CHAPTER 3. AFFECTED ENVIRONMENT

The affected environment is the baseline for assessing potential impacts of the alternatives considered in this Draft Supplemental Environmental Impact Statement (SEIS). The information in this chapter comes primarily from the comprehensive environmental monitoring and surveillance programs that the U.S. Department of Energy (DOE) maintains at the Savannah River Site (SRS). DOE performs effluent monitoring and environmental surveillance within a 31,000-square-mile area surrounding the SRS (out to a distance of 100 miles from the Site boundary) that includes cities, towns, and counties in Georgia and South Carolina.

This chapter describes the following:

- Land use, biota, geology and soils, and cultural features of locations on the SRS that could host salt processing activities
- Site and regional ambient conditions for air, surface water, and groundwater
- Socioeconomic conditions of the counties and communities that compose the SRS region of influence, information on the location of minority and low-income populations, and projections of regional growth and related socioeconomic indicators.

In addition, this chapter presents information on existing facilities and the SRS infrastructure to provide a basis for an examination of the capacity of existing systems to handle projected waste streams, power and water requirements, and inter-area transportation.

As mentioned in Chapter 2, Section 2.5, DOE proposes to locate salt processing activities in either S Area or Z Area of SRS. S Area is approximately 270 acres and Z Area is about 180 acres. Both sites are within existing heavily industrialized zones. Regardless of where salt processing activities occur, grout disposal would be in vaults in Z Area.

Westinghouse Savannah River Company (WSRC) uses a formal, documented facility site selection process. Criteria include: proximity to existing, related facilities; sufficient acreage; and ecological, human health, geoscience and engineering considerations. Applying this process to the requirements for a salt processing facility identified four potential sites (Sites A – D; Figures 2-2 and 3-1) for Small Tank Precipitation, Ion Exchange, or Solvent Extraction facilities. Selection of the primary site was based on subsequent geotechnical characterization. The site in Z Area selected for the Direct Disposal in Grout facility was chosen because a grout-production facility that would be modified is located there. Z Area was selected as the saltstone disposal site prior to construction of the Defense Waste Processing Facility (DWPF) (DOE 1982).

The primary site (Site B in S Area; see Figure 2-2) for a Small Tank Precipitation, Ion Exchange, or Solvent Extraction facility is approximately 25 acres. It is 950 feet east-southeast of the DWPF and approximately 650 feet east of the Low Point Pump Pit between H Area and DWPF. The site was used as a lay-down area during construction of DWPF, and is situated along an eastward slope of a previously existing topographic high point. The land surface is flat, gently sloping, and covered with grass and gravel. The surface elevation is about 280 feet above mean sea level (msl) (Figure 3-1) (WSRC 1999a).

Z Area is partially developed and contains the Saltstone Manufacturing and Disposal Facility, two vaults, a paved parking area, a rail spur, and perimeter road. Surface elevation ranges from about 270 to 300 feet above msl (Figure 3-2). The land at the site for a Direct Disposal in Grout facility is presently mounded with excavated soils and covered with grass (Shedrow and Wike 1999). The site covers approximately 15 acres.

The remaining sections of this chapter characterize the SRS and its environs, as well as pertinent information on Site B in S Area and the Z-Area site. Chapter 4 describes potential impacts

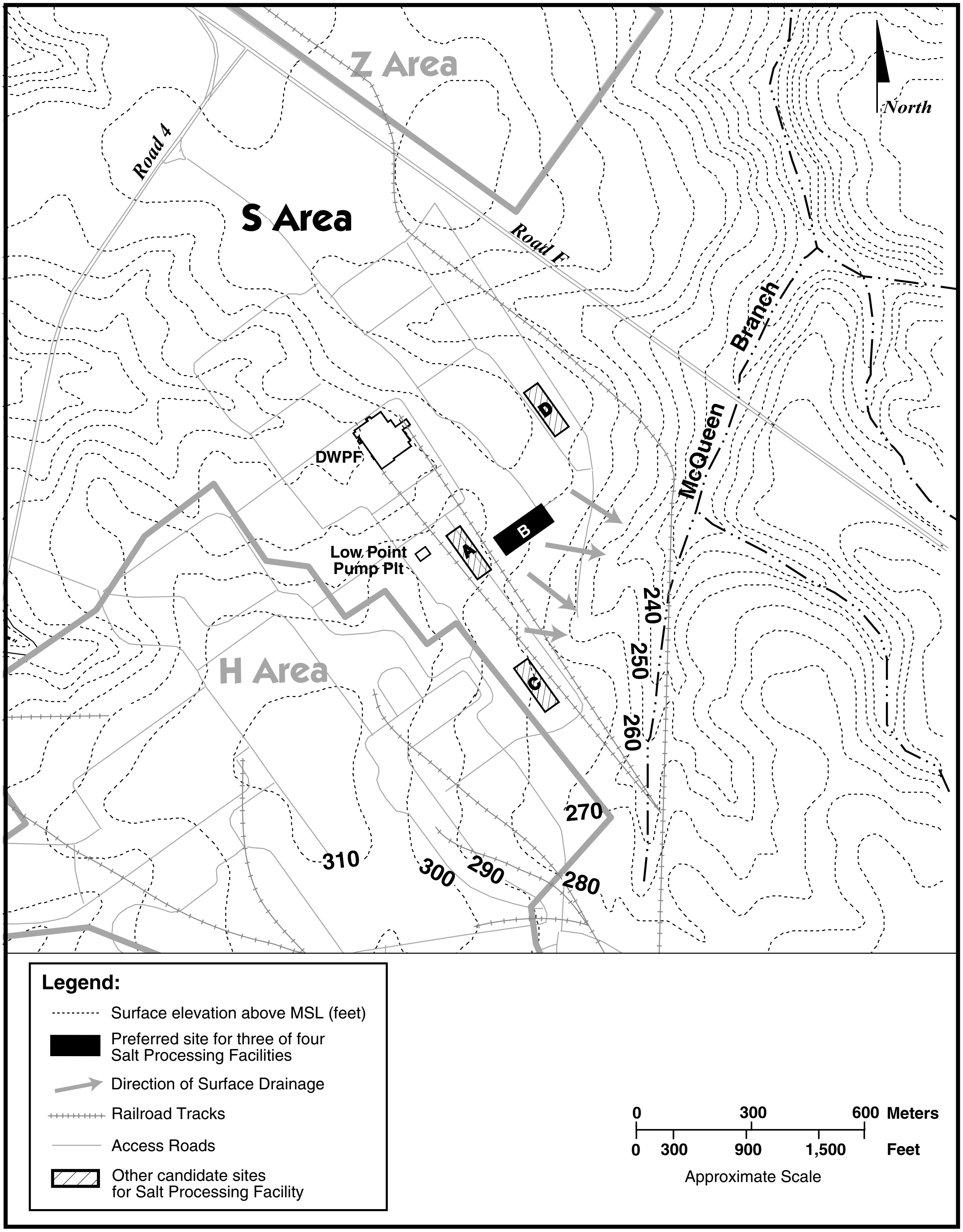

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Figure 3-1. Surface elevation and direction of surface drainage in the vicinity of S Area.

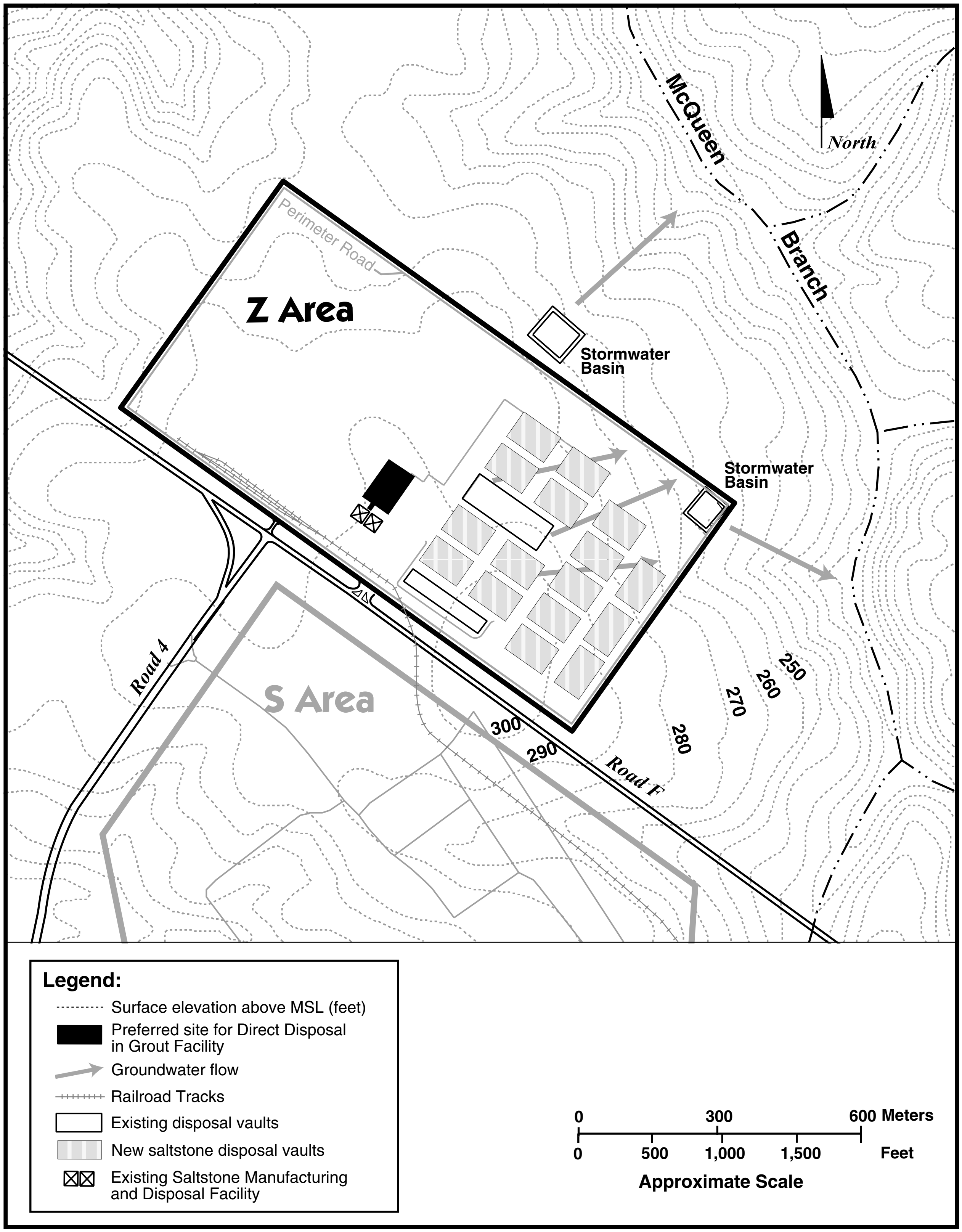

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Figure 3-2. Surface elevation and direction of surface drainage in the vicinity of Z Area.

of the No-Action alternative and the different alternatives for processing salt, including the impacts of constructing and operating processing facilities.

3.1 Geologic Setting and Seismicity

The SRS is in west-central South Carolina, approximately 100 miles from the Atlantic coast (Figure 3-3). 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 semiconsolidated sediments that extend from the Fall Line to the Continental Shelf. The Aiken Plateau is the subdivision of the Coastal Plain that includes SRS. Coastal Plain sediments underlying SRS consist of sandy clays and clayey sands, although occasional beds of clean sand, gravel, clay, or carbonate occur (DOE 1995a). The formations that must be considered in evaluating potential groundwater transport from S and Z Areas are part of the shallow (Floridan) aquifer system (Figure 3-4).

Surface soils at both Site B in S Area and the Z Area site are classified as Udorthents. The generic term Udorthents describes natural soil weathering horizons that have been disturbed or removed, usually by erosion or construction activities. These soils are generally well-drained and range from sandy to clayey, depending upon their origin. Dominant soil types in the undisturbed western portion of Z Area include Fuquay and Blanton soils, respectively, as shown on Figure 3-5 (USDA 1990).

3.1.2 SUBSURFACE FEATURES

A benchmark study of geophysical evidence (summarized by Wike et al. 1996) and an earlier study (Stephenson and Stieve 1992) identified the onsite geologic faults. Since these studies were published, new seismic reflection data have been acquired specifically for refinement of the fault map or in support of other characterization projects. In addition, several other relevant geologic studies relating to SRS basement geology have been completed. These studies resulted in the current map of subsurface faults shown on Figure 3-6. The lines on Figure 3-6 represent the location of the faults on the basement surface. The actual faults do not reach the surface, but stop several hundred feet below it.

Based on available information, none of the faults discussed in this section are capable, which means that none of the faults have moved at or near the ground surface within the past 35,000 years or are associated with another fault that has moved in the past 35,000 years. Appendix A of 10 CFR 100 contains a more detailed definition of a capable fault.

Rock strata under some areas of SRS include layers of pockets of carbonate rock that are subject to dissolution. Sites underlain by these "soft zones" are considered unsuitable for structural formations unless extensive soil stabilization is done. There are no carbonate soft zones underlying Site B (WSRC 1999a). Z Area data were not evaluated for soft zones.

3.1.3 SEISMICITY

Two major earthquakes have occurred within 186 miles of SRS.

- The Charleston, South Carolina, earthquake of 1886 had an estimated Richter magnitude of 6.6; it occurred approximately 90 miles from the SRS area, which experienced an estimated peak horizontal acceleration of 8 percent of gravity (0.08g) (Lee, Maryak, and McHood 1997). Lee, Maryak, and McHood (1997) re-evaluated historical data for the 1886 event and for other earthquakes in the Charleston area and determined that the Charleston epicentral zone could produce a magnitude 7.5 earthquake.

