeling and are factored in the calculated alpha concentration and total dose values. However, those radionuclides are not listed in Table C.3.1-1 because this table was intended to present those radionuclides that constitute the majority of the calculated radiation dose.

Response to comment L-8-3: While DOE does not envision relinquishing control of the area in or near the Tank Farms, it recognizes that there is uncertainty in projecting future land use and 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 from the date of tank closure. 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 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. Section 4.2.4 of the EIS describes the long-term land use impacts of the residual radioactive and non-radioactive material in the closed HLW tanks.

The EIS presents results in groundwater downgradient from the tank farms at the 1-meter well, the 100-meter well, and the seepline. The point of compliance at the seepline is based on two factors: (1) the General Separations Area where the tank farms are located precludes residential use as described by the Savannah River Site Land Use Plan and in Section 4.2.4 of the EIS and (2) this point of compliance is agreed upon with the SCDHEC.

Drew Grainger

12/06/00 12:30 PM

To: L Ling/DOE/Srs@Srs, youngp@ttnus.com, John Knox/DOE/Srs@Srs
cc: Donna Martin/WSRC/Srs@Srs
Subject: Tank EIS Comment

Mr. Frank Watters called the toll-free line and wanted to submit comments on the tank EIS. I called him back and discussed the EIS with him.

Mr. Watters said he was one of the "original 17" duPont employees assigned to the Savannah River project in Wilmington in 1951, and was author of the design data report for the tank farms. He worked at SRP from 1953 to 1981, when he retired.

He had one comment:

Add to the list of acronyms HDB and FDB - H Diversion Box and F Diversion Box. They are in the legend for the tank farm drawings but he felt they should be in the acronym list, too. L-9-1

He had one question, which we should treat as a comment:

There are two parallel waste headers (a redundancy) from the canyons. They are in concrete casements. How will these (and other waste transfer lines) be closed? Would some lines be grouted into the tanks and disposed of that way? L-9-2

He also observed that he would have picked the preferred alternative as the closure method. L-9-3

Response to comment L-9-1: The figure has been extensively revised and no longer contains the referenced terms.

Response to comment L-9-2: Closure of these and similar components will be addressed case by case in a specific closure module for each tank. One option would be to flush these transfer lines and grout them in place.

Response to comment L-9-3: Comment noted.

Drew Grainger

01/24/01 01:03 PM

To: L Ling/DOE/Srs@Srs, George Hannah@Srs, John Knox/DOE/Srs@Srs
cc:
Subject: Comments - Draft Tank Closure EIS

----- Forwarded by Drew Grainger/DOE/Srs on 01/24/01 01:05 PM -----

NEPA

01/24/01 12:59 PM

To: Drew Grainger/DOE/Srs
cc:
Subject: Comments - Draft Tank Closure EIS

cc:Mail Forwarding Information
--------------- cc:Mail Forwarded ---------------
From: "Ernest S. Chaput" <ESandC@prodigy.net> AT SRS
Date: 01/24/2001 11:49 AM
To: "Andrew R. Grainger" <nepa@mailhub.srs.gov> AT SRS
Subject: Comments - Draft Tank Closure EIS

Forward Header
Subject: Comments - Draft Tank Closure EIS
Author: "Ernest S. Chaput" <ESandC@prodigy.net> at SRS
Date: 1/24/01 11:49 AM

Dear Mr. Grainger:

I have two comments on the Draft Environmental Impact Statement High-Level Waste Tank Closure (DOE/EIS-0303D):

Comment No. 1:

There appears to be an inconsistency in the evaluation of the alternatives. In the preferred "Clean and Stabilize" alternative, it is stated that oxalic acid cleaning could be required on as many as three-quarters of the tanks to meet performance objectives.

For the "Clean and Remove" alternative the document states that cleaning techniques such as oxalic acid might be required to reduce worker exposure during tank removal operations. The draft EIS then states that DOE considers these additional actions are "not technically and economically feasible within the meaning of DOE Order 435.1" because of criticality safety and possible interference with downstream processing activities. L-10-1

It appears that DOE is stating that oxalic acid is acceptable for the preferred grout option but, without explanation, is unacceptable for the removal option. This apparent inconsistency and source of confusion should be corrected. L-10-1

Comment No. 2:

All closure options are predicated upon removing sufficient waste from each tank so that the safety and environmental "performance objectives" will be met. However, the draft EIS does not describe the process by which the amount of waste remaining in each tank (the source term) will be determined - either in volume or curies. It is unclear whether the "source term" will be determined/ estimated by measurement or by analysis without measurement. The EIS should describe the process that will assure that the source term (and follow-on safety and environmental impacts) reflect the actual conditions in each tank prior to closure. L-10-2

Thank you for the opportunity to comment on this draft EIS.

Ernest S. Chaput
108 Cherry Hills Drive
Aiken, SC 29803

803-648-5402

Response to comment L-10-1: See response to comment L-4-23.

Response to comment L-10-2: See response to comment L-7-5.

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
and Prevention (CDC)
Atlanta GA 30341-3724

December 18, 2000

Rec.
DEC 22 2000

Andrew R. Grainger, NEPA Compliance Officer
U.S. DOE, Savannah River Operations Office
Building 742A, Room 183
Aiken, South, Carolina 29802

Dear Mr. Grainger:

We have completed our review of the Draft Environmental Impact Statement (DEIS) for the Savannah River Site, High-Level Waste Tank Closure Draft Environmental Impact Statement (DOE/EIS-0303D), Aiken, SC. We are responding on behalf of the U.S. Public Health Service, Department of Health and Human Services. Technical assistance for this review was provided by Dr. Robert C. Whitcomb, Radiation Studies Branch, National Center for Environmental Health, Centers for Disease Control & Prevention.

This DEIS provides an evaluation of three alternatives regarding the HLW tanks at the SRS. The document appears to be well documented, organized, and referenced. However, there are some inconsistencies in projected doses and risks as reported in tables throughout the document. The recommendations are attached in a memo to me from Dr. Whitcomb. Please consider the attached comments as you prepare the Final EIS. If you should have any questions regarding these technical comments, you may contact Dr. Whitcomb directly at (404) 639-2517.

Thank you for the opportunity to review and comment on this DEIS. Please send us a copy of the Final EIS, and any future environmental impact statements which may indicate potential public health impact and are developed under the National Environmental Policy Act (NEPA).

Sincerely,

Kenneth W. Holt

Kenneth W. Holt, MSEH
National Center for Environmental Health (F16)

attachment

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service
Centers for Disease Control

Memorandum

Date December 8, 2000

From Robert C. Whitcomb, Jr., Physical Scientist, National Center for Environmental Health, Division of Environmental Hazards and Health Effects, Radiation Studies Branch

Subject Review of the "Savannah River Site, High-Level Waste Tank Closure Draft Environmental Impact Statement" (DOE/EIS-0303D, November 2000)

To Ken Holt, Environmental Health Scientist, Emergency and Environmental Health Services, National Center for Environmental Health

This memorandum provides a review that focuses on the public health consequences associated with several proposed alternatives for closure of 49 high-level waste (HLW) tanks at the Savannah River Site (SRS). This Environmental Impact Statement (EIS) evaluates three alternatives regarding the HLW tanks at the SRS. The three alternatives are to clean and stabilize tanks, clean and remove tanks, or no action. Three options are considered for tank stabilization: Fill with Grout (Preferred Alternative); Fill with Sand; or Fill with Saltstone. Overall, this EIS is well documented, organized, and referenced. However, there are some inconsistencies in projected doses and risks as reported in tables throughout the document. Recommended changes to these inconsistencies would improve the document as follows.