- As summarized by Geomatrix (1991), the Union County, South Carolina, earthquake of 1913 had an estimated magnitude of 4.5

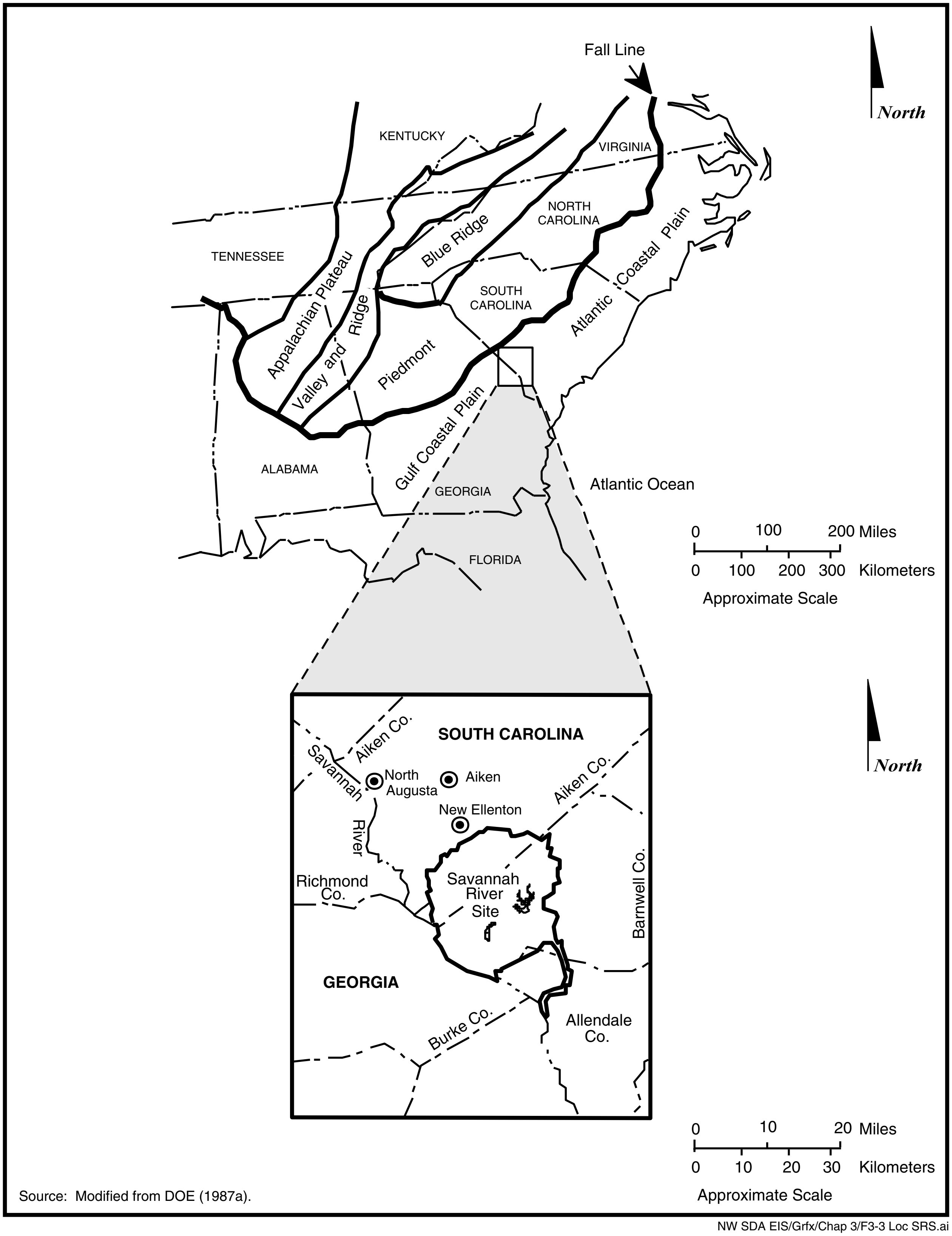
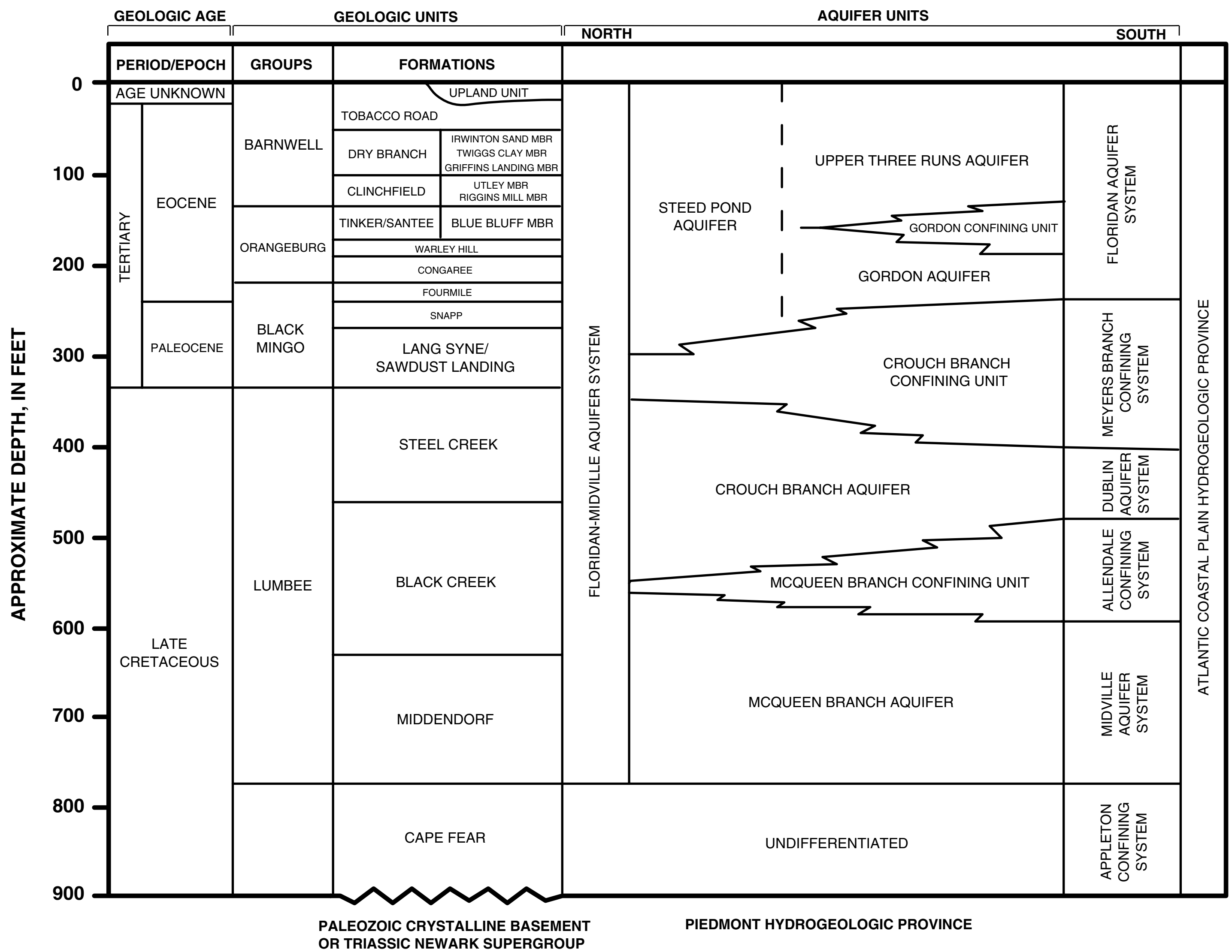


Figure 3-3. Generalized location of Savannah River Site and its relationship to physiographic provinces of southeastern United States.



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

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Figure 3-4. Generalized geologic and aquifer units in SRS region.

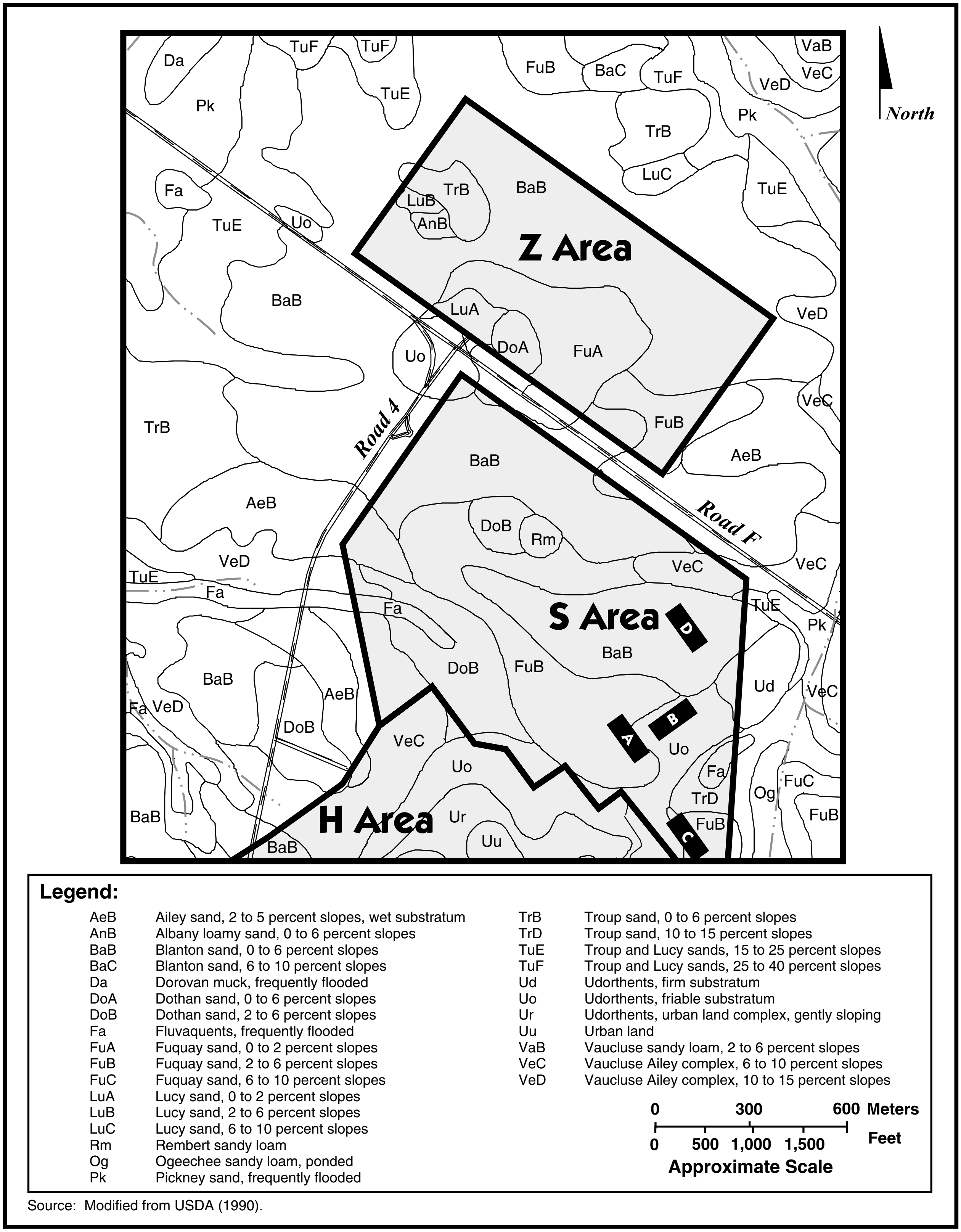

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Figure 3-5. Soil series in H, S, and Z areas.

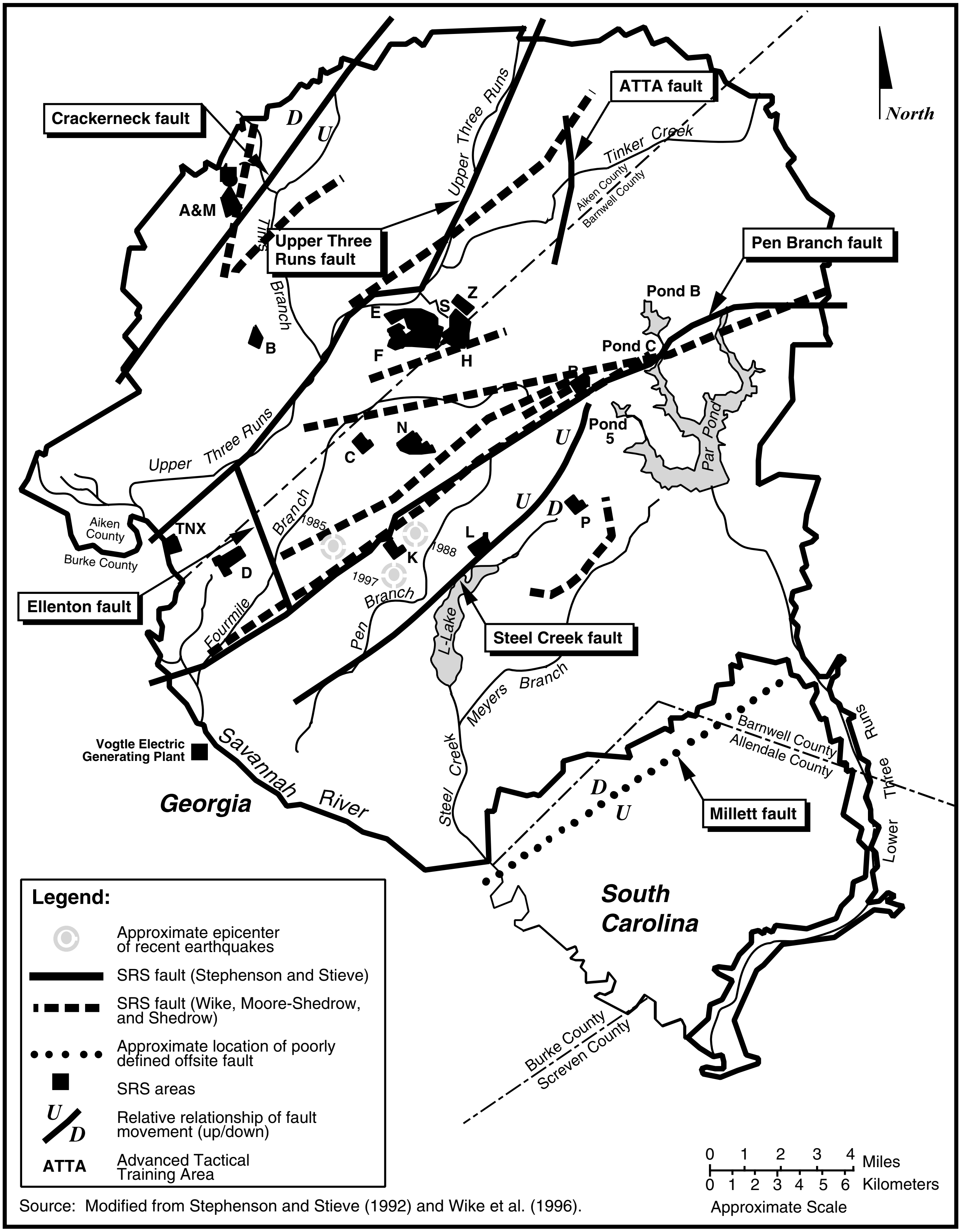

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Figure 3-6. Savannah River Site, showing fault lines and locations of onsite earthquakes and their year of occurrence.

and occurred 90 to 100 miles from SRS. The Union County earthquake is included in a group of historical epicenters that form a diffuse northwesterly trending zone from the Charleston region to the Appalachian tectonic province. Within that zone, Geomatrix (1991) concluded that an earthquake of up to magnitude 6.0 could theoretically occur.

In recent years, the following three earthquakes occurred inside the SRS boundary, as reported by local print media and cited in DOE (2000a):

- On May 17, 1997, with a Richter magnitude of 2.3 and a focal depth of 3.38 miles; its epicenter was southeast of K Area
- On August 5, 1988, with a Richter magnitude of 2.0 and a focal depth of 1.6 miles; its epicenter was northeast of K Area
- On June 8, 1985, with a Richter magnitude of 2.6 and a focal depth of 3.7 miles; its epicenter was south of C Area and west of K Area.

Existing information does not relate these earthquakes conclusively with known faults under the Site. In addition, the focal depth of these earthquakes is currently being reevaluated. Figure 3-6 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 (Aiken Standard 1993).

3.2 Water Resources

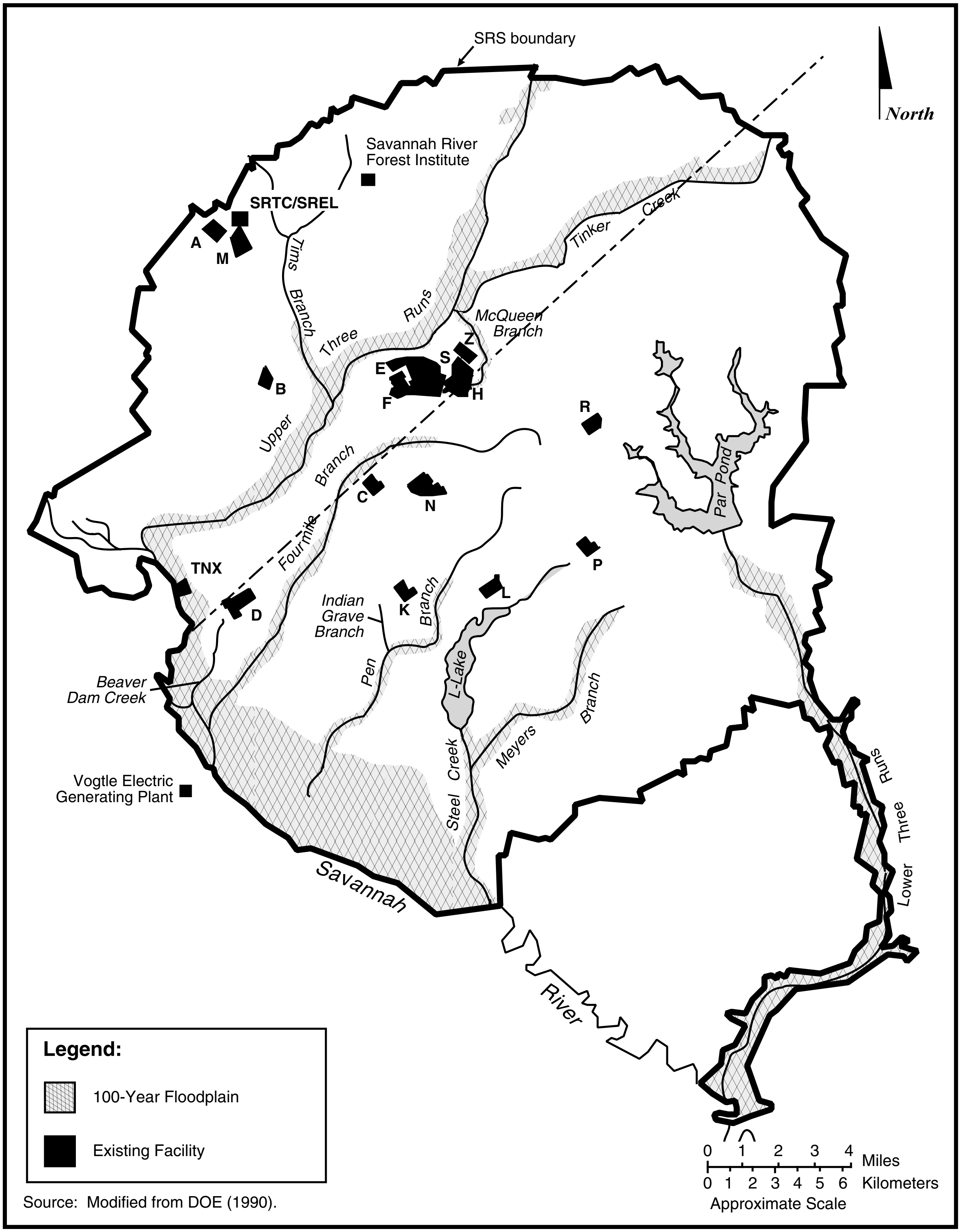
This section describes surface and subsurface water in the area potentially affected by the proposed action. Surface water and groundwater are characterized in terms of flow and quality (physical properties and concentrations of chemicals and contaminants).

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 – minimize the effects of droughts and the impacts of low flow on downstream water quality and fish and wildlife resources in the river. River flow averages about 10,000 cubic feet per second at SRS (DOE 1995b).

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 1995b).

The SRS streams that could be affected by the alternatives are blackwater streams, which means that the water has a dark coloration due to the dissolution of natural organic matter from soils and decaying vegetation. Three SRS streams potentially could be affected by construction and operation of salt processing facilities in S Area or Z Area: McQueen Branch, Upper Three Runs, and Fourmile Branch (Figure 3-7). Of the three, only Fourmile Branch ever received the high flows and elevated temperatures associated with thermal discharges from nuclear reactors. McQueen Branch, which lies east of the proposed facilities, receives surface runoff from both proposed sites (Figures 3-1 and 3-2) and potentially could be affected by land-disturbing construction activities. Process wastewater from salt processing operations would be treated in the Effluent Treatment Facility (ETF) and discharged to Upper Three Runs via National Pollutant Discharge Elimination System (NPDES) outfall H-16. Sanitary wastewater from salt processing facilities would be treated in the Centralized Sanitary Wastewater Treatment Facility and discharged to Fourmile Branch via NPDES outfall G-10 (WSRC 1999b).



NW SDA EIS/Grfx/F3-7100 yr flood.ai

Figure 3-7. Savannah River Site, showing 100-year floodplain and major stream systems.

McQueen Branch flows approximately 3 miles from its headwaters east of H Area to its confluence with Tinker Creek (see Figure 3-7). Tinker Creek flows west for several hundred feet before entering Upper Three Runs, approximately 1 mile north of Z Area. McQueen Branch is a shallow blackwater stream with an average width of approximately 6 feet. For most of its length, it lies in a bottomland hardwood forest.

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 creek 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 from nuclear reactors; however, it does receive NPDES-permitted wastewater discharges from other SRS facilities (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 drains an area of about 22 square miles, including much of F, H, and C Areas. In its lower reaches, Fourmile Branch broadens and flows via braided channels through a delta formed by the disposition of sediments eroded form upstream during high flows associated with reactor operations. 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 1995b).

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 *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) contain detailed information on flow rates and water quality of the Savannah River and SRS streams.

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 NPDES program. A comparison of 1997 Savannah River water quality analyses showed no significant differences between stations up- and down-stream of SRS (Arnett and Mamatey 1998a). Table 3-1 summarizes the water quality of Fourmile Branch and Upper Three Runs for 1997. Occasionally, reported concentrations in Table 3-1 exceed water quality criterion (see, for example, aluminum). An exceedance suggests the potential for adverse effects to aquatic biota, but should not be construed as an actual risk. Water quality criteria are based on laboratory studies that do not take into account site-specific ameliorative or mediating factors in the environment that reduce or limit the bioavailability of a chemical. Concentrations that exceed water quality criteria may have natural or anthropogenic origins.

In 1997, major releases of radionuclides from the SRS to surface waters amounted to 8,950 curies of tritium, 0.262 curie of strontium-89 and -90, and 0.177 curie of cesium-137 (Arnett and Mamatey 1998b). Table 3-2 lists radioactive liquid releases by source for 1997; Table 3-3 lists radioactive liquid releases by outfall or facility and compares annual average radionuclide concentrations to DOE concentration guides. Figure 3-8 shows outfall and facility locations for radioactive surveillance. The resulting dose to a downriver consumer of river water from radionuclides released from the Site was less than 2 percent of the U.S. Environmental Protection Agency (EPA) and DOE standards for public water supplies (40 CFR Part 141 and DOE Order 5400.5, respectively) and less than 0.1 percent of the DOE dose standard from all pathways (DOE 1990; Arnett and Mamatey 1998b). Table 3-4 lists potential contributors of contamination to Upper Three Runs and Fourmile Branch.

Table 3-1. SRS stream water quality (onsite downstream locations).

Parameter[a]	Units	Upper Three Runs (U3R-4) (average)	Water Quality Standard[b]
Aluminum	mg/L	0.274[c]	0.087
Cadmium	mg/L	ND[d]	0.00066
Calcium	mg/L	1.62	NA[e]
Cesium-137	pCi/L	0.67	120[d]
Chromium	mg/L	ND	0.011
Copper	mg/L	0.036[c]	0.0065
Dissolved oxygen	mg/L	8.2	≥5
Iron	mg/L	0.586	1
Lead	mg/L	ND	0.0013
Magnesium	mg/L	0.385[c]	0.3
Manganese	mg/L	0.026	1
Mercury	mg/L	ND	0.000012
Nickel	mg/L	0.012	0.088
Nitrate	mg/L	0.24	10[f]
pH	pH	6.3	6-8.5
Plutonium-238	pCi/L	ND	1.6[g]
Plutonium-239	pCi/L	0.0005	1.2[g]
Sodium	mg/L	1.58	NA
Strontium-89,90	pCi/L	0.061	8[f]
Suspended solids	mg/L	14.1	NA
Temperature[h]	°C	17.3	32.2
Total dissolved solids	mg/L	36	500[i]
Tritium	pCi/L	4.260	20,000[f]
Uranium-234	pCi/L	0.093	20[g]
Uranium-235	pCi/L	0.046	24[g]
Uranium-238	pCi/L	0.110	24[g]
Zinc	mg/L	0.028	0.059

Source: Arnett and Mamatey (1998a).

a. Parameters DOE routinely measures as a regulatory requirement or as part of ongoing monitoring programs.
b. Water Quality Criteria for aquatic life unless otherwise indicated.
c. Concentration exceeded WQC; however, these criteria are for comparison only. WQCs are not legally enforceable.
d. ND = Not detected.
e. NA = Not applicable.
f. MCL = Maximum Contaminant Level; State Primary Drinking Water Regulations.
g. 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.
h. 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.
i. Secondary MCL; State Drinking Water Regulations.

Table 3-2. Annual liquid releases by source for 1997 (including direct and seepage basin migration releases).

		Curies					
Radionuclide[a]	Half-life (years)	Reactors	Separations[b]	Reactor materials	TNX	SRTC	Total
H-3 (oxide)	12.3	2.91×10^{3}	5.24×10^{3}		4.02×10^{2}	1.82	8.55×10^{3}
Sr-89,90[c]	29.1	6.46×10^{-2}	1.40×10^{-1}		5.09×10^{-3}	4.10×10^{-3}	2.14×10^{-1}
I-129[d]	1.6×10^{7}		7.82×10^{-2}				7.82×10^{-2}
Cs-137	30.2	2.86×10^{-3}	4.49×10^{-2}				4.78×10^{-2}
U-234	2.46×10^{5}	4.45×10^{-3}	2.30×10^{-2}	2.68×10^{-5}	1.52×10^{-6}	1.06×10^{-4}	2.76×10^{-2}
U-235	7.04×10^{8}	4.91×10^{-5}	7.23×10^{-4}		1.37×10^{-7}	3.44×10^{-6}	7.76×10^{-4}
U-238	4.47×10^{9}	3.83×10^{-3}	2.57×10^{-2}	5.71×10^{-5}	9.19×10^{-6}	1.11×10^{-4}	2.97×10^{-2}
38	87.7	4.24×10^{-5}	9.57×10^{-4}		7.68×10^{-7}	1.78×10^{-6}	1.00×10^{-3}
Pu-239[d]	24,100	1.10×10^{-2}	3.39×10^{-2}	1.14×10^{-3}	1.12×10^{-3}	3.38×10^{-3}	5.05×10^{-2}
Am-241	432.7		7.81×10^{-6}	2.11×10^{-6}			9.92×10^{-6}
Cm-244	18.1		2.93×10^{-6}	4.14×10^{-7}			3.34×10^{-6}

Notes: Blank spaces indicate no quantifiable activity.
Source: Arnett and Mamatey (1998a).
a. H = hydrogen (H-3 = tritium), Sr = strontium, I = iodine, Cs = cesium, U = uranium, Pu = plutonium, Am = americium, Cm = curium.
b. Includes separations, waste management, and tritium facilities.
c. Includes unidentified beta.
d. Includes unidentified alpha.
TNX = a technology development facility adjacent to the Savannah River.
SRTC = Savannah River Technology Center.

3.2.2 GROUNDWATER RESOURCES

3.2.2.1 Groundwater Features

In the SRS region, the subsurface contains two hydrogeologic provinces. The uppermost, consisting of a wedge of unconsolidated Coastal Plain sediments of Late Cretaceous and Tertiary age, is the Atlantic Coastal Plain hydrogeologic province. Beneath the sediments of the Atlantic Coastal Plain hydrogeologic province are rocks of the Piedmont hydrogeologic province. These rocks consist of Paleozoic igneous and metamorphic basement rocks and Upper Triassic Age lithified mudstone, sandstone, and conglomerates of the Upper Triassic Dunbarton basin. Sediments of the Atlantic Coastal Plain hydrogeologic province are divided into three aquifer systems: the Floridan Aquifer System, the Dublin Aquifer System, and the Midville Aquifer System as shown in Figure 3-4 (Aadland, Gellici, and Thayer 1995). The Meyers Branch Confining System and/or the Allendale Confining System, as shown in Figure 3-4, separate the aquifer systems.

Groundwater within the Floridan System (the shallow aquifer beneath the Site) flows slowly toward SRS streams and swamps and into the Savannah River. The depth to which onsite streams cut into soils, the lithology of the soils, and the orientation of the soil 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.