Specific Comments

1. Page 2-12, Table 2-2 Summary comparison of short-term impacts by tank closure alternative.

   The table value for the noninvolved worker dose from the fill with saltstone alternative is 2.6×10^{-3} mrem/yr. L-11-1

   This value should be 2.7×10^{-3} mrem/yr, which is consistent with higher dose estimates from this alternative as listed in Table 4.1.8-1, page 4-17.

2. Page 2-13, Table 2-2 Summary comparison of short-term impacts by tank closure alternative.

   a. The table value for the maximally exposed offsite individual dose from the fill with saltstone alternative is 5.0×10^{-5} mrem/yr. L-11-2

      This value should be 5.2×10^{-5} mrem/yr, which is consistent with summing the dose estimates for both the H-area and F-area tank farms (e.g., 2.6×10^{-5} mrem/yr + 2.6×10^{-5} mrem/yr = 5.2×10^{-5} mrem/yr).

Page 2 – Mr. Ken Holt

b. The table value for the noninvolved worker estimated latent cancer fatality risk from all alternatives is 5.1 x 10^{-5}.

This value should be 5.3 x 10^{-8} (*a thousand-fold difference*) for the fill with saltstone alternative and 5.1 x 10^{-8} for the other alternatives. This is consistent with summing the dose estimates for both the H-area and F-area tank farms (e.g., 2.6 x 10^{-3} mrem/yr + 2.6 x 10^{-3} mrem/yr = 5.2 x 10^{-3} mrem/yr), multiplying by the number of years to complete the work (24.5) on 49 total tanks at the rate of two tanks per year (e.g., 5.2 x 10^{-3} mrem/yr x 24.5 years = 1.3 x 10^{-1} mrem), converting mrem to rem (e.g., 1.3 x 10^{-1} mrem x 0.001 rem/mrem = 1.3 x 10^{-4} rem), and multiplying by the worker risk coefficient (e.g., 1.3 x 10^{-4} rem x 4.0 x 10^{-4} risk/rem = 5.1 x 10^{-8}). L-11-3

3. Page 2-18, Table 2-3 Estimated accident consequences by alternative.

The table values for the latent cancer fatalities for the maximally exposed offsite individual are 4.8 x 10^{-5}, 9.6 x 10^{-5}, 1.7 x 10^{-7}, 4.8 x 10^{-5}, and 9.6 x 10^{-5} respectively. L-11-4

These values should be 6.0 x 10^{-5}, 1.2 x 10^{-4}, 2.1 x 10^{-7}, 6.0 x 10^{-5}, and 1.2 x 10^{-4}. Apparently, the authors incorrectly used the worker risk coefficient (4 x 10^{-4} risk/rem) for the maximally exposed offsite individual instead of the population risk coefficient (5 x 10^{-4} risk/rem).

4. Page 2-23, Table 2-4 Summary comparison of long-term impacts by tank closure alternative.

The table value for the adult resident latent cancer fatality risk for the fill with grout alternative is 2.0 x 10^{-6}. L-11-5

This value differs from the 3.9 x 10^{-7} value listed in Table 4.2.5-2 page 4-49 and Table S-3, page S-23 of the Summary document. Calculating the risk based on a 0.7 mrem dose estimate produces a risk number of 3.5 x 10^{-7} (e.g., 0.7 mrem x 0.001 rem/mrem x 5 x 10^{-4} risk/rem = 3.5 x 10^{-7}).

5. Page 2-24, Table 2-4 Summary comparison of long- term impacts by tank closure alternative

The table value for the adult resident lifetime dose for the fill with grout alternative is 4 mrem. L-11-6

This value differs from the 0.7 mrem value listed in Table 4.2.5-2 page 4-49 and Table S-3, page S-23 of the Summary document.

Page 3 – Mr. Ken Holt

6. Page 4-11, Table 4.1.3-5 Annual radionuclide emissions (curies/year) resulting from tank closure activities.

   Annual emission rates (curies/year) are listed for F-Area, H-Area, and the Saltstone Facility for all alternatives. L-11-7

   Why are only the Saltstone Facility emission rates found in Table S-2, page S-19 in the Summary document? Shouldn't the F-Area, H-Area, and Total emission rates be listed in Table S-2 also?

7. Page 4-11, Table 4.1.3-6 Annual doses from radiological air emissions from tank closure activities.

   The table value for the noninvolved worker dose from the fill with saltstone alternative is 2.6×10^{-3} mrem/yr. L-11-8

   This value should be 2.7×10^{-3} mrem/yr, which is consistent with higher dose estimates from this alternative as listed in Table 4.1.8-1, page 4-17.

8. Page 4-17, Table 4.1.8-1 Estimated radiological dose and health impacts to the public and noninvolved worker from SRS airborne emissions.

   The table values for the latent cancer fatality risk for the maximally exposed offsite individual have exponential values of 10^{-10} for the first two columns and 10^{10} for the remaining columns. L-11-9

   These exponential values should all be 10^{-10}.

9. Page 4-29, Table 4.1.12-1 Estimated accident consequences by alternative.

   The table dose value for the maximally exposed offsite individual from the potential failure of salt solution hold tank (saltstone option only) is 2.1 rem. L-11-10

   This value probably should be 4.2×10^{-4} rem to be consistent with the values listed in Table 2-3, page 2-18 and Table B-3, page B-9.

10. Page 4-49, Table 4.2.5-2 Radiological results from contaminant transport from H-Area Tank Farm.

    The table value for the adult resident latent cancer fatality risk for the fill with grout alternative is 3.9×10^{-7}. L-11-11

    This value should be 3.5×10^{-7} (e.g., 0.7 mrem x 0.001 rem/mrem x 5×10^{-4} risk/rem = 3.5×10^{-7}).

Response to comment L-11-1: The value in Table 2-2 is correct. The values in Table 4.1.8-1 have been corrected.

Response to comment L-11-2: The value in Table 2-2 is correct. The values in Table 4.1.8-1 have been corrected.

Response to comment L-11-3: The values in Table 2-2 have been updated due to a correction in Table 4.1.8-1.

Response to comment L-11-4: The incorrect risk coefficient was used in the calculation. The correct risk coefficient has now been used and the values have been revised in Table 2-3.

Response to comment L-11-5: The value in Table 2-4 has been corrected.

Response to comment L-11-6: The value in Table 2-4 has been corrected.

Response to comment L-11-7: The original intent was to present the values that discriminate among the alternatives, not to list all of them. However, the total emission rate is more appropriate for this intent and has replaced the values for the saltstone facility in Table S.2.

Response to comment L-11-8: The value in Table 4.1.3-6 is correct. The value in Table 4.1.8-1 has been corrected.

Response to comment L-11-9: The values have been changed to the appropriate order of magnitude in Table 4.1.8-1.

Response to comment L-11-10: The value should be 4.2×10^{-4} rem and has been corrected in Table 4.1.12-1.