Groundwater flow in the shallow (Floridan) aquifer system is generally horizontal, but does have a vertical component. In divide areas between surface-water drainages, the vertical component of the hydraulic gradient typically is

Table 3-3. Liquid radioactive releases by outfall/facility and comparison of annual average radionuclide concentrations to DOE derived concentration guides.[b]

Outfall or Facility	Radionuclide[a]	Quantity of Radionuclides Released during 1997 (curies)	Average Effluent Concentration during 1997 (microcuries per milliliter)	DOE DCGs[b] (microcuries per milliliter)
F Area (Separations and Waste Management)				
F-01	H-3	5.03×10^{-2}	2.54×10^{-7}	2.00×10^{-3}
	Sr-89,90	Below MDL[d]	1.02×10^{-11}	1.00×10^{-6}
	Cs-137	Below MDL	1.32×10^{-9}	3.00×10^{-6}
F-012 (281-8F Retention Basin)	H-3	7.6710^{-1}	9.83×10^{-6}	2.00×10^{-3}
	Sr-89,90	Below MDL	3.01×10^{-9}	1.00×10^{-6}
	Cs-137	1.58×10^{-3}	2.07×10^{-8}	3.00×10^{-6}
F-013 (200-F Cooling Basin)	H-3	1.73×10^{-2}	1.63×10^{-6}	2.00×10^{-3}
	Sr-89,90	3.13×10^{-5}	4.39×10^{-9}	1.00×10^{-6}
	Cs-137	5.92×10^{-4}	2.30×10^{-8}	3.00×10^{-6}
Fourmile Branch-3 (F-Area Effluent)	H-3	1.32	7.80×10^{-7}	2.00×10^{-3}
	Sr-89,90	Below MDL	4.16×10^{-10}	1.00×10^{-6}
	Cs-137	Below MDL	8.97×10^{-10}	3.00×10^{-6}
Upper Three Runs-2 (F Storm Sewer)	H-3	1.66×10^{-1}	8.78×10^{-7}	2.00×10^{-3}
	Sr-89,90	Below MDL	8.56×10^{-11}	1.00×10^{-6}
	Cs-137	Below MDL	5.13×10^{-10}	3.00×10^{-6}
	U-234	6.86×10^{-5}	3.48×10^{-10}	6.00×10^{-7}
	U-235	5.15×10^{-6}	3.02×10^{-11}	6.00×10^{-7}
	U-238	1.90×10^{-4}	9.15×10^{-10}	6.00×10^{-7}
	Pu-238	1.54×10^{-5}	9.10×10^{-11}	4.00×10^{-8}
	Pu-239	7.73×10^{-6}	4.66×10^{-11}	3.00×10^{-8}
	Am-241	7.77×10^{-6}	3.98×10^{-11}	3.00×10^{-8}
	Cm-244	2.92×10^{-6}	1.74×10^{-11}	6.00×10^{-8}
Upper Three Runs F-3 (Naval Fuel Effluent)	H-3	3.45×10^{-2}	1.46×10^{-6}	2.00×10^{-3}
	Sr-89,90	Below MDL	1.16×10^{-10}	1.00×10^{-6}
	Cs-137	Below MDL	2.47×10^{-10}	3.00×10^{-6}
	U-234	1.62×10^{-5}	8.95×10^{-10}	6.00×10^{-7}
	U-235	5.86×10^{-6}	2.30×10^{-9}	6.00×10^{-7}
	U-238	3.04×10^{-6}	1.76×10^{-10}	6.00×10^{-7}
	Pu-238	1.61×10^{-7}	6.23×10^{-12}	4.00×10^{-8}
	Pu-239	2.60×10^{-8}	5.04×10^{-12}	3.00×10^{-8}
	Am-241	4.49×10^{-8}	7.07×10^{-13}	3.00×10^{-8}
	Cm-244	9.54×10^{-9}	-6.84×10^{-11}	6.00×10^{-8}
H Area (Separations and Waste Management)				
Fourmile Branch-1C (H-Area Effluent)	H-3	3.85	9.22×10^{-6}	2.00×10^{-3}
	Sr-89,90	7.93×10^{-5}	7.05×10^{-10}	1.00×10^{-6}
	Cs-137	6.77×10^{-4}	3.27×10^{-9}	3.00×10^{-6}
H-017 (281-8H Retention Basin)	H-3	7.17×10^{-1}	1.02×10^{-5}	2.00×10^{-3}
	Sr-89,90	5.21×10^{-4}	7.91×10^{-9}	1.00×10^{-6}
	Cs-137	1.04×10^{-2}	1.11×10^{-7}	3.00×10^{-6}

Table 3-3. (Continued).

Outfall or Facility	Radionuclide[a]	Quantity of Radionuclides Released during 1997 (curies)	Average Effluent Concentration during 1997 (microcuries per milliliter)	DOE DCGs[b] (microcuries per milliliter)
H-018 (200-H Cooling Basin)	H-3	1.44×10^{-1}	2.27×10^{-5}	2.00×10^{-3}
	Sr-89,90	2.75×10^{-4}	4.58×10^{-8}	1.00×10^{-6}
	Cs-137	2.21×10^{-4}	3.71×10^{-7}	3.00×10^{-6}
HP-15 (Tritium Facility Outfall)	H-3	1.74	1.55×10^{-5}	2.00×10^{-3}
	Cs-137	Below MDL	7.75×10^{-11}	3.00×10^{-6}
HP-52 (H-Area Tank Farm)	H-3	2.43	1.30×10^{-6}	2.00×10^{-3}
	SR-89,90	Below MDL	7.67×10^{-11}	1.00×10^{-6}
	Cs-137	1.58×10^{-4}	1.92×10^{-9}	3.00×10^{-6}
McQueen Branch at Road F	H-3	1.20×10^{1}	1.05×10^{-5}	2.00×10^{-3}
	Cs-137	Below MDL	4.85×10^{-10}	3.00×10^{-6}
Upper Three Runs – 2A (Effluent Treatment Facility Outfall at Rd C)	H-3	3.82×10^{2}	4.72×10^{-3}	2.00×10^{-3}
	Sr-89,90	1.28×10^{-5}	2.24×10^{-9}	1.00×10^{-6}
	Cs-137	1.79×10^{-2}	2.16×10^{-7}	3.00×10^{-6}
S Area	H-3	9.18×10^{-1}	1.57×10^{-5}	2.0×10^{-3}
S-004 (Defense Waste Processing Facility)	Sr-89,90	2.98×10^{-6}	1.43×10^{-10}	1.00×10^{-6}
	Cs-137	Below MDL	6.30×10^{-10}	3.00×10^{-6}
	U-234	2.63×10^{-7}	1.74×10^{-11}	6.00×10^{-7}
	U-238	7.80×10^{-7}	3.13×10^{-11}	6.00×10^{-7}
	Pu-238	1.17×10^{-7}	7.08×10^{-13}	4.00×10^{-8}
	Pu-239	6.15×10^{-8}	2.79×10^{-12}	3.0×10^{-8}

Notes: MDL denotes "minimum detectable level."
Source: Arnett and Mamatey (1998a).
a. H = hydrogen (H-3 = tritium), Sr = strontium, I = iodine, Cs = cesium, U = uranium, Pu = plutonium, Am = americium, Cm = curium.
b. DCG = Derived Concentration Guide. Source: DOE Order 5400.5. In cases where different chemical forms have different DCGs, the lowest DCG for the radionuclide is given. DCGs are defined as the concentration of that radionuclide that will give a 50-year committed effective dose equivalent of 100 mrem under conditions of continuous exposure for one year. DCGs are reference values only and are not considered release limits or standards.

downward. In the lower reaches of streams, groundwater again moves generally in a horizontal direction, but may have an upward vertical component.

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. For example, to the south of H Area, Fourmile Branch cuts into the Upper Three Runs Aquifer, but does not cut into the Gordon Aquifer; the hydraulic head is greater in the Gordon Aquifer than in the overlying Upper Three Runs Aquifer. At such a location, contaminants in the overlying aquifer system would be prevented from migrating into deeper aquifers by the upward hydraulic gradient.

Shallow groundwater flow in S and Z Areas is to the southwest toward Crouch Branch, to the northeast toward McQueen Branch, and to the northwest toward Upper Three Runs. Northwest-flowing Crouch and McQueen Branches are tributaries to Upper Three Runs, which flows southwest to the Savannah River. Groundwater flow in deeper aquifers (e.g., Crouch Branch and McQueen Branch Aquifers) is generally to the southwest. Thus, at some depth there is a reversal of flow from that of the shallow aquifers.

Based on data in the SRS groundwater geochemical database, no groundwater plumes are

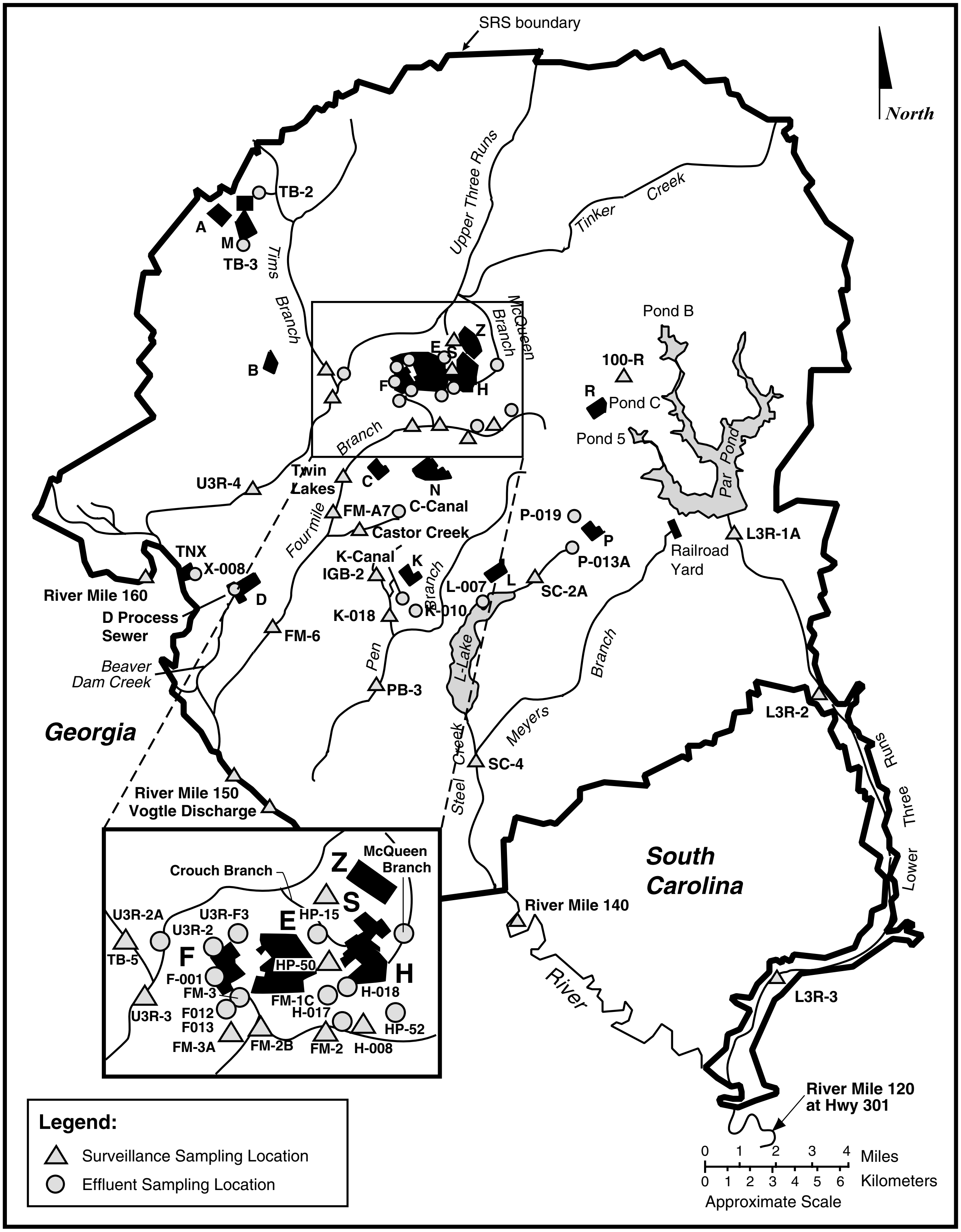


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Figure 3-8. Radiological surface water sampling locations.

Table 3-4. Potential F and H Area contributors of contamination to Upper Three Runs and Fourmile Branch.

Fourmile Branch Watershed	Upper Three Runs Watershed
Burial Ground Complex Groundwater[a]	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	

Source: WSRC (1996)
a. Units located in more than one watershed.

mapped as emanating from S- or Z-Area sources. However, a preliminary review of groundwater monitoring data for S Area indicates tritium contamination in one monitoring well. The contamination is likely from the tritium facility in H Area. This well is located just south of Site B. No tritium contamination was noted in groundwater monitoring data for Z Area. Within the immediate vicinity of Site B in S Area, depth to the water table averages approximately 45 feet below grade. Groundwater flow in the area is to the northeast to McQueen Branch (Figure 3-9). At the Z-Area site, average depth to the water table ranges from 70 to 60 feet. Groundwater flow below the subject site is to the northeast toward McQueen Branch (Figure 3-10).

3.2.2.2 Groundwater Use

At SRS, most groundwater production for domestic and process water comes from the intermediate/deep aquifers (i.e., the Crouch Branch and McQueen Branch Aquifers). A few lower-capacity domestic water wells pump from the shallower Gordon (Congaree) Aquifer and the lower zone of the Upper Three Runs (Barnwell-McBean) Aquifer. These wells are located in outlying areas, away from the main operations areas including guard barricades and operations offices/laboratories (DOE 1998a).

Domestic water requirements for the General Separations Area (an area that includes S and Z Areas) are supplied from groundwater wells located in A Area (Arnett and Mamatey 1998b).

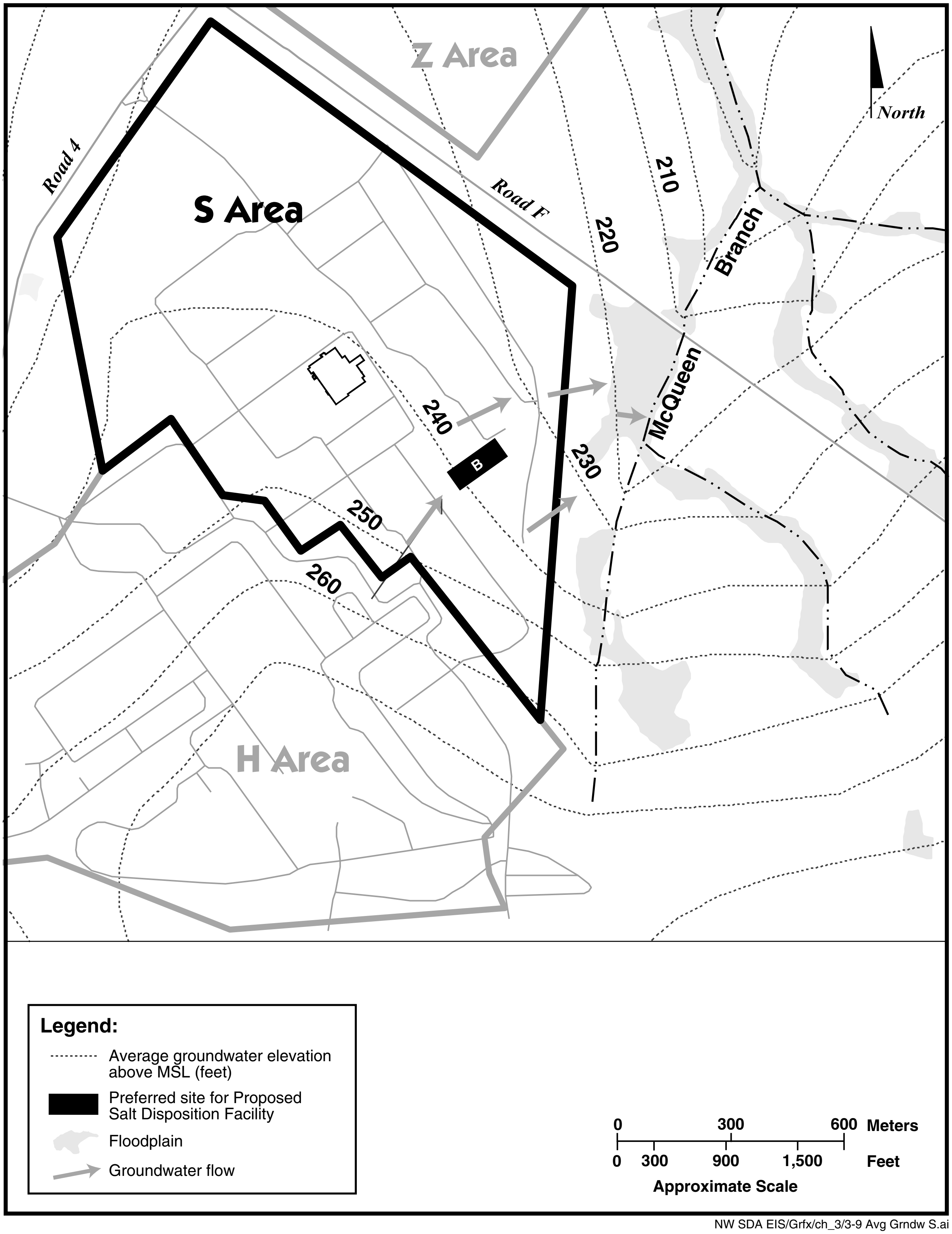

Figure 3-9. Average groundwater elevation and direction of flow in the vicinity of S Area.