Response to comment L-11-11: The value has been corrected in Table 4.2.5-2.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive N.
St. Petersburg, Florida 33702
(727) 570-5317, FAX 570-5300

January 8, 2001 F/SER4:DR:am

Rec JAN 16 2001

Mr. Andrew R. Grainger, NEPA Compliance Officer
U.S. Department of Energy
Savannah River Operations Office
Building 742A, Room 183 Attn: Tank Closure EIS
Aiken, South Carolina 29802

Dear Mr. Grainger:

The National Marine Fisheries Service (NMFS) has reviewed the Draft Environmental Impact Statement (DEIS) for the Savannah River Site High-Level Waste Tank Closure, Aiken, South Carolina (DOE/EIS-0303D). Based on our review, we find that the document sufficiently addresses potential impacts to resources for which we have stewardship responsibilities. Although we are concerned over the possibility of unintentional releases of highly toxic chemicals, it appears that great effort has been devoted to ensuring containment of radioactive and other toxic substances. We further note that the planned action is not expected to cause adverse impacts to wetlands or significant diminution in the quality of surrounding aquatic systems, and it is deemed to be the most environmentally sound and least hazardous means for tank closure. L-12-1

Several agencies, including the NMFS, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, and the States of Georgia and South Carolina are jointly and individually examining aquatic resource protection and restoration needs in the Savannah River. These efforts have been initiated as a result of increasing concern over the river's environmental quality and growing recognition of its enormous fishery, natural aesthetic, recreational, power production, and other public interest features. Of particular interest to the NMFS is the river's function as a spawning and nursery site for anadromous fishes including American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), striped bass *(Morone saxatilis*), Atlantic sturgeon (*Acipenser oxyrinchus*), and shortnose sturgeon (*Acipenser brevirostrum*). Because of their migratory nature, these species utilize significant portions of the river, including sections that would be affected by discharges (if any) from the Savannah River Site. Accordingly, any modification in the selected alternative and associated action that could potentially affect these resources should be disclosed. This includes possible release of toxic materials into tributary waters of the Savannah River. L-12-2

Finally, in accordance with the Endangered Species Act of 1973, as amended, it is the responsibility of the appropriate federal regulatory agency to review its activities and programs and to identify any activity or programs that may affect endangered or threatened species or their habitat. If it is determined that these activities may adversely affect any species listed as endangered or threatened, formal consultation with our Protected Species Management Branch must be initiated. The appropriate contact person for matters pertaining to protected species is the Assistant Regional Administrator for Protected Resources who may be contacted at the letterhead address. L-12-3

We appreciate the opportunity to review the subject DEIS and to provide comments. Related questions or comments should be directed to the attention of Mr. David Rackley at our Charleston Area Office. He may be reached at 219 Fort Johnson Road, Charleston, South Carolina 29412-9110, or at (843) 762-8574.

Sincerely,

Andreas Mager, Jr.
Assistant Regional Administrator
Habitat Conservation Division

Response to comment L-12-1: Comment noted.

Response to comment L-12-2: Any potential changes in the HLW tank closure program would be disclosed.

Response to comment L-12-3: Comment noted. As noted in Section 3.4.1, no threatened or endangered species or critical habitat occurs in one near the F- and H-Area Tank Farms.

Drew Grainger To: L Ling/DOE/Srs@Srs, John Knox/DOE/Srs@Srs
cc:
Subject: Additional Comments on DOE/EIS-0303D

01/31/01 09:34 AM

----- Forwarded by Drew Grainger/DOE/Srs on 01/31/01 09:37 AM -----

Ec.
JAN 31 2001

NEPA To: Drew Grainger/DOE/Srs
cc:
Subject: Additional Comments on DOE/EIS-0303D

01/31/01 09:34 AM

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   cc:Mail Forwarding Information
--------------- cc:Mail Forwarded ---------------
From:       Cliff Blackman <cliff_blackman@mail.dnr.state.ga.us> AT SRS
Date:       01/26/2001 08:30 AM
To:         nepa@mailhub.srs.gov AT SRS
Cc:         Jim Hardeman <Jim_Hardeman@mail.dnr.state.ga.us> AT SRS
Subject:    Additional Comments on DOE/EIS-0303D
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______________________________ Forward Header __________________________________
Subject: Additional Comments on DOE/EIS-0303D
Author:  Cliff Blackman <cliff_blackman@mail.dnr.state.ga.us> at SRS
Date:    1/26/01 8:30 AM
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Please accept the attached additional EIS comments for review. I apologize for being a couple of days late, but I didn't receive the EIS for review until the end of December.

These comments relate mainly to Kd assumptions used in the MEPAS model. High aluminum values measured in groundwater from E, F, and H Areas suggest a much lower Kd value than used in the model. In addition, the projected groundwater flow from F and H Tank farms to Four Mile Creek will traverse the seepage basins where very low pH values have been reported. This factor, along with the high results for aluminum, suggests that much lower Kd values for soil may apply for groundwater flow south of the water table divide. The implication is that some radionuclides will reach Four Mile Creek sooner, and that higher doses may result, since the radionuclides will not have as much decay time. L-13-1

Other comments relate to possible exponent problems with projected risk calculations (risk > 1E+10) and with possible concentration unit problems for reported concentrations of tritium in groundwater (H-3 = 0.296 mCi/ml in E Area). L-13-2

Thank you for your consideration.

Cliff Blackman (Ga-DNR)

Comments on DOE/EIS-0303D Draft Regarding High-Level Waste Tank Closure

1/25/2001 ... Additional Comments

From: Cliff Blackman, Georgia Department of Natural Resources, Environmental Radiation Program
404/894-2418 or 404/362-2675 (Fax 404/894-3828) ... e-mail Cliff.Blackman@oip.gatech.edu

1) Maximally Exposed Offsite Individual Latent Cancer Risk Exponent Problem:

Table 4.1.8-1 reports this risk as 3.1×10^{10} for the H-Tank area options. Presumably this is a typo, as this level of risk would probably require an individual to jump into the waste tank! L-13-3

2) Maximum Groundwater Contaminant Concentration Units Problem:

Tables 3.2-3, 3.2-4, and 3.2-5 report the maximum groundwater contaminant concentrations for parameters in excess of the regulatory limit for E-Area, F-Area, and H-Area, respectively. Likewise, Figure 3.2-5 provides a map of these areas with some of the same results listed. However, there may be a typo or else some confusion over units for tritium. The tables provide tritium concentrations in uCi/ml (micro), whereas the map reports tritium concentrations in mCi/ml (milli). For example, Table 3.2-3 indicates that the maximum tritium concentration in E-Area was 2.96×10^{-1} uCi/ml, whereas Figure 3.2-5 indicates that the maximum concentration was 0.296 mCi/ml, which would actually be $2.96 \times 10^{+2}$ uCi/ml or 1000 times higher than reported in the table. Presumably the intent was to report in uCi/ml. L-13-4

3) Projected vs Measured Concentrations of Aluminum in Groundwater and Possible Kd Implications:

Table C.4.1-14 provides the MEPA modeled concentration of aluminum in groundwater for all options under consideration. This table suggests that the aluminum concentration will be less than 1×10^{-6} mg/L, which is the same as 1×10^{-3} ug/L. However, actual groundwater measurements provided in Tables 3.2-3, 3.2-4, and 3.2-5 indicate that the maximum concentrations measured in E, F, and H Areas are currently $3.67 \times 10^{+3}$, $3.7 \times 10^{+4}$, and $1.3 \times 10^{+4}$ ug/L, respectively. Since the modeled results are over 1,000,000 times lower than currently measured values, doesn't that suggest that the soil Kd values for aluminum (and possibly other nuclides) in groundwater in this area must be much lower than the Kd values used in MEPAS as provided in Table C.3.2-1 (35,300)? L-13-5

4) Groundwater Flow Past Seepage Basins with Low pH and Possible Kd Implications:

Figures 3.2-2 and 3.2-3 indicate that groundwater flow from the F and H Tank Farms on the south side of the divide will intercept closed seepage basins en-route to Four Mile Creek. Groundwater testing in these areas indicated very low pH in some monitoring wells (WSRC-TR97-00322 and WSRC-TR98-00312, Groundwater Data Section). Low pH has been linked with lower Kd values for some radionuclides (<10 for Cs and <1 for Sr as provided in DOE/EIS-0082, p. F-12) and, consequently, more mobility and higher concentrations than would otherwise be predicted, down-gradient. How does the MEPAS model account for this phenomenon? L-13-6

Response to comment L-13-1: See response to comment L-13-5.

Response to comment L-13-2: See response to comment L-13-3.

Response to comment L-13-3: The values have been changed to the appropriate order of magnitude in Table 4.1.8-1.

Response to comment L-13-4: The units shown on Figure 3.2-5 for tritium were incorrect and have been revised (all constituents, in addition to tritium, have been checked and revised as needed).