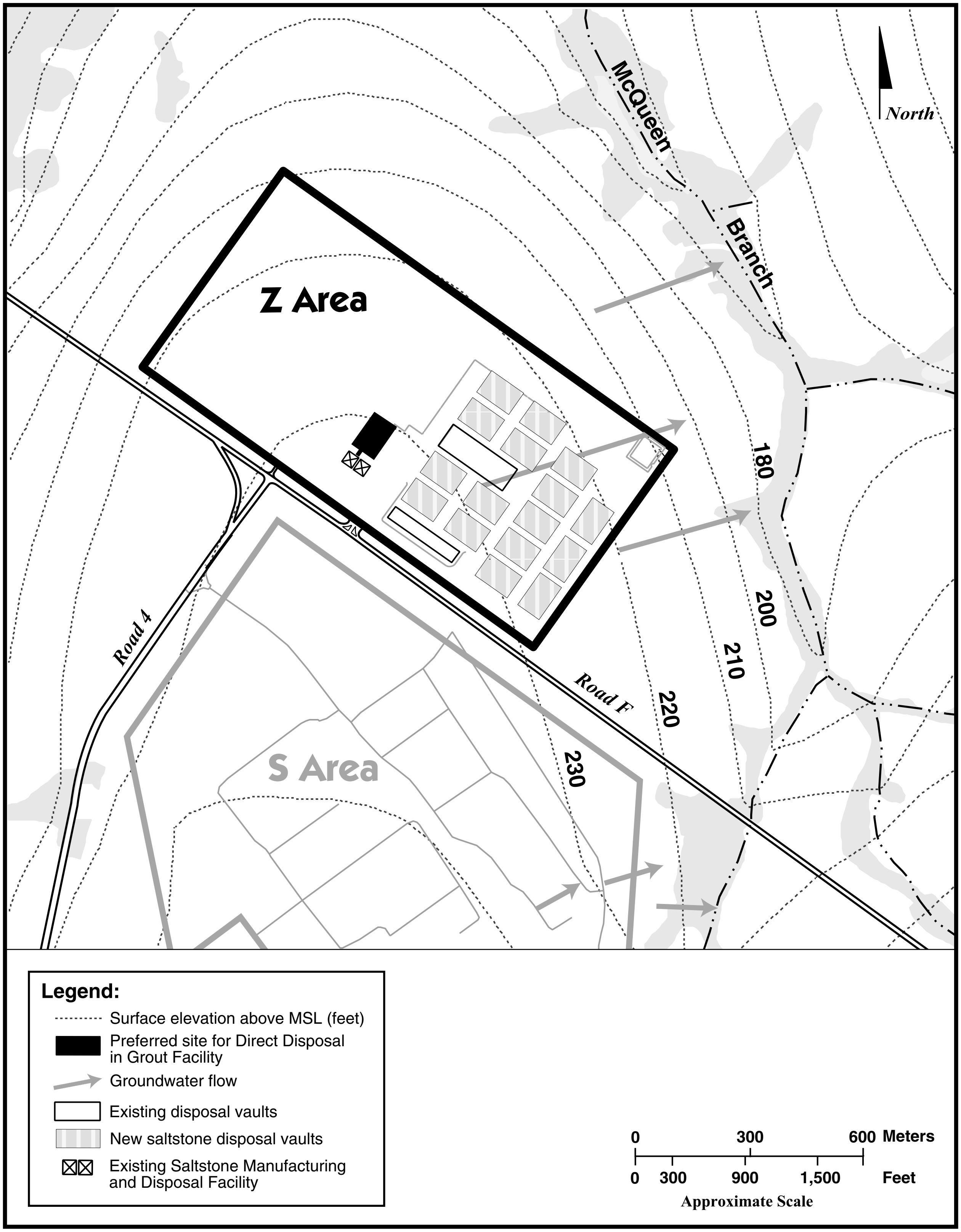

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Figure 3-10. Average groundwater elevation and direction of groundwater flow in vicinity of Z Area.

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 2.086 million gallons per day. These wells are installed in the deeper Cretaceous aquifers. During 1998, 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 1999b). S Area's groundwater production is three process/former domestic wells (WSRC 1995a).

3.2.2.3 Hydrogeology

The aquifers of primary interest for H, S, and Z Areas are the Upper Three Runs and Gordon Aquifers. The Upper Three Runs Aquifer includes the Tinker/Santee Formation, the Dry Branch Formation, and the Tobacco Road Formation. Table 3-5 provides descriptions of the lithologic and hydrologic characteristics of these formations. The Twiggs Clay Member of the Dry Branch Formation locally acts as a confining unit (colloquially known as the "tan clay") that separates the Upper Three Runs Aquifer into an upper and a lower zone. Averages of various types of field tests for horizontal hydraulic conductivity of the upper zone of the Upper Three Runs Aquifer ranges from 0.7 to 13 feet per day. Comparable ranges of horizontal hydraulic conductivity of the lower zone of the Upper Three Runs Aquifer are approximately 0.9 to 33.3 feet per day, although the overall average is about one-half that of the upper zone (Aadland, Gellici, and Thayer 1995). The vertical hydraulic conductivity of the Upper Three Runs Aquifer (upper and lower zones) is understood to be less than the horizontal.

The Gordon Confining unit (colloquially the "green clay") that separates the Upper Three Runs and Gordon Aquifers consists of the Warley Hill Formation and the Blue Bluff Member of the Santee Limestone. It is not a continuous unit, but consists of overlapping lenses of clay that thicken, thin, and pinch out. Beds of calcareous mud (Blue Bluff Member of the Santee Formation) locally add to the thickness of the unit (Aadland, Gellici, and Thayer 1995).

The Gordon Aquifer consists of the Congaree, Fourmile, and Snapp Formations. Table 3-5 provides lithologic and hydrologic soil descriptions of these formations. The Gordon Aquifer is partly eroded near the Savannah River and along Upper Three Runs. This aquifer is recharged directly by precipitation in outcrop areas, at inter-stream divides in and near outcrop areas, and by leakage from overlying and underlying aquifers. Average field tests for horizontal hydraulic conductivity range between approximately 5 and 35 feet per day (Aadland, Gellici, and Thayer 1995). The vertical hydraulic conductivity is less than the horizontal.

3.2.2.4 Groundwater Quality

Most contaminated groundwater at SRS occurs beneath a few facilities; the contaminants reflect the operations and chemical processes performed at those facilities. In the H, S, and Z Areas, contaminants above regulatory and DOE guidelines include tritium and other radionuclides, metals, nitrates, sulfates, and chlorinated and volatile organics.

Tables 3-6 through 3-8 list concentrations of individual analytes above regulatory or SRS guidelines for the period from fourth quarter 1997 through third quarter 1998 for H, S, and Z Areas, respectively (WSRC 1997a; WSRC 1998a,b,c).

3.3 Air Resources

3.3.1 METEOROLOGY

The southeastern United States has a humid subtropical climate characterized by relatively short, mild winters and long, warm, 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 and evening thunderstorms.

Table 3-5. Soil formations of the Floridan aquifer system in F and H Areas.

Aquifer Unit	Formation	Description
Upper Three Runs Aquifer (formerly Water Table and Barnwell/McBean Aquifers)	"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
	Dry Branch Formation	Variably colored, poorly sorted to well-sorted sand with interbedded tan to gray clay
	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 gravely, 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 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, the 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.

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

Table 3-6. H Area maximum reported groundwater parameters in excess of regulatory and SRS limits.

Analyte	Concentration	Regulatory limit
Aluminum[a]	13,000 μg/L[b]	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[b]	1.5×10^{-8} μCi/mL[d]
Iodine-129	1.09×10^{-7} μCi/mL	1.0×10^{-9} μCi/mL[e]
Iron[a]	17,100 μg/L	300 μg/L[c]
Lead[a]	417 μg/L	50 μg/L[f]
Manganese[a]	1,650 μg/L	50 μg/L[c]
Mercury[a]	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]
Phosphate	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[a]	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[a]	139 μg/L	133 μg/L[h]

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

Table 3-7. S Area maximum reported groundwater parameters in excess of regulatory and SRS limits.

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

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

Table 3-8. Z Area maximum reported groundwater parameters in excess of regulatory and SRS limits.

Analyte	Concentration	Regulatory limit
Gross alpha	9.77×10^{-8} µCi/mL[a]	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. µCi/mL = microcuries per milliliter.
b. EPA Final Primary Drinking Water Standards (WSRC 1997a; 1998a,b,c).
c. EPA Interim Final Primary Drinking Water Standard (WSRC 1997a; 1998a,b,c).
d. Radium-226, 228 combined proposed Maximum Contaminant Level of 5.0×10^{-8} microcuries per milliliter.

The influence of the Bermuda high starts to diminish during the fall, resulting in lower humidity and more moderate temperatures. Average seasonal rainfall is usually lowest during the fall.

During the winter months, weather conditions frequently tend to alternate between warm, moist, subtropical air from the Gulf of Mexico region and cool, dry polar air. Measurable snowfall is rare.

Spring is characterized by a higher frequency of tornadoes and severe thunderstorms than the other seasons. Spring weather is somewhat windy, with mild temperatures and relatively low humidity.

3.3.1.1 Local Climatology

Data collection sources 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), and seven meteorological towers (winds and atmospheric stability).

The average annual temperature at SRS is 64.7°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 extremes recorded at SRS since 1961 range from a maximum of 107°F in July 1986 to -3°F in January 1985.

Annual precipitation at SRS 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.

The observed wind at SRS indicates no prevailing wind direction, 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 northeast sector (9.7 percent) followed by winds from the north-northeast sector (9.4 percent) (Arnett and Mamatey 1998b). Measurements of air 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 1999a).

3.3.1.2 Severe Weather

An average of 54 thunderstorm days per year were recorded by the National Weather Service in Augusta, Georgia, between 1950 and 1996. About half of the annual 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, one of which was 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 low-intensity tornado striking SRS is 2×10^{-4} times per year or about once every 5,000 years (Weber et al. 1998). A tornado of this frequency would have a maximum wind speed (three-second gust) of 45 miles per hour. Similarly a tornado with a maximum wind speed of 120 miles per hour would occur approximately once every 25,000 years.

The highest sustained wind recorded by the Augusta National Weather Service Office is 82 miles per hour. Hurricanes 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 74 miles per hour or greater 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). 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 micrometers 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. The PSD regulations provide a framework for managing 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. There are no Class I areas within 62 miles of SRS.

SCDHEC has been delegated the 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: total suspended particulates (TSP) and gaseous fluorides (as hydrogen fluoride, HF). SCDHEC Standard 7 implements the PSD limits. In addition, SCDHEC Standard 8 establishes ambient standards for 256 toxic air pollutants. The ambient limits found under Standards 2 and 8 are enforceable at or beyond the Site boundary.

The EPA promulgated new standards for ground-level ozone and particulate matter, that became effective on September 16, 1997 (62 FR 138). However, on May 14, 1999, in response to challenges filed by industry and others, a three-judge panel from the U.S. Court of Appeals for the District of Columbia Circuit issued a split opinion (2 to 1) directing EPA to develop a new particulate matter standard (meanwhile reverting back to the previous PM_{10} standard) and ruling that the new ozone standard "cannot be enforced" (EPA 1999). The full (11-member) Court revised the decision of the panel somewhat, but did not take action to render the proposed new standards enforceable. The EPA has asked the U.S. Department of Justice to appeal this decision and the U.S. Supreme Court has decided the case and upheld the decision. Therefore, it is uncertain at this time when new ozone and particulate matter standards will become enforceable.

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 County and Barnwell County, South Carolina, are summarized in Table 3-9. These data indicate that ambient concentrations of the measured criteria pollutants are generally much less than the standard.

Significant sources of criteria and toxic air pollutants at SRS include coal-fired boilers for power and steam production, diesel generators, chemical storage tanks, 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 3-10 shows the actual atmospheric emissions from all SRS sources in 1997.

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 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. Table 3-11 provides a summary of the most recent regulatory compliance modeling for SRS emissions. These calculations were performed with EPA's Industrial Source Complex air dispersion model and site-wide maximum potential emissions data from the 1998 air emissions inventory. Model estimates of ambient SRS boundary concentrations for all air pollutants emitted at SRS are less than their respective ambient standards.

3.3.2.2 Radiological Air Quality

In the SRS region, airborne radionuclides originate from natural sources (i.e., terrestrial and cosmic), 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 1998b).

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 3-12 lists 1997 radionuclide releases from each major operational group of SRS facilities. All radiological impacts are within regulatory requirements.

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 (mrem) 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 the CAP88 computer code. The dose to the MEI from 1997 SRS emissions was estimated at 0.05 mrem which is 0.5 percent of the 10 mrem-per-year EPA standard. The CAP88 collective dose was estimated at 5.5 person-rem. Tritium oxide accounts for 94 percent of both the MEI and the population dose (Arnett and Mamatey 1998b). The contributions to dose from other radionuclides can be found in *SRS Environmental Data for 1997* (Arnett and Mamatey 1998a). Table 3-13 lists average and maximum atmospheric concentrations of radioactivity at the SRS boundary and at background monitoring locations (100-mile radius) during

Table 3-9. SCDHEC ambient air monitoring data for 1997.

Pollutant	Averaging time	SC Standard ($\mu g/m^3$)	Aiken Co. ($\mu g/m^3$)	Barnwell Co. ($\mu g/m^3$)
Sulfur dioxide	3-hr[a]	1,300	60	44
	24[a]	365	21	10
	Annual[b]	80	5	3
Total suspended particulates	Annual	75	36	--
Particulate matter (≤10 µm)	24-hr[a]	150	45	44
	Annual[b]	50	21	19
Carbon monoxide	1-hr[a]	40,000	5,100[c]	--
	8-hr[a]	10,000	3,300[c]	--
Ozone	1-hr	235	200	210
Nitrogen dioxide	Annual	100	9	8
Lead	Max. quarter	1.5	0.01	--

Source: SCDHEC (1998).
a. Second highest maximum concentration observed.
b. Arithmetic mean of observed concentrations.
c. Columbia, Richland County, South Carolina (nearest monitoring station to SRS).

Table 3-10. Criteria and toxic/hazardous air pollutant emissions from SRS (1997).