Response to comment L-13-5: The aluminum concentrations detected in groundwater monitoring wells reported in Tables 3.2-3 through - 5 may represent location-specific conditions (e.g., source terms, release mechanisms, soil chemistry, and groundwater sample characteristics [turbidity]) different from general assumptions used in the MEPAS modeling for the HLW tank farms. For instance, the maximum aluminum concentration of 37,100 micrograms/liter reported in Table 3.2-3 for the F-Area occurred in well FSB77 during the 3rd quarter of 1998 sampling. This well is located adjacent to the F-Area seepage basin and a groundwater pH of 3.4 was reported. This low pH is due to the presence of the seepage basin and is not indicative of natural conditions. This very site-specific condition that may locally affect parameters such as K_d should not overshadow the soil and groundwater chemistry along the entire 6,000 foot groundwater flowpath between the F tank farm and the seepline along Four Mile Creek. Therefore, the values reported in the tables for aluminum (and other constituents) measured during groundwater monitoring conducting in 1997 and 1998 do not suggest that the selected K_d value for aluminum (and other constituents) used in the MEPAS modeling are inappropriate.

The K_d value selected to represent aluminum in the aquifer was taken from data for soils with <10% clay and a pH range of 5 to 9. A review of published reports for the General Separations Area containing descriptions of the site geology, the aquifer formations, soil and groundwater chemistry, and previous modeling efforts was the basis for selecting physical and chemical parameter values that DOE believed were representative of the predominant aquifer conditions across the groundwater flow paths at each of the tank farms. The descriptions of numerous soil core samples from borings in the Upper Three Runs aquifer in the General Separations Area, including the F and H Areas, suggests that the average clay content of the aquifer might be higher than 10%. Because K_d values often increase with an increase in clay content, it is possible that an even higher K_d value than the one used in the modeling could be justified. However, because most groundwater flow and contaminant transport will occur in the most transmissive zone of an aquifer, we have used a K_d for aluminum based on a conservatively low clay content of 10% for the aquifer matrix (generally, in porous aquifers, higher transmissivity is associated with lower clay content).

Response to comment L-13-6: The MEPAS model cannot directly account for a change in K_d over the flow path of the groundwater plume. DOE has allowed for such variations by selecting appropriate K_d values for each radionuclide (and nonradionuclide) migrating through the saturated zone (i.e., through which the plume would migrate beneath the seepage basins enroute to Four Mile Creek) that represents the majority of the aquifer material through which the flow occurs. We recognize that some portion of the flowpath may contain altered chemistry (e.g., low pH at the seepage basins), but on the other hand, a portion of the flowpath may contain offsetting chemistry (e.g., higher than average soil pH). K_d values can also be strongly affected by the clay and organic content of the aquifer matrix.

It should also be noted that most groundwater flow and contaminant transport will occur in the most transmissive zone of an aquifer. At the same time, the most transmissive zone allows for the most flushing of the aquifer with upgradient groundwater that has not been impacted by the low pH conditions locally beneath the seepage basins. This suggests that the most transmissive aquifer zone is less affected by any low pH leachate from the seepage basins and that changes to the K_d of the aquifer would be minimized. Wells demonstrating low pH in the vicinity of the seepage basins may not be screened in the most transmissive section of the aquifer.

Please also note that although a combination of site-specific and literature-based sources for the K_d values were used in the MEPAS modeling, the MEPAS data base indicates that the Kd values for the primary contributors to the radiological dose (i.e., Se-79, Tc-99, C-14, and I-129) do not vary with pH, so no adjustment to the K_d values for these constituents would be necessary to model flow beneath the seepage basins. In addition, the major contributor to the radiological dose, Tc-99, has a relatively low Kd value of 0.36 ml/g. Decreasing this already low K_d value by an order of magnitude (i.e., K_d = 0.036 ml/g) would have no effect on the maximum plume concentration (and doses); only the time of the maximum concentration would change from 750 to 737 years.

Finally, because the low pH conditions occur some distance downgradient of the tank farms, there is no potential to increase the release of constituents from the source zone in the bottom of the tanks, and no potential effects on the 1-and 100-meter well concentration predictions.

Drew Grainger

To: John Knox/DOE/Srs@Srs, L Ling/DOE/Srs@Srs
cc:
Subject: Comments on High-Level Waste Tank Closure DOE EIS 0303D

01/24/01 09:49 AM

----- Forwarded by Drew Grainger/DOE/Srs on 01/24/01 09:51 AM -----

NEPA

To: Drew Grainger/DOE/Srs
cc:
Subject: Comments on High-Level Waste Tank Closure DOE EIS 0303D

01/24/01 09:43 AM

cc:Mail Forwarding Information
--------------- cc:Mail Forwarded ---------------
From: Cliff Blackman <cliff_blackman@mail.dnr.state.ga.us> AT SRS
Date: 01/22/2001 10:48 AM
To: nepa@mailhub.srs.gov AT SRS
Cc: Jim Hardeman <Jim_Hardeman@mail.dnr.state.ga.us> AT SRS
Subject: Comments on High-Level Waste Tank Closure DOE EIS 0303D

Forward Header
Subject: Comments on High-Level Waste Tank Closure DOE EIS 0303D
Author: Cliff Blackman <cliff_blackman@mail.dnr.state.ga.us> at SRS
Date: 1/22/01 10:48 AM

Please accept the attached comments and questions regarding the Draft EIS 0303D ... High-Level Waste Tank Closure. The main concern that I have is that the residual source term appears to be significantly underestimated. This may result in future doses that will be at least 2 orders of magnitude higher than presented in the EIS. L-14-1

The impact of such an underestimate will likely carry over from ground water to the Savannah River, as well. In such a case, drinking water and fish consumption from the Savannah River could be significantly impacted for thousands of years. Georgia and South Carolina cannot afford to ignore such potential impacts. Therefore, additional review is highly recommended prior to finalizing your EIS and closure methodology. L-14-2

It is recognized that the proposed grout-fill option probably represents the most cost-effective and safe method for closure of the tanks, at this time. If lower residual source terms cannot be guaranteed, however, additional barriers may be needed. L-14-3

Thank you for the opportunity to review this document.

Cliff Blackman,
Georgia Department of Natural Resources
404/894-2418 or 404/362-2675

Comments on DOE/EIS-0303D Draft Regarding High-Level Waste Tank Closure

1/22/2001

From: Cliff Blackman, Georgia Department of Natural Resources, Environmental Radiation Program
404/894-2418 or 404/362-2675 (Fax 404/894-3828) ... e-mail Cliff.Blackman@oip.gatech.edu

Residual Source-Term Concerns and Potential Consequences:

The long-term dose model appears to be based on an unrealistically low residual source term, as presented in Table C.3.1-1. Thus, the long-term dose estimates presented in the EIS may be at least two orders of magnitude too low. This source term, which was used in modeling the long-term consequences, represents only a fraction of the DOE figure-of-merit, achievable goal (1 – 2 % residual) spelled out in DOE/EIS-0303D (p 2-3). The residual term listed in Table C.3.1-1 is equivalent to 0.04% of the Sr-90 tank inventory, 0.2% of the Tc-99, 0.01% of the Cs-137, and 0.1% of the Pu-238 tank inventory, as derived from Table 3.3 of DOE/EIS-0082, WSRC-RP-92-250 (p 3-13), WSRC-RP-92-984 (p 3-23), and WSRC-RP-92-879-Rev 1 (p 3-19). In addition, source terms were not provided for several other significant, long-lived radionuclides that were reported to be in the waste tanks, including Pu-240, Am-241, and Cm-244. L-14-4

The use of the low EIS source term appears to be dependent on the use of oxalic acid for final wash and rinse. It should be noted that, based on the Bradley and Hill (1977) study of chemical dissolution of high level waste tank sludge, the highest dissolution achieved was 70% with well-mixed sludge. Assuming that this represents the best-case recovery, then the residual in Tank 16, after oxalic acid wash, may be higher than reported in Table 2-1. Since 6.0E+04 Ci was reportedly removed at this stage, a 70% recovery would suggest that as much as 2.6E+04 Ci or 0.9% of the initial 2.82E+06 Ci bulk in the tank may remain. This represents a much higher residual percentage than Table C.3.1-1, consistent with the DOE figure of merit (1-2 % residual): Therefore, lower residual fractions should not be assumed, unless adequate in-situ (in-tank) assays can demonstrate otherwise. L-14-5

Even if a lower residual can be demonstrated, oxalic acid is currently not approved without further criticality studies. Therefore, it's use should not be considered in the current EIS, especially since a criticality accident scenario was not included in the Accident Analysis (Appendix B) portion of the EIS. If later studies approve it's use, then an amended EIS can be generated, assuming that the interior of the tank is still accessible. The current EIS indicates that DOE considers bulk removal with spray washing (98% to 99% curie removal) as the limit of what is economically and technically practicable (P 2-3). Based on this statement and on Tank 16 experience, a 2 % residual should, therefore, be assumed. Using a 2% residual, the EIS residual inventory should be amended as follows: L-14-6

Radionuclide	EIS Source Term (Ci)	Proposed Amended Source Term (Ci)	Basis
Tc-99	4.9E+01	4.0E+02	DOE/EIS-0082 Table 3-3
Sr-90 (F+H)	1.6E+05	8.4E+06	WSRC-RP-92-984 p 3-23
Cs-137 (F+H)	9.9E+03	3.9E+06	WSRC-RP-92-250 p 3-13
Pu-238 (H)	1.7E+03	3.2E+04	WSRC-RP-92-879-Rev 1 Table 3-7
Pu-239 (F+H)	1.5E+02	4.4E+02	WSRC-RP-92-879-Rev 1 Table 3-7
Pu-240	Not Listed	2.2E+02	WSRC-RP-92-879-Rev 1 Table 3-7
Pu-241	Not Listed	1.7E+04	WSRC-RP-92-879-Rev 1 Table 3-7
Am-241	Not Listed	2.2E+03	WSRC-RP-92-879-Rev 1 Table 3-7 ... estimated in-growth from Pu-241, prior to 20-year decay
Cm-244	Not Listed	1.2E+03	DOE/EIS-0082 Table 3-3
Other Nuclides	---	No Change	

1

Comments on DOE/EIS-0303D Draft Regarding High-Level Waste Tank Closure … cont.

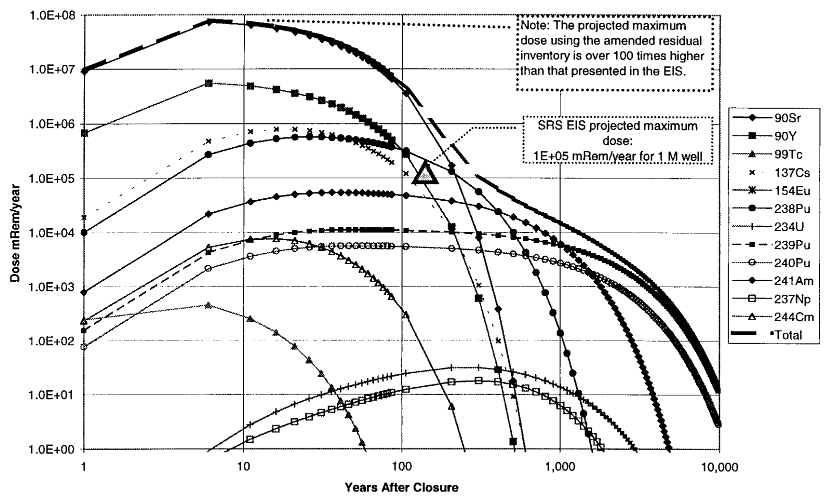
1/22/2001

From: Cliff Blackman, Georgia Department of Natural Resources, Environmental Radiation Program
404/894-2418 or 404/362-2675 (Fax 404/894-3828) … e-mail Cliff.Blackman@oip.gatech.edu

Of course, the Cs-137 residual inventory cannot be very well defined, at this stage, since the in-tank precipitate process has not worked. This leaves the fate of this material and residual inventory in question, at this time. A supplemental EIS for this process is currently under review, accordingly (p 1-14, 1-15 of DOE/EIS-0303D). It would appear that the lack of a good source term for Cs-137 could pose a significant problem, especially if high residuals (> 10%) are left. L-14-7

Using the above-proposed amended source term, the projected long-term doses and consequences should be re-evaluated. An initial dose projection using the D&D code (NRC) suggests that long-term dose may be underestimated by at least a factor of 100, as illustrated below for the 1-meter well scenario. Similar underestimates would apply for the 100-meter well, seepline, and surface water scenarios. If this is the case, then more thought should be given to improved closure options, and additional modeling would be in order. Of the options presented in the EIS, the tank closure with grout option still appears to be the most effective choice. Unless the residual can be improved, however, additional costs may be justified, in order to mitigate future consequences to groundwater and the Savannah River. L-14-8

Projected 1-M Well Drinking Water Doses for Tank Farm Closure With Amended Residual Inventory and Grout Option



2

Response to comment L-14-1: See response to L-14-4.

Response to comment L-14-2: See response to L-14-8.

Response to comment L-14-3: See response to L-14-8.

Response to comment L-14-4: DOE believes that the assumed source term values are appropriate for use in this EIS. As discussed in the response to comment L-2-8, Appendix C has been revised to present Table C.3.1-2, which lists the assumed volume of residual waste remaining in each closed HLW tank if the tanks are cleaned. Table C.3.1-1 has been revised to present the average concentration for each listed radionuclide (curies/gallon). These assumed volume estimates are based on previous experience with closure of Tanks 17 and 20 and on judgments of the effectiveness of the waste removal method. For example, 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. These volume estimates (which typically are 100 or 1,000 gallons of sludge remaining in the closed tank) are not derived from applying the "figure-of-merit" referred to in the comment.

The characteristics of this residual sludge were based on knowledge of the processes that generated the waste. It was assumed that the residuals left behind after waste removal would have approximately the same composition as the sludge currently in the tanks. Before each tank is closed, the residual in that tank will be estimated and modeled to ensure that the closure is within requirements. In Tanks 17 and 20, the two tanks that were 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 species of interest. A similar procedure will be followed in the future for residual waste in each tank.

Response to comment L-14-5: While it is true that oxalic acid cannot completely dissolve sludge, dissolving the sludge is not required to remove it. The hydraulic slurry techniques used to remove wastes from SRS waste tanks were designed to slurry and hydraulically convey solids out of the tank. The residuals remaining at the end of waste removal would be either (1) large, fast-settling particles that were not pumped out of the tank or (2) particles in difficult-to-reach locations where the liquid velocity was too low to suspend them. Oxalic acid loosens the particles and causes them to crumble, so that the larger particles can be removed, and particles can be dislodged from most difficult-to-reach locations. Admittedly, experience with oxalic acid cleaning is limited to one tank at SRS, Tank 16. See response to comment L-14-4 regarding DOE's assumed residual material volumes.

Response to comment L-14-6: See response to comment L-4-23.

Response to comment L-14-7: The residual material remaining in the closed HLW tanks would be composed of sludge. The quantity and characteristics of residual sludge depends on the completeness of bulk waste removal and cleaning, if necessary. It would be unaffected by decisions made regarding processing of the salt and supernate components of the waste.

Response to comment L-14-8: As discussed in the response to comment L-14-4, DOE believes that the assumed source term values are appropriate for use in this EIS. Therefore, additional long-term dose and consequence analysis is not necessary.