Pollutant	Actual tons/year
Criteria pollutants[a]	
Sulfur dioxide	490
Total suspended particulates	2,000
Particulate matter (≤10 µm)	1,500
Carbon monoxide	5,200
VOCs[b]	290
Oxides of nitrogen	430
Lead	0.019
Toxic/hazardous air pollutants[c]	
Benzene	13
Beryllium	0.0013
Biphenyl	0.013
Mercury	0.039
Methyl alcohol (methanol)	0.73

Source: Mamatey (1999). Includes actual emissions from all SRS sources (permitted and unpermitted).
a. Includes an additional pollutant, PM-10, regulated under SCDHEC, Standard 2. Note: gaseous fluoride is also regulated under Standard 2, but is not expected to be emitted as a result of salt processing activities.
b. VOCs are not criteria pollutants, but they are reported here because they are precursors to ozone, which is regulated.
c. Pollutants listed include only air toxics of interest to salt processing activities. A complete list of air toxic emissions from SRS can be found in Mamatey (1999).
VOCs = volatile organic compounds

Table 3-11. SRS baseline air quality for maximum potential emissions and observed ambient concentrations.

Pollutant	Averaging time	SCDHEC ambient standard (μg/m^3)[a]	Estimated SRS baseline concentration (μg/m^3)[b]
Criteria pollutants			
Sulfur dioxide[c]	3-hr	1,300	1,200[c]
	24-hr	365	350
	Annual	80	34
Total suspended particulates	Annual	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[e]	Annual	100	26[e]
Lead	Calendar Quarterly mean	1.5	0.03
Ozone[f]	1-hr	235	220
Toxic/hazardous air pollutants			
Benzene	24-hr	150	4.6
Beryllium	24-hr	0.01	0.009
Biphenyl	24-hr	6	0.02
Mercury	24-hr	0.25	0.03
Methyl alcohol (methanol)	24-hr	1,310	0.9
Formic acid	24-hr	225	0.15

a. Source: SCDHEC Standard 2, "Ambient Air Quality Standards," and Standard 8, "Toxic Air Pollutants" (SCDHEC 1976).
b. Source: Hunter (2000). Concentration is the sum of modeled air concentrations using the permitted 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.
c. Based partly on dispersion modeling of emissions for all oxides of sulfur (SO_x).
d. New NAAQS for particulate matter ≤2.5 microns (24-hour limit of 65 μg/m^3 and an annual average limit of 15 μg/m^3) will become enforceable during the life of this project.
e. Based partly on dispersion modeling of emissions for all oxides of nitrogen (NO_x).
f. New NAAQS for ozone (8 hours limit of 0.08 parts per million) will become enforceable during the life of this project.

1997. SRS-specific computer dispersion models, such as MAXIGASP and POPGASP, were used to calculate radiological doses to members of the public from the 1997 releases, based on the amounts released and the estimated concentration in the environment. Whereas the CAP88 code assumes that all releases occur from one point (for SRS, at the center of the site), MAXIGASP models multiple release locations, which is more representative of 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, aquatic, 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

Table 3-12. Radiological atmospheric releases by operational group for 1997.

Radionuclide[a]	Half-life	Reactors	Separations[b]	Reactor materials	Heavy water	SRTC[c]	Diffuse and fugitive[d]	Total
		Curies released						
Gases and Vapors								
H-3 (oxide)	12.3 years	5.2×10^{3}	3.3×10^{4}		350		150	3.9×10^{4}
H-3 (elem)	12.3 years		1.9×10^{4}					1.9×10^{4}
H-3 Total	12.3 years	5.2×10^{3}	5.2×10^{4}		350		150	5.8×10^{4}
C-14	5.73×10^{3} years		3.1×10^{-2}				1.9×10^{-8}	3.1×10^{-2}
Kr-85	10.73 years		9.6×10^{3}					9.6×10^{3}
I-129	1.57×10^{7} years		7.1×10^{-3}				1.2×10^{-7}	7.1×10^{-3}
I-131	8.040 days		2.9×10^{-5}			2.98×10^{-5}		5.9×10^{-5}
I-133	20.8 hours					4.92×10^{-4}		4.9×10^{-4}
Particulates								
Na-22	2.605 years						1.1×10^{-9}	1.1×10^{-9}
Mn-54	312.2 days						4.8×10^{-12}	4.8×10^{-12}
Co-57	271.8 days		2.2×10^{-7}				1.0×10^{-9}	2.1×10^{-7}
Co-58	70.88 days						1.7×10^{-12}	1.7×10^{-12}
Co-60	5.271 years		3.5×10^{-7}				9.1×10^{-7}	1.3×10^{-6}
Ni-59	7.6×10^{4} years						3.2×10^{-10}	3.2×10^{-10}
Ni-63	100 years						2.3×10^{-9}	2.3×10^{-9}
Zn-65	243.8 days						3.7×10^{-12}	3.7×10^{-12}
Se-79	6.5×10^{4} years						2.2×10^{-10}	2.2×10^{-10}
Sr-89,90[e]	29.1 years	1.8×10^{-3}	2.2×10^{-4}	4.2×10^{-5}	1.8×10^{-4}		8.2×10^{-5}	2.3×10^{-3}
Zr-95	64.02 days						2.1×10^{-5}	2.1×10^{-5}
Nb-95	34.97 days						1.6×10^{-15}	1.6×10^{-15}
Tc-99	2.13×10^{5} years						3.6×10^{-8}	3.6×10^{-8}
Ru-106	1.020 years						0.070	0.070
Sn-126	1×10^{5} years						3.4×10^{-15}	3.4×10^{-15}
Sb-124	60.2 days						3.4×10^{-12}	3.4×10^{-12}
Sb-125	2.758 years						5.9×10^{-7}	5.9×10^{-7}
Cs-134	2.065 years		1.4×10^{-6}				1.2×10^{-9}	1.4×10^{-6}
Cs-137	30.17 years	2.5×10^{-4}	4.2×10^{-4}		2.9×10^{-6}		4.2×10^{-3}	4.9×10^{-3}
Ba-133	10.53 years						3.0×10^{-12}	3.0×10^{-12}
Ce-144	284.6 days		4.2×10^{-6}				6.1×10^{-6}	1.0×10^{-5}
Pm-144	360 days						1.3×10^{-12}	1.3×10^{-12}

Table 3-12. (Continued).

Radionuclide[a]	Half-life	Reactors	Separations[b]	Reactor materials	Heavy water	SRTC[c]	Diffuse and fugitive[d]	Total
		Curies released						
Particulates (continued)								
Pm-147	2.6234 years						1.0×10^{-8}	1.0×10^{-8}
Eu-152	13.48 years						5.3×10^{-9}	5.3×10^{-9}
Eu-154	8.59 years		1.5×10^{-7}				6.4×10^{-6}	6.6×10^{-6}
Eu-155	4.71 years		4.9×10^{-6}				1.7×10^{-6}	6.6×10^{-6}
Ra-226	1.6×10^{3} years						1.2×10^{-8}	1.2×10^{-8}
Ra-228	5.76 years						1.8×10^{-10}	1.8×10^{-10}
Th-228	1.913 years						2.2×10^{-10}	2.2×10^{-10}
Th-230	7.54×10^{4} years						2.0×10^{-10}	2.0×10^{-10}
Th-232	1.40×10^{10} years						1.4×10^{-10}	1.4×10^{-10}
Th-234	24.10 days						2.3×10^{-10}	2.3×10^{-10}
Pa-231	3.28×10^{4} years						1.0×10^{-9}	1.0×10^{-9}
Pa-234	6.69 hours						2.3×10^{-10}	2.3×10^{-10}
U-233	1.592×10^{5} years						2.1×10^{-8}	2.1×10^{-8}
U-234	2.46×10^{5} years		8.0×10^{-6}	4.0×10^{-6}			1.5×10^{-5}	2.7×10^{-5}
U-235	7.04×10^{8} years		6.3×10^{-7}	6.4×10^{-7}			4.8×10^{-7}	1.8×10^{-6}
U-236	2.342×10^{7} years						4.8×10^{-7}	4.8×10^{-7}
U-238	4.47×10^{9} years		1.9×10^{-5}	1.7×10^{-6}			3.5×10^{-5}	5.6×10^{-5}
Np-237	2.14×10^{6} years						1.4×10^{-9}	1.4×10^{-9}
Np-239	2.35 days						2.2×10^{-7}	2.2×10^{-7}
Pu-238	87.7 years		3.3×10^{-5}	4.4×10^{-9}			3.6×10^{-4}	3.9×10^{-4}
Pu-239[f]	2.410×10^{4} years	2.9×10^{-4}	5.1×10^{-5}	6.9×10^{-6}	2.3×10^{-5}	2.5×10^{-6}	6.9×10^{-6}	3.8×10^{-4}
Pu-240	6.56×10^{3} years						1.1×10^{-6}	1.1×10^{-6}
Pu-241	14.4 years						5.2×10^{-5}	5.2×10^{-5}
Pu-242	3.75×10^{5} years						3.7×10^{-11}	3.7×10^{-11}
Am-241	432.7 years		1.4×10^{-5}	1.2×10^{-8}			8.7×10^{-7}	1.5×10^{-5}
Am-243	7.37×10^{3} years						1.8×10^{-5}	1.8×10^{-5}

Table 3-12. (Continued).

Radionuclide[a]	Half-life	Reactors	Separations[b]	Reactor materials	Heavy water	SRTC[c]	Diffuse and fugitive[d]	Total
		Curies released						
Particulates (continued)								
Cm-242	162.8 days						8.2×10^{-12}	8.2×10^{-12}
Cm-244	18.1 years		2.5×10^{-5}	2.0×10^{-10}			1.3×10^{-4}	1.5×10^{-4}
Cm-245	8.5×10^{3} years						1.9×10^{-12}	1.9×10^{-12}

Source: Arnett and Mamatey (1998a).

a. H = hydrogen (H-3 = tritium), C = carbon, Kr = krypton, I = iodine, Na = sodium, Mn = manganese, Co = cobalt, Ni = nickel, Zn = zinc, Se = selenium, Sr = strontium, Zr = zirconium, Nb = niobium, Tc = technetium, Ru = ruthenium, Sn = tin, Sb = antimony, Cs = cesium, Ba = barium, Ce = cerium, Pm = promethium, Eu = europium, Ra = radium, Th = thorium, Pa = protactinium, U = uranium, Np = neptunium, Pu = plutonium, Am = americium, Cm = curium.
b. Includes F- and H-Area releases.
c. SRTC = Savannah River Technology Center.
d. Estimated releases from minor unmonitored diffuse and fugitive sources.
e. Includes unidentified beta emissions.
f. Includes unidentified alpha emissions.

Table 3-13. Radioactivity in air at the SRS boundary and at a 100-mile radius during 1997 (picocuries per cubic meter).

Location	Tritium	Gross alpha	Gross beta	Cobalt-60	Cesium-137	Strontium-89,90	Plutonium-238	Plutonium-239
Site boundary								
Average[a]	11	9.8×10^{-4}	0.015	5.7×10^{-4}	1.5×10^{-4}	8.0×10^{-5}	(b)	(b)
Maximum[c]	65	0.0033	0.032	0.024	0.0073	3.6×10^{-4}	4.1×10^{-6}	7.0×10^{-6}
Background (100-mile radius)								
Average	3.2	0.0011	0.011	(b)	(b)	8.9×10^{-4}	6.9×10^{-6}	(b)
Maximum	5.4	0.0030	0.018	0.0073	0.0055	0.0019	4.2×10^{-5}	2.6×10^{-5}

Source: Arnett and Mamatey (1998a).
a. The average value is the average value of the arithmetic means reported for the Site perimeter sampling locations.
b. Below background levels.
c. The maximum value is the highest value of the maximums reported for the Site perimeter sampling locations.

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 1995b).

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).

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

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 proposed sites in S and Z Areas, which are surrounded by roads, parking lots, construction shops, and construction laydown areas and are continually exposed to high levels of human disturbance (SRFS 1996).

S and Z Areas

Site B, the primary site for the Small Tank Precipitation, Ion Exchange, and Solvent Extraction technologies, is in S Area, approximately one-quarter mile south of DWPF. This open grassy area, which is currently being used as an equipment laydown and storage area, lies in a transitional zone between the heavily-developed central portion of S Area and the relatively undeveloped woodlands to the east (see Figure 2-1). The wildlife of these open, grassy habitats of the SRS that are adjacent to heavy-industrial areas include ground-foraging birds (e.g., American robin, killdeer, mourning dove), small mammals (e.g., cotton mouse, cotton rat, and Eastern cottontail), and reptiles, (e.g., Eastern hognose snake, rat snake, black racer) (Mayer and Wike 1997). East of Site B, the terrestrial habitat grades from pine plantation into a riparian bottomland hardwood community along McQueen Branch.

The site for the Direct Disposal in Grout facilities occupies the eastern half of Z Area, a 180-acre area dedicated in the mid-1980s for the Saltstone Manufacturing and Disposal and support facilities (see Figure 2-2). The western part of Z Area encompasses approximately 70 acres of planted pines. This community is dominated by 35-foot and taller slash pine, with a dense mid-story hardwood component. Dominant tree and shrub species in the mid-story and understory include southern red oak (*Quercus rubra*), water oak (*Q. nigra*), willow oak (*Q. phellos)*, hickory *(Carya* spp.*)*, sassafras (*Sassafras albidum*), cherry (*Prunus* spp.), wild plum (*Prunus* spp.), and smooth sumac (*Rhus glabra*) (WSRC 1999a). The developed portion of Z Area consists of the Saltstone Manufacturing and Disposal Facility, vaults, and parking areas. The eastern portion of Z Area consists of old fields and early successional wooded habitats (herbaceous vegetation, small slash pine, and small hardwoods). A few scattered mature southern red oaks are also present (WSRC 1999a). Wildlife of SRS old fields and open woodlands includes upland game birds (e.g., bobwhite quail, Eastern wild turkey), songbirds (e.g., Eastern meadowlark, field sparrow, song sparrow), small mammals (e.g., cotton mouse, cotton rat, and Eastern cottontail), reptiles (e.g., fence lizard, pine snake, scarlet snake, black racer), and amphibians (e.g., southern toad, eastern narrow-mouthed toad) (Sprunt and Chamberlain 1970; Cothran et al. 1991; Gibbons and Semlitsch 1991; Halverson et al. 1997). The terrestrial habitat adjacent to Z Area consists primarily of pine plantations that grade into a riparian hardwood community along the McQueen Branch stream corridor.

There are no jurisdictional wetlands (wetlands protected by law) within or immediately adjacent to either of the proposed salt processing sites. However, there are jurisdictional wetlands along McQueen Branch in the general vicinity of Z Area. There are no threatened or endangered species or critical habitats on the sites proposed for development (WSRC 1999a).

3.4.2 ECOLOGICAL COMMUNITIES POTENTIALLY AFFECTED BY DEVELOPMENT AND OPERATION OF SALT PROCESSING FACILITIES

Aquatic Communities Downstream of S and Z 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, the American sand-burrowing mayfly (*Dolania americana*), a mayfly relatively common in Upper Three Runs, was until 1996 listed by the U.S. Fish and Wildlife Service as a Category 2 candidate species for listing under the Endangered Species Act. 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 in the southeast 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 residential development of the Upper Three Runs watershed north of 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). Recent fish sampling (Specht and Paller 1998) indicates that fish diversity is greater at downstream locations than at upstream locations. This is probably related to factors other than NPDES discharges (Specht and Paller 1998).

To assess potential impacts of groundwater outcropping to Fourmile Branch, WSRC 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, and 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 to the effect of contaminants entering the stream in groundwater.