Drew Grainger

01/24/01 10:36 AM

To: John Knox/DOE/Srs@Srs, L Ling/DOE/Srs@Srs, George Hannah@Srs
cc:
Subject: DOE/EIS-0303D Tank Closure ... Additional Comments (Ga-DNR)

----- Forwarded by Drew Grainger/DOE/Srs on 01/24/01 10:37 AM -----

NEPA

01/24/01 10:13 AM

To: Drew Grainger/DOE/Srs
cc:
Subject: DOE/EIS-0303D Tank Closure ... Additional Comments (Ga-DNR)

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   cc:Mail Forwarding Information
--------------- cc:Mail Forwarded ---------------
From:       Cliff Blackman <cliff_blackman@mail.dnr.state.ga.us> AT SRS
Date:       01/24/2001 09:59 AM
To:         nepa@mailhub.srs.gov AT SRS
Cc:         Jim Hardeman <Jim_Hardeman@mail.dnr.state.ga.us> AT SRS
Subject:    DOE/EIS-0303D Tank Closure ... Additional Comments (Ga-DNR)
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Additional comments from GDNR I just received.

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Subject: DOE/EIS-0303D Tank Closure ... Additional Comments (Ga-DNR)
Author:  Cliff Blackman <cliff_blackman@mail.dnr.state.ga.us> at SRS
Date:    1/24/01 9:59 AM
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Please accept for review the additional EIS comments contained in the attachment. These comments relate to enhanced groundwater contaminant transport in the water table on the south side of the H-Area, and a possible relationship between a previously unknown fault (H-Fault) and highly permeable channels that reportedly transport a majority of this water to Four Mile Creek.

Thank you for the opportunity to review this EIS.

Cliff Blackman
Georgia Dept. of Natural Resources, Env. Radiation Program
cliff.blackman@oip.gatech.edu
404/894-2418 or -3776 (voice)
404/894-3828 (fax)

(See attached file: Tank_Rev2.doc)

- Tank_R~1.doc

Comments on DOE/EIS-0303D Draft Regarding High-Level Waste Tank Closure

1/24/2001 ... Additional Comments

From: Cliff Blackman, Georgia Department of Natural Resources, Environmental Radiation Program
404/894-2418 or 404/362-2675 (Fax 404/894-3828) ... e-mail Cliff.Blackman@oip.gatech.edu

H-Area (H-Fault and Channels) Hydro-Geologic Concerns:

Section 3.1.3 (Seismicity) and Figure 3.1.1 (map of seismic fault lines) of EIS-0303D indicate the presence of a previously unknown fault (H-Fault ... for lack of another name) that passes through the southeastern corner of H-Area (Wike et al. 1996, WSRC-TR-96-0279 Rev. 1, p4-14). Previous hydro-geological studies of Sr-90 transport (Carlton et al., WSRC-RP-92-984) in this same area of SRS (Four-Mile Creek side of the water table divide) report that "much of the groundwater flow in this area of the plant appears to occur in narrow, high permeability channels in the sediments." It was suggested that the majority of the flow of underground contaminants entering the water table in this portion of H-Area follow these channels to outcrop into Four-Mile Creek. A similar study of Cs-137 transport (Carlton et al., WSRC-RP-92-250, p4-11) suggests "facilitated transport is taking place in this locality." L-15-1

The overlapping presence of H-Fault and the narrow, highly permeable channels are likely inter-connected, and thus provide a mechanism to facilitate future movement of contaminants from H-Area Tanks to Four-Mile Creek. Since several H-Area tanks (including 9 through 12) are reported to be in the water table (p.1-7 of EIS-0303D), contaminants from these tanks are likely to move rapidly through these channels to Four Mile Creek, once the bottom of these tanks corrode. This is likely to occur within 100 years, in which case the Sr-90 could pose a significant problem for consumption of surface water and fish from Four-Mile Creek and from the Savannah River. Current problems with Sr-90 in Four-Mile Creek would be insignificant compared to what could reach this creek in the future. Given the enhanced transport mechanism identified, provisions need to be made to insure that Sr-90 does not reach the water table in this area, at least until after 200 years. Possible facilitated transport of longer-lived contaminants (Pu-238, Pu-239, Am-241, etc.) in this area should also be reviewed in the MEPAS model presented in the EIS. L-15-2

Response to comment L-15-1: The offsets and displacements of the "H-Fault" are at a far greater depth than the solution channels around the seepage basins that can produce "facilitated transport."

Response to comment L-15-2: The channels causing "facilitated transport" occur in the vicinity of the F and H Area seepage basins, where very acidic water released into the sediments dissolved some of the soil constituents. Such dissolution channels do not occur in the area around the F- and H-Area Tank Farms. Transport from the tank farm areas would be through intact sediments for the greatest part of the flow paths.

United States Department of the Interior

OFFICE OF THE SECRETARY
OFFICE OF ENVIRONMENTAL POLICY AND COMPLIANCE
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

January 11, 2001

Rec.
JAN 16 2001

ER-00/840

Andrew R. Grainger, NEPA Coordinator
U.S. Department of Energy, Savannah River Operations Office
Building 742A, Room 183
Aiken, South Carolina 29802

ATTN: Tank Closure EIS

Dear Mr. Grainger:

The Department of the Interior has reviewed the draft Environmental Impact Statement for the High Level Waste Tank Closure at the Savannah River Site, Aiken, SC as requested. We have no comments to offer at this time. L-16-1

Thank you for the opportunity to review and comment on this draft EIS.

Sincerely,

James H. Lee

James H. Lee
Regional Environmental Officer

Response to comment L-16-1: Comment noted.

01/16/01 TUE 14:54 FAX 727 570 5517 PROTECTED SPECIES SER 001

Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29802

RECEIVED
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November 16, 2000

Dear Stakeholder

Enclosed for your review and comment is the U.S. Department of Energy's (DOE) *Savannah River Site High-Level Waste Tank Closure Draft Environmental Impact Statement* (EIS) (DOE/EIS-0303). DOE prepared this Draft EIS in accordance with the National Environmental Policy Act (NEPA) of 1969 and its implementing regulations.

This EIS evaluates three alternatives regarding closure of the high-level waste (HLW) tanks at the Savannah River Site (SRS). The three alternatives are: Clean and Stabilize the Tanks, Clean and Remove the Tanks, and No Action. Under the Clean and Stabilize the Tanks alternative, DOE is considering three options for tank stabilization: fill with grout (preferred alternative), fill with sand, and fill with saltstone.

DOE proposes to close the HLW tanks at 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.

Under the Clean and Stabilize Tanks or the Clean and Remove Tanks alternatives, DOE would close 49 HLW tanks and associated waste handling equipment, including evaporators, pumps, diversion boxes, and transfer lines. The Draft EIS assesses impacts primarily in the areas of water resources, air resources, public and worker health, waste management, socioeconomic impacts, and cumulative impacts.

The public comment period on this EIS extends through January 23, 2001. The Department will hold two public meeting—each with two sessions—to discuss the Draft EIS and receive comments. The meetings will be held in North Augusta and Columbia, South Carolina, in early January 2001. Dates and locations will be announced in the Federal Register and local media at least 15 days before the meetings.

In addition, comments may be submitted by mail to Andrew R. Grainger, NEPA Compliance Officer, Savannah River Site, Building 742-A, Room 185, Aiken, South Carolina 29802; electronically to nepa@srs.gov; or by calling 1-800-881-7292 and leaving a message.

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL

	# of pages ►
To Grainger	From Hawk
Dept./Agency	Phone # 727 570-5312
Fax #	Fax #

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

01/16/01 TUE 14:55 FAX 727 570 5517 PROTECTED SPECIES SER 002

In preparing the Final EIS, DOE will consider all comments transmitted or postmarked by January 23, 2001. Comments submitted after this date will be considered to the extent practicable. DOE expects to issue the Final EIS in early 2001 and to issue a Record of Decision on SRS tank closure no sooner than 30 days after the Final EIS is issued. Thank you for your interest in the Department's activities.