Savannah River

An extensive information base is available regarding the aquatic ecology of the Savannah River in the vicinity of SRS. The most recent water quality data available from environmental monitoring conducted on the river in the vicinity of SRS and its downstream reaches can be found in *Savannah River Site Environmental Data for 1997* (Arnett and Mamatey 1998a). 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 State-*

ment 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 1999a).

3.5 Land Use

The SRS is in west-central South Carolina (Figure 3-3), approximately 100 miles from the Atlantic Coast. The major physical feature at SRS is the Savannah River, which is the southwestern boundary of the Site and is also 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 3-7). The production facilities occupy less than 10 percent of the SRS; the remainder of the site is undeveloped forest or wetlands (DOE 1997b) (see Section 3.4).

S and Z Areas are in the north-central portion of the SRS, bounded by Upper Three Runs to the north and Fourmile Branch to the south. Land within a 5-mile radius of these areas lies entirely within the SRS boundaries and is either industrial or forested (DOE 1997b).

In March 1998, the *Savannah River Site Future Use Plan* (DOE 1998b) was formally issued. It was developed in partnership with all major site contractors, support agencies, and DOE Headquarters counterparts and with the input of stakeholders; it 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 industrial areas (i.e., between Upper Three Runs and Fourmile Branch) will be considered in the industrial use category (DOE 1998b). Consequently, DOE's plan is to continue active institutional control for those areas as long as is necessary to protect the public and the environment (DOE 1998b).

3.6 Socioeconomics and Environmental Justice

3.6.1 SOCIOECONOMICS

The socioeconomic region of influence (ROI) 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 ROI, as well as most of the information discussed in this section. The study includes full discussions of regional fiscal conditions, housing, community services and infrastructure, social services and institutions, and educational services. This section will, however, focus on population and employment estimates that have been updated to reflect the most recently available data.

Population

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

Population projections indicate that the overall population in the region should continue to grow at less than 1 percent per year until about 2040, except Columbia County, which could experience 2 to 3 percent annual growth. Table 3-14 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. 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. had 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 1999a).

Employment

In 1994, the latest year consistently developed information is available for all counties in the ROI, the total civilian labor force for the region was 206,518, with 6.9 percent unemployment. The unemployment rate for the U.S. for the same period was 6.1 percent. For the Augusta-Aiken Metropolitan Statistical Area, which does not exactly coincide with the counties in the ROI, 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.

Table 3-14. Population projections and percent of region of influence.

	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

Source: HNUS (1997), scaled from HNUS (1997) and Bureau of the Census (1999).
ROI = region of influence.

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. By September 1997, DOE had reduced the total workforce to 14,379 (DOE 1998c).

3.6.2 ENVIRONMENTAL JUSTICE

In 1995, 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 1995c). That EIS evaluated whether minority or low-income communities could receive disproportionately high and adverse human health and environmental impacts from the alternatives included in that EIS. The EIS examined the population within a 50-mile radius of the SRS boundary, plus areas downstream of the Site that withdraw drinking water from the Savannah River. The area encompasses a total of 147 census tracts, (if any portion of a census tract fell within the 50-mile radius, the entire tract was included for purposes of analysis), with a total affected population of 993,667. Of that population, 618,000 (62 percent) are Caucasian. In the minority population, approximately 94 percent are African-American; the remainder consists of small percentages of Asian, Hispanic, and Native American (Table 3-15).

The *Interim Management of Nuclear Materials EIS* used data on minority and low-income populations from the 1990 census. Although the Bureau of Census publishes county- and state-level population estimates and projects in odd (inter-census) years, census-tract-level statistics on minority and low-income populations are only collected for decennial censuses. Updated census tract information is expected to be published by the Bureau of Census in 2001.

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 of them toward the south and in the immediate vicinities of Augusta and Savannah (Figure 3-11).

Low-income communities (25 percent or more of the population living in poverty [i.e., annual income of $10,915 for a family of two]) occur in 72 census tracts distributed throughout the ROI, but primarily to the south and west of SRS (Figure 3-12). This represents more than 169,000 persons or about 17 percent of the total population (Table 3-16).

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 services re-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.

Savannah River archaeologists 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 on an area's potential for containing sites of historical or archaeological significance (DOE 1995b). 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 3-15. General racial characteristics of population in the Savannah River Site region of influence.

State	Total population	Caucasian	Total Minority	African American	His-panic	Asian	Native American	Other	Percent minorities[a]
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. Minority population divided by total population.
ROI = region of influence.

Studies of S and Z Areas prior to construction of DWPF found no evidence of historic or cultural resources (DOE 1982). Because S and Z Areas are in industrialized sections of the SRS, it is likely that any resources that may have been present were destroyed during initial construction activities in the 1950s.

3.8 Public and Worker Health

Radiological and nonradiological hazardous materials released from SRS reach the workers and public through various environmental transport pathways. The primary transport pathways include inhalation, ingestion, or direct contact exposure pathways from air and drinking water. This SEIS evaluates the collective impacts to workers and the public from radiological and nonradiological pollutant transport pathways.

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 (mrem), rem (1,000 mrem), and person-rem (sum of dose to all individuals in population). An individual's radiation exposure in the vicinity of SRS is estimated to be approximately 357 mrem 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 3-13 shows the relative contribution of each of these sources to the dose that would be received by an individual living near SRS. All radiation doses mentioned in this SEIS are committed effective dose equivalents, which include both the dose from internal deposition of radionuclides and the dose attributable to sources external to the body.

Releases of radioactivity from SRS to the environment 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 mrem per year, or 82 percent of the annual dose of the estimated 357 mrem received by an average member of the population within 50 miles of the Site. Based on national averages, medical exposure accounts for an additional 14.8 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 1987).

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 approximately 11 miles from S Area and Georgia Power Company's Vogtle Electric Generating Plant, directly across the Savannah River from SRS and approximately 13 miles from S Area. In addition, Starmet CMI (formerly Carolina Metals), Inc., which is northwest of Boiling Springs in Barnwell County, approximately 15 miles from S Area, processes depleted uranium.

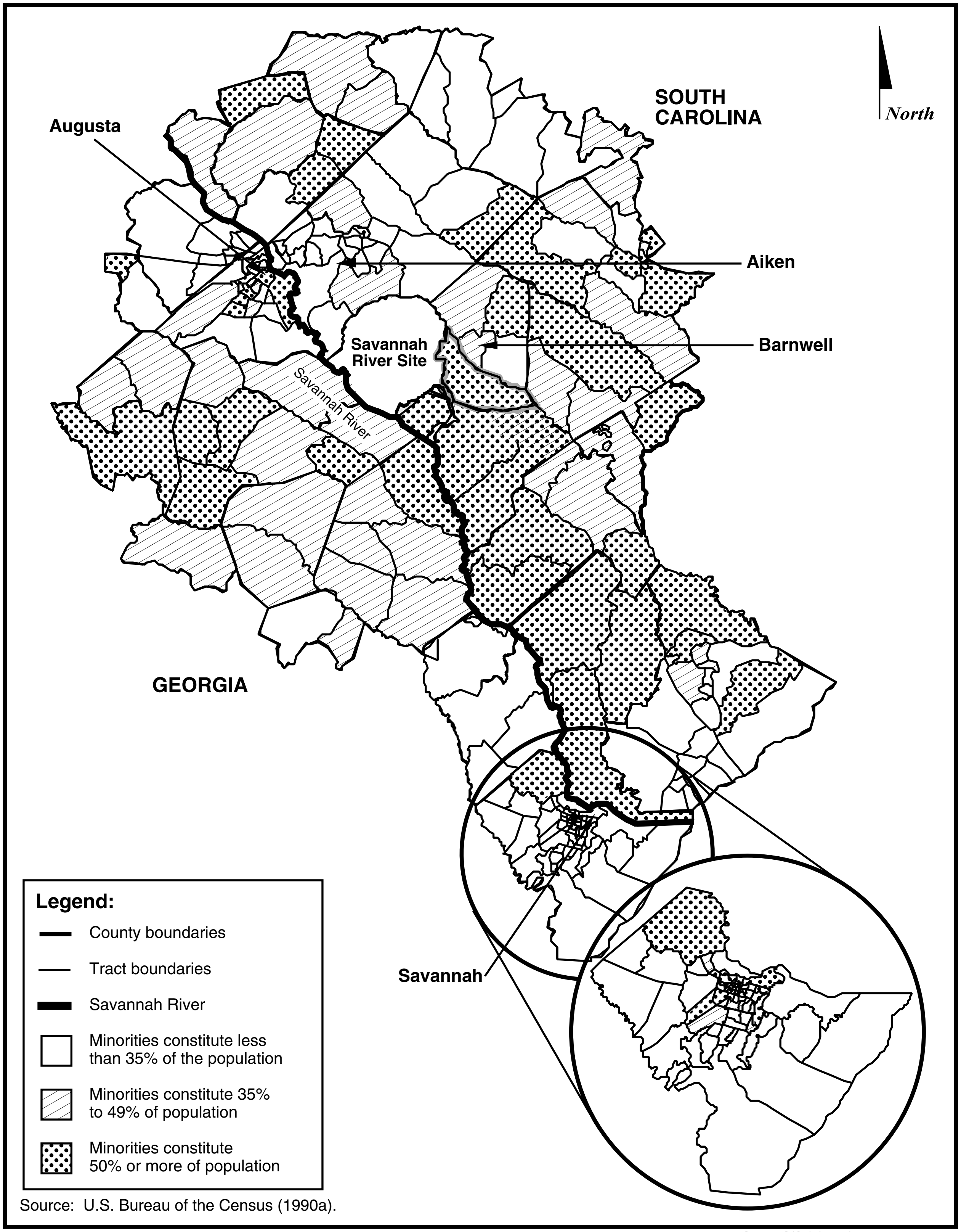
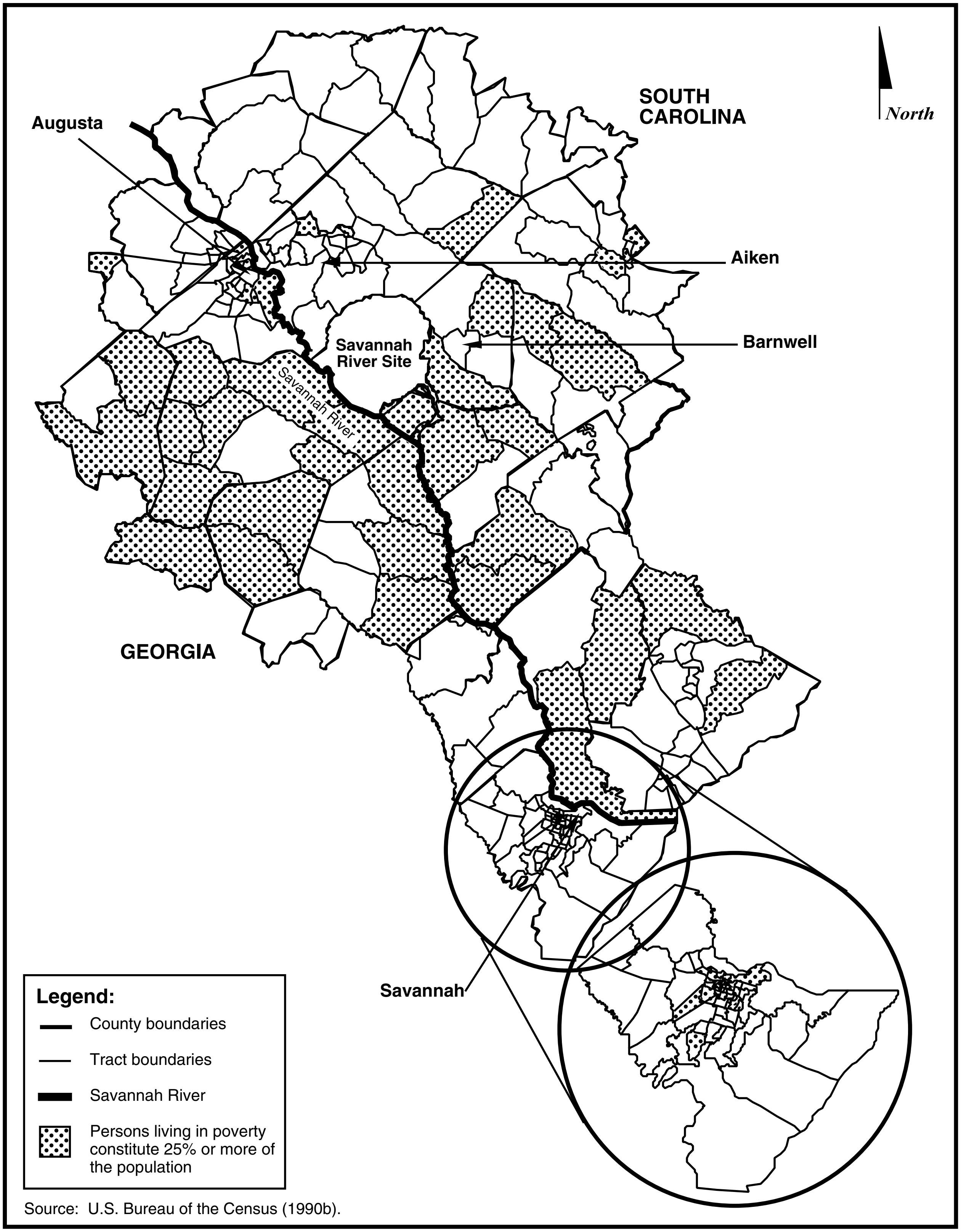


Figure 3-11. Distribution of minority population by census tracts in the SRS region of analysis.



NW SDA EIS/Grfx/ch_3/F3-12 Low income.ai

Figure 3-12. Low income census tracts in the SRS region of analysis.

Table 3-16. General poverty characteristics of populations in the Savannah River Site region of influence.

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 1998 was an annual income of $10,915 for a family of two.

The SCDHEC *South Carolina Nuclear Facility Monitoring Annual Report 1995* (SCDHEC 1995) indicates 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 releases produced an annual dose of 0.54 mrem to the MEI at the plant boundary and a total population dose within a 50-mile radius of 0.045 person-rem (NRC 1996).

In 1997, releases of radioactive material to the environment from SRS operations resulted in an estimated MEI air pathway dose of 0.05 mrem at the Site boundary in the west-southwest sector of the Site, and an estimated maximum dose from water of 0.13 mrem, for an estimated maximum total annual dose at the boundary of 0.18 mrem.