Sincerely,

Andrew Grainger
NEPA Compliance Officer

Enclosure:
Savannah River Site High-Level Waste Tank Closure Draft Environmental Impact Statement

THE PROPOSED ACTION IS NOT LIKELY TO ADVERSELY AFFECT LISTED ENDANGERED OR THREATENED SPECIES OR DESIGNATED CRITICAL HABITAT PROTECTED BY THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED.

SECTION 7 COORDINATOR
NATIONAL MARINE FISHERIES SERVICE
SOUTHEAST REGIONAL OFFICE
ST. PETERSBURG, FLORIDA
DATE: Dec 22, 2000

L-17-1

<u>Response to comment L-17-1</u>: Comment noted.

Dec 14 00 08:06a EH-421 202 586-7031 p.2

STATE OF SOUTH CAROLINA

State Budget and Control Board

OFFICE OF STATE BUDGET

1122 LADY STREET, 12TH FLOOR
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LES BOLES
DIRECTOR

ACKNOWLEDGEMENT

November 30, 2000

Ms. Carol M. Borgstrom
Director
Office of NEPA Policy & Compliance
1000 Independence Avenue, S.W.
Washington, DC 20585

Project Name: High - Level Waste Tank Closure Draft Environmental Impact Statement Savannah River Operations office Aiken, SC DOE/EIS-0303D

State Application Identifier:EIS-001115-012
Suspense Date: 1/13/2001

Dear Ms. Borgstrom:

Receipt of the above referenced project is acknowledged. The Grant Services Unit, Office of State Budget, has initiated an intergovernmental review of this project. You will be notified of the results of this review by the suspense date indicated above. South Carolina state agencies are reminded that if additional budget authorization is needed for this project, three copies of the completed GCR-1 form and two copies of the project proposal must be submitted to this office. This action should be initiated immediately, if required. Please include the State Application Identifier in any correspondence with our office regarding this project. If you have any questions please contact me at 734-0485. L-18-1

Sincerely,

Angela F. Stoner
Fiscal Manager, Grant Services

DEC 12 2000
EH-42

Fax (803) 734-0645

Response to comment L-18-1: Comment noted.

D.3 Public Meeting Comments and DOE Responses

The public meetings consisted of brief presentations by DOE on the Draft EIS, followed by a question and answer and comment period. Court reporters documented comments and statements made during these public meeting sessions. In the sessions, eight individuals had questions, provided comments, or made public statements.

In this section, each public speaker's statement is placed in context and paraphrased because some statements are dependent on previous statements and interspersed with other discussion. The transcripts from the meetings can be reviewed at the DOE Public Reading Rooms: DOE Freedom of Information Reading Room, Forrestal Building, Room 1E-190, 1000 Independence Avenue, S.W., Washington, D.C., 20585, Phone: 202-586-6020 and DOE Public Document Room, University of South Carolina, Aiken Campus, University Library, 2nd Floor, 171 University Parkway, Aiken, SC 29801, Phone: 803-648-6815.

Paraphrased comments from the meetings and DOE's responses are as follows:

M-01: The commenter asked if the EIS evaluated the potential re-use of the Tank Farm area as a brownfield site, which might be available for other future uses.

Response: As noted in the *Savannah River Site Future Use Plan*, DOE plans to continue active institutional control over the land around the F and H Areas (i.e., between Upper Three Runs and Fourmile Branch) as long as necessary to protect the public and the environment. Future industrial uses of this area would not be precluded as a result of tank closure actions, but DOE does not expect to consider nonindustrial uses. [The EIS does evaluate the potential long-term impacts of other future uses of the tank farm areas, by calculating radiation doses to persons obtaining drinking water from wells located 1 meter and 100 meters downgradient from the tank farm boundaries.]

M-02: The commenter asked if there were there any disposal ramifications connected with oxalic acid. The commenter further asked if there was a product other than oxalic acid that could be used to remove the residual material in the tanks.

Response: Extensive use of oxalic acid cleaning may result in conditions that, if not addressed by checks within the Defense Waste Processing Facility (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.

Section 2.1 of the EIS cites an earlier DOE 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 compatible with HLW processes. The studies included tests with waste simulants 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-mixed sample at 25º C, which was the highest of any of the cleaning agents tested.

M-03: The commenter asked if the Clean and Remove Tanks Alternative would result in making the Tank Farm area more favorable for potential future uses.

Response: Under the Clean and Remove Tanks Alternative, the tanks would be cleaned to the extent of allowing the steel tank components to be cut up, removed, and transported to SRS radioactive waste disposal facilities. DOE would then backfill the excavations left after tank removal. As noted in the response to comment M-01, future industrial uses of this area would not be precluded as a result of tank closure actions, but DOE does not expect to consider non-industrial uses. [As discussed in Section S.8.2, the Clean and Remove Tanks Alternative would have somewhat less impact on future land use because the tank systems would be removed.]

M-04: The commenter asked if the long-term impact analysis was based on standard EPA drinking water assumptions (i.e., two liters per day). Also, for the 1-meter and 100-meter wells, do the impacts assume a direct use of groundwater?

Response: The long-term impact analysis assumed a water ingestion rate of two liters per day. The impacts presented in the EIS for the 1-meter and 100-meter wells were based on direct consumption of the groundwater from hypothetical wells at these locations. Other assumptions are described in Appendix C.

M-05: The commenter asked where does Fourmile Branch eventually flow to.

Response: The water in Fourmile Branch flows directly to the Savannah River.

M-06: The commenter asked, for the Clean and Remove Tanks Alternative, if the removed tank components would be disposed in the SRS E-Area vaults.

Response: The removed tank components would be transported to SRS radioactive waste disposal facilities (assumed to be the E-Area Vaults) for disposal.

M-07: The commenter asked if the stabilizing material (i.e., grout, sand, or saltstone) would also be emplaced in the tank annulus.

Response: For those tank types that have annuli, in addition to cleaning the tanks, DOE would also clean and backfill the annulus with a stabilizing material (uncontaminated grout in the Fill with Saltstone Option). [Section 2.1.1. has been revised to clarify this point.]

M-08: The commenter asked if, after tank closure has been completed, the Tank Farm area would be considered a brownfield site that is available for other uses, or would it be left in an unusable state. The commenter further asked what DOE envisions the area will look like when tank closure activities have been completed (i.e., would the area be flat, would it be covered with a clay cap, would it be asphalted).

Response: As noted in the *Savannah River Site Future Use Plan*, land around the F and H Areas (i.e., between Upper Three Runs and Fourmile Branch) as long as necessary to protect the public and the environment. Future industrial uses of this area would not be precluded as a result of tank closure actions. [The EIS does evaluate the potential long-term impacts of other future uses of the tank farm areas, by calculating radiation doses to persons obtaining drinking water from wells located 1-meter and 100-meters downgradient from the tank farm boundary]. The area may be capped or an in situ groundwater treatment system may be installed. The necessity for a low-permeability cap, such as a clay cap, over a tank group to reduce rainwater infiltration would be established in accordance with the environmental restoration program described in the Federal Facility Agreement. The cap construction would ensure that rain falling on the area drains away from the closed tank(s) and surrounding soil. A soil cover could be placed over the cap and seeded to prevent erosion.

M-09: The commenter asked what is the regulatory scheme once a tank has been closed. The commenter asked if it would be regulated as a low-level waste under South Carolina law. The commenter further asked what implications the regulatory scheme would have on the proposed administrative control over the Tank Farm area. Does the EIS assume that the federal government maintains administrative control over the site for the entire 10,000-year period of analysis?

Response: The residual material would be managed as low-level waste consistent with the requirements of DOE Order 435.1, "Radioactive

Waste Management." As noted in the *Savannah River Site Future Use Plan*, 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. Consequently, DOE plans to continue active institutional control for those areas as long as necessary to protect the public and the environment. [The future land use of the tank farm area would not be affected by regulations governing the tank closure program or by the choice of a tank closure alternative. In addition, over the 10,000-year period of analysis in the EIS, DOE does not envision relinquishing control of this area. However, DOE recognizes that there is uncertainty in projecting future land use and 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.]

M-10: The commenter asked if, for all of the tanks, DOE's preference is to leave them in the ground and fill them with grout.

Response: DOE's preferred alternative is the Fill with Grout Option under the Stabilize Tanks Alternative. Before each individual tank is closed, DOE will prepare a tank-specific closure module for that tank.

M-11: The commenter asked what DOE would do if, in the course of performing waste removal on the single-shell tanks, a leakage of waste is found that has moved beneath the tank. The commenter expressed the desire that DOE then consider removal of that tank.

Response: If, during the closure process, DOE were to discover a leaking tank, DOE would identify the location of the leak and take immediate action to stop the leak (e.g., remove the waste to below the level of the leak). DOE would then re-evaluate the closure plans for that tank. 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. Only one tank (Tank 16) has leaked waste to the environment. In Tank 16, the waste overflowed the annulus pan (secondary containment) and a few tens of gallons of waste migrated into the surrounding soil, presumably through a construction joint in the concrete encasement. Waste removal from the Tank 16 primary vessel was completed in 1980.

M-12: The commenter stated that, over a period of time, these tanks rust away anyway. The commenter noted that, if these tanks were to rust away, this would get rid of them.

Response: The situation described by the commenter is equivalent to the No Action Alternative evaluated in the EIS. In the assessment of that alternative, DOE assumes that, at some point in the future, the tank top, grout, and basemat would fail, with a corresponding increase in their respective hydraulic conductivities. The long-term impacts of No Action are reviewed in the EIS. In accordance with the Federal Facility Agreement, DOE intends to remove the tanks from service as their missions are completed. For 24 tanks that do not meet the EPA's secondary containment standards, DOE is obligated to remove the tanks from service by 2022.

M-13: The commenter asked if a Record of Decision were to be issued that says that DOE will stabilize the tanks with grout, is there then nothing that would preclude, on a case-by-case basis, removing a given tank.

Response: In the Draft EIS, DOE examined the impacts of both tank removal and grouting in-place. 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.

M-14: The commenter asked why the long-term dose at the 1-meter well for H Area is substantially higher than for F Area.

Response: In the H-Area Tank Farm north of the groundwater divide, most of the calculated radiation dose at the 1-meter well is attributable to Tanks 9 through 12. Those four tanks are submerged in the water table aquifer; thus, the transport of contaminants is driven by horizontal infiltration of groundwater rather than vertical infiltration of rainwater, causing the rapid transport of contaminants (i.e., before they can decay) to nearby locations such as the 1-meter well.

M-15: The commenter noted that, for the Fill with Saltstone Option, the EIS presents a radiation dose value of 1,800 person-rem. The commenter asked what time period that exposure represented (i.e., is it over 10,000 years or one lifetime). The commenter further asked about the radiation dose to the downstream consumers of water from the Savannah River.

Response: The short-term impacts were evaluated over a 30-year time frame. The value cited by the commenter represents the collective radiation dose to the workers doing the tank closure activity (i.e., over that period of time that it takes to close all 49 tanks). The downstream drinking water numbers for people consuming Savannah River water over the long term are also presented in the EIS (Table 4.2.5-3).

M-16: The commenter stated that there are many sources other than the Tank Farms in the General Separations Area that could impact the same groundwater and surface water. These include the canyons, the old radioactive waste burial ground, and the Mixed Waste Management Facility. The commenter asked if these sources are all covered under the same 4 millirem/year performance objective.

Response: In the HLW tank closure process, DOE considers all other non-tank sources within the Groundwater Transport Segment (GTS) applicable to the Tank Farm tanks. The combined impacts of all sources in the GTS must be below the performance objective. [Section 5.7 of the EIS discusses the long-term impacts of non-tank sources.]

M-17: The commenter asked if there was a schedule for the Final EIS. The commenter asked if this Final EIS schedule would impact the schedule for closure of Tank 19.

Response: DOE intends to issue a Final EIS in October 2001 and a ROD by November 2001. This will not impact the Tank 19 closure schedule, which is required by the Federal Facility Agreement to be closed by Fiscal Year 2003. [This schedule was DOE's stated intention as of January 2001.]

M-18: The commenter asked for further description of saltstone. The commenter further asked if SRS has previously produced or disposed of any saltstone.

Response: Saltstone is a low-activity waste that is produced at SRS. It is an evaporated low-radioactivity waste, which is mixed with cement, slag, and fly ash to produce a grout. The grout, which contains large concentrations of nitrates, is then poured into concrete vaults. In this EIS, this material is being considered as a potential tank stabilization material. The SRS Saltstone Manufacturing and Disposal Facility began operations in 1990 and operated until 1998 (when it was shut down for lack of feed material). During this period, saltstone was emplaced into two saltstone disposal vaults. The current plan is for this facility to resume operations in 2002.

M-19: The commenter expressed a concern regarding the potential impacts that new SRS missions might have on the amount of HLW generated and stored in the Tank Farms. The commenter was concerned about how this additional waste could affect the HLW tank closure process. The commenter also asked about what tank closure activities have occurred since 1996.

Response: The HLW program utilizes a "High-Level Waste System Plan" to help plan and manage the operation of the Tank Farms, DWPF, and associated systems. This plan is updated annually and whenever there are major perturbations to the system. Included in this plan are the known influents to the HLW system. Potential impacts from new missions will be included in this planning document. This EIS considers alternatives for closure of empty HLW tanks; therefore, impacts of new HLW generation are not within the scope of this document. [Section 4.1.10.1 of this EIS does consider the potential impacts of tank closure alternatives on HLW volumes.]

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* 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*. 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 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.

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; some residual radioactivity will remain but, with rational judgement and prudent management, it is reasonable to expect all options will result in very low risks. Recommendations made by the Council 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.

M-20: The commenter made a statement that it is important to close the HLW tanks and the commenter is happy that DOE is making progress toward this goal.

Response: Comment noted.

M-21: The commenter stated that he recalled difficulty in removing waste from the tanks, particularly the saltcake material. The commenter inquired if the use of oxalic acid would be necessary to remove this material from the tanks.

Response: The salt portion of the waste is soluble and thus readily removed by water. The use of oxalic acid would only be required when removing insoluble materials (i.e., sludge) from the tanks. DOE anticipates that oxalic acid would be needed to clean tanks that contain the more radioactive first-cycle wastes (about three-fourths of the tanks).

M-22: The commenter stated that a factor affecting the tank closure process is operation of the DWPF. The commenter asked if DWPF was currently operating or if it was shut down.

Response: The DWPF is operating to process and vitrify the sludge component of the HLW. As of December 2000, DWPF had produced approximately 1,000 canisters of vitrified waste.

References

DOE (U.S. Department of Energy), 1995. *Final Environmental Impact Statement Waste Management,* DOE/EIS-0217, Savannah River Site, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1996. *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems*, Savannah River Operations Office, Aiken, South Carolina, July 10.

DOE (U.S. Department of Energy), 1997. *Regulatory Basis for Incidental Waste Classification at the Savannah River Site High-Level Waste Tank Farms,* Rev. 1, Savannah River Operations Office, Savannah River Site, Aiken, South Carolina, April 30.

National Research Council, 1999. *Alternative High-Level Waste Treatments at the Idaho National Engineering and Environmental Laboratory,* National Academy Press, Washington, D.C.