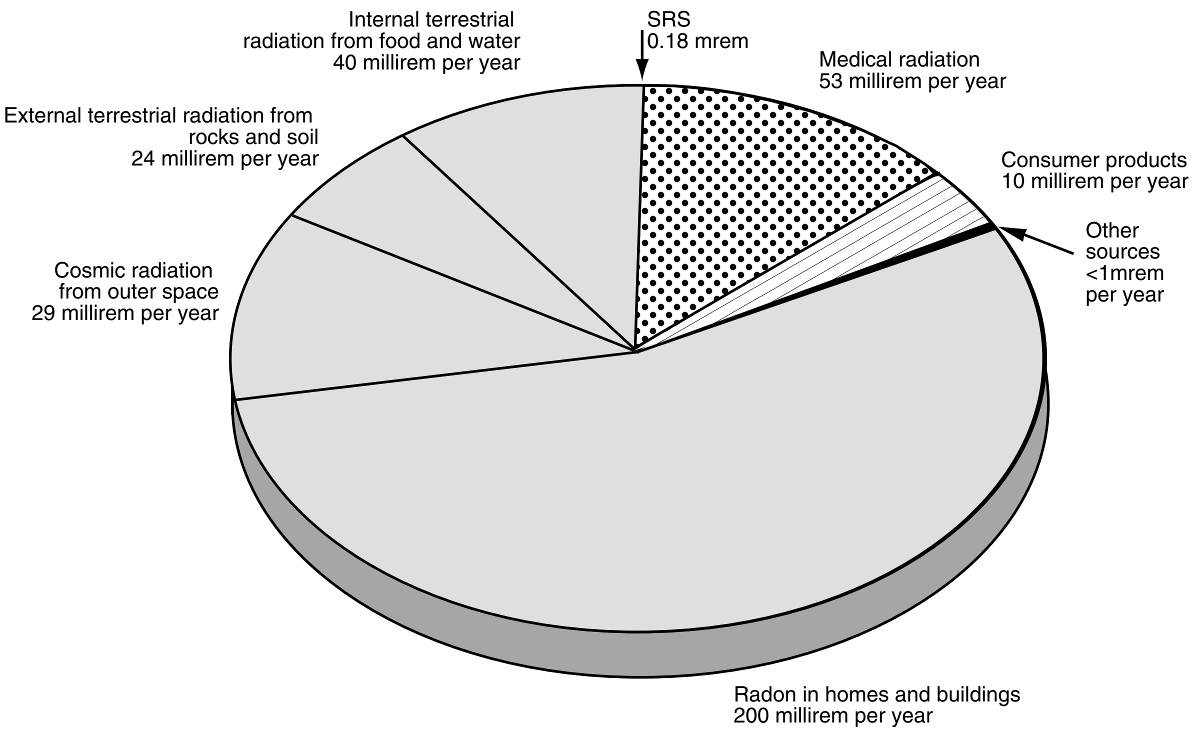
The estimated maximum dose from water pathways to downstream consumers of Savannah River water – 0.07 mrem – occurred to users of the Port Wentworth and the Beaufort-Jasper public water supplies (Arnett and Mamatey 1998b).

In 1990, the population within 50 miles of the Site was approximately 620,100. The estimated collective effective dose equivalent to that population in 1997 was 2.2 person-rem from atmospheric releases. The 1997 population of 70,000 people using water from the Port Wentworth, Georgia, public water supply and 60,000 people using water from the Beaufort-Jasper Water Treatment Plant near Beaufort, South Carolina, received an estimated collective dose equivalent of 2.4 person-rem in 1997 (Arnett and Mamatey 1998b).

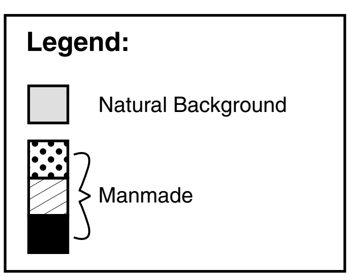
Population statistics indicate that cancer caused 23.3 percent of the deaths in the United States in 1997 (CDC 1999). If this percentage of deaths from cancer continues, 23.3 percent of the U.S. population would contract a fatal cancer from all causes. Thus, in the 1990 population of 620,100 within 50 miles of SRS, approximately 144,000 persons would be likely to contract fatal cancers from all causes. The total calculated population dose from SRS of 4.6 person-rem (2.2 person-rem from atmospheric pathways plus 2.4 person-rem from water pathways) could result in 0.0023 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 SEIS include exposure to nonradiological chemicals in the form of water and air pollution (see Sections 3.2 and 3.3). Nonradiological chemical air pollutants are released from SRS facilities that involve chemical processes, such as separations and high-level waste (HLW) treatment and storage. Due to dilution and dispersion, lower levels of these air pollutants would occur at locations near the Site boundary, offsite, and farther away from the sources. Table 3-11 lists ambient air quality standards and estimated SRS baseline concentrations for selected criteria and toxic pollutants. The purpose of these standards is to protect public health. As discussed in Section 3.3, all estimated SRS baseline concentrations are below the ambient standards for all air pollutants emitted at SRS (Table 3-11).



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. Value for SRS contribution is from Arnett and Mamatey (1998b).
5. Other sources include commercial nuclear facilities (nationwide), occupational exposure, air travel, and fallout.



NW SDA EIS/Grfx/ch_3/3-13 Major rad expo.ai

Figure 3-13. Major sources of radiation exposure in the vicinity of the Savannah River Site.

Nonradiological pollutants from past SRS operations have been identified in other environmental pathways (such as groundwater, surface water, and soils). Environmental sampling programs for these resources indicate that the public is not exposed to these pollutants at concentrations that would impact its health. Groundwater monitoring results in recent years have indicated that ongoing remediation efforts at A and M Areas have diminished the spread of contamination (primarily organics and metals) and reduced the groundwater impact of operations in those areas. Each SRS stream receives varying amounts of treated wastewater and rainwater runoff from site facilities. Stream water quality is sampled monthly and quarterly. In addition, river sampling sites are located upriver of, adjacent to, and downriver of the Site in order to compare the SRS contribution of pollutants to background levels of chemicals from natural sources and upriver non-SRS industrial sources. Analysis of the data for samples collected in 1997 indicates that SRS discharges are not adversely affecting the water quality of the site streams or the river. Table 3-1 lists selected water quality standards, guidelines, and measured concentrations at the Upper Three Runs sampling location downstream of McQueen's Branch. SRS's sediment surveillance program also indicates that inorganic contaminant results were within the expected range (Arnett and Mamatey 1998b).

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 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.

SRS worker doses have typically been well below Federal worker exposure limits. DOE sets 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 mrem per year, and the 1998 SRS as-low-as-reasonably-achievable administrative control level for the whole body was 500 mrem per year. Every year, DOE evaluates the SRS as-low-as-reasonably-achievable administrative control levels and adjusts them as needed.

Table 3-17 lists average individual doses and SRS collective doses from 1989 to 1998.

3.8.4 WORKER NONRADIOLOGICAL HEALTH

Industrial hygiene and occupational health programs at SRS deal with all aspects of worker health and the relationship of the worker to the work environment. The objective of an effective occupational health program is to protect employees from hazards in their work environments. 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.

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

Table 3-18 lists OSHA-regulated workplace pollutants likely to be generated by salt processing activities and the applicable OSHA limits.

Table 3-17. SRS annual individual and collective radiation doses.

Year	Employees with measurable dose	Average individual worker dose (rem)[a]	Site worker collective dose (person-rem)
1989	12,363	0.070	863
1990	11,659	0.065	753
1991	8,391	0.055	459
1992	6,510	0.054	352
1993	5,202	0.051	264
1994	6,284	0.050	315
1995	4,846	0.053	256
1996	4,736	0.053	252
1997	3,327	0.050	165
1998	3,163	0.052	166

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

Table 3-18. Potential occupational safety and health hazards and associated exposure limits.

Pollutant	OSHA PEL[a] (mg/m^3)	Time period
Benzene	3.1	8 hours
Carbon monoxide	55	8 hours
Nitrogen dioxide	9	Ceiling limit
Sulfur dioxide	13	8 hours
Particulate matter (<10 microns)	150	24 hours
	50	annual
Total particulates	15	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.

A well-defined worker protection program is in place at 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 3-19 and 3-20 display the results of these health and safety programs, which have resulted in lower incidences of injury and illness than in the general industry construction and manufacturing workforces.

3.9 Waste and Hazardous Materials Management

This section describes the waste generation baseline that DOE uses in Chapter 4 to gauge the relative impact of each salt processing 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 30 years (DOE 1995b).

Table 3-19. Comparison of injury and illness incident rates for SRS construction to general industry construction.

Incident rate	SRS construction department[a]	Construction industry[b]
Total recordable cases per 200,000 hours worked[c]	5.11	9.70
Total lost workday cases per 200,000 hours worked[c]	2.41	4.45

a. Source: DOE (2000b). Data includes direct-hire and subcontract construction hours worked for the years 1995 through 1999.
b. Source: Bureau of Labor Statistics (2000). Industry average for the years 1995 through 1998. No data available for 1999.
c. 200,000 hours is the standard base for incidence rates, and represents the equivalent of 100 employees working 40 hours per week for 50 weeks.

Table 3-20. Comparison of injury and illness incident rates for SRS operations to private industry and manufacturing.

Incident rate	SRS operations[a]	Private industry[b]	Manufacturing[b]
Total recordable cases per 200,000 hours worked[c]	1.24	7.33	10.55
Total lost workday cases per 200,000 hours worked[c]	0.54	3.35	4.93

a. Source: DOE (2000b). Data includes direct-hire and subcontract operations hours worked for the years 1995 through 1999.
b. Source: Bureau of Labor Statistics (2000). Industry average for the years 1995 through 1998. No data available for 1999.
c. 200,000 hours is the standard base for incidence rates, and represents the equivalent of 100 employees working 40 hours per week for 50 weeks.

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 SEIS considers because they are possible byproducts of the SRS salt processing activities. The following sections describe the waste types. Table 3-21 lists projected total waste generation volumes for a 30-year period that encompasses the expected duration of the salt processing activities addressed in this SEIS. 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 SRS salt processing activities evaluated in this SEIS.

Tables 3-22 through 3-24 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 LOW-LEVEL RADIOACTIVE WASTE

DOE (1999b) 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 radioactivity level. DOE volume-reduces these wastes by incineration, compaction, supercompaction, smelting, or repackaging (DOE 1995b). After volume reduction, DOE packages the remaining low-activity waste and places it in either shallow land disposal or vault disposal in E Area.

Table 3-21. Total waste generation forecast for SRS (cubic meters).[a]

	Waste class				
Inclusive dates	Low-level	HLW	Hazardous	Mixed low-level	Transuranic and alpha
1998 to 2029	180,299	14,129	6,315	3,720	6,012

a. Derived from Halverson (1999). Projected quantities for hazardous and mixed low-level waste derived using ratio of expected waste forecasts for these waste types in DOE (1995b).

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.

3.9.2 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 ETF.

As described in the *Approved Site Treatment Plan* (WSRC 1999d), storage facilities for mixed low-level waste 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 under the Clean Water Act as permitted tank systems. Several treatment processes described in WSRC (1999d) could be used for mixed LLW. These facilities, which are listed in Table 3-23, include the Consolidated Incineration Facility (CIF), the M-Area Vendor Treatment Facility, and the Hazardous Waste/Mixed Waste Containment Building.

CIF operations were suspended in October 2000. It was constructed primarily to incinerate benzene generated in the In-Tank Precipitation process. Additionally, it was scheduled to destroy plutonium uranium extraction (PUREX) wastes from Canyon operations, some solid LLW from ongoing operations, and waste from decontamination and decommissioning (D&D) projects. However, because the benzene stream and the D&D projects did not materialize, and LLW could be more cost-effectively compacted than incinerated, it became cost-prohibitive to operate CIF solely for the PUREX waste stream. If an effective alternative to PUREX disposal can be identified, CIF will not be necessary. DOE is expected to make a decision on CIF by April 2002.

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.

3.9.3 HIGH-LEVEL WASTE

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

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 supernatant. 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 salt component of HLW by evaporation. The salt supernatant is a highly concentrated liquid.

Table 3-22. Planned and existing waste storage facilities.

Storage facility	Location	Capacity	Original waste stream[a]						Status
			Low-level	HLW	Transuranic	Alpha[b]	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	(c)		X					51 underground tanks; one (16H) has been removed from service and two (17F, 20F) have been closed.[d]
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[e]		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	(f)			X	X		X	19 pads exist; additional pads will be constructed as necessary.

Sources: DOE (1994; 1995b), WSRC (1999d).
a. Sanitary waste is not stored at SRS; therefore, it is not addressed in this table.
b. Currently, alpha waste is handled and stored as transuranic waste. After it is surveyed and separated, most will be treated and disposed of as low-level or mixed low-level waste.
c. As of April 1998, there were approximately 660,000 gallons of space available in each of the HLW Tank Farms.
d. Twenty-four of these tanks do not meet secondary containment requirements and have been scheduled for closure.
e. Usable storage capacity of 2,159 canisters due to floor plug problems.
f. Transuranic waste storage capacities depend on the packaging of the waste and the configuration of packages on the pads.
m^3 = cubic meters, SRTC = Savannah River Technology Center.

Table 3-23. Planned and existing waste treatment processes and facilities.

Waste Treatment Facility	Waste Treatment Process	Waste type: Low-level	High-level	Transuranic	Alpha[a]	Hazardous	Mixed Low-level	Sanitary	Status
Consolidated Incineration Facility	Incineration	X				X	X		Operations suspended in 2000
Offsite facility	Incineration	X				X	X		Not currently operating
Offsite facility	Compaction	X							Not currently operating
Onsite facility	Supercompaction	X							Operating
Offsite facility	Smelting	X							Not currently operating
Onsite facility	Repackaging	X							Operating
Defense Waste Processing Facility	Vitrification		X						Operating (sludge only)
Saltstone Manufacturing and Disposal	Stabilization						X		Not currently operating
Replacement High-Level Waste Evaporator[c]	Volume Reduction		X						Began treating waste 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 Decontamination					X	X		Plan to begin operations in 2006
Treatment at point of waste stream origin	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[b]	Amalgama-tion/Stabilization/Macro encapsulation						X		DOE is considering use of the Broad Spectrum Contract
Offsite facility	Offsite Treatment and Disposal					X			Currently operational
Offsite facility	Decontamination						X		Began treating waste onsite in December 1998. Plan to pursue treatment offsite in 2000, if neces-sary.
High-activity mixed transuranic waste facility	Repackaging/size re-duction			X	X				Planned to begin operations in 2012
Low-activity mixed transuranic waste facility	Repackaging/size re-duction/super compac-tion			X	X				Planned to begin operations in 2002
Various onsite and offsite facilities[d]	Recycle/Reuse	X				X	X	X	Currently operational
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

Sources: DOE (1994, 1995b); WSRC (1999d,e; 2000).

a. Currently, alpha waste is handled as transuranic waste. After it is surveyed and separated, most will be treated and disposed of as low-level or mixed low-level waste.

b. Evaporation precedes treatment at the DWPF and is used to maximize HLW storage capacity.

c. 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 3-24. Planned and existing waste disposal facilities.

			Original waste stream[a]						
Disposal facility	Location	Capacity (m^3)	Low-level	High-level	Transuranic	Hazardous	Mixed Low-level	Sanitary	Status
Shallow land disposal trenches	E Area	(b)	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	Z Area	80,000/vault[c]	X						Two vaults exist; future vault needs to be determined by SRS salt processing alternatives.
Three Rivers Landfill	Intersection of SC 125 and SRS Road 2	NA						X	Current destination for SRS sanitary waste.
Burma Road Cellulosic and Construction Waste Landfill	SRS Intersection of C Road and Burma Road	NA						X	Current destination for demolition/construction debris. DOE expects to reach permit capacity in 2008.
Waste Isolation Pilot Plant (WIPP)	New Mexico	175,600			X				Current destination for some SRS transuranic waste.[d]
Federal repository	See Status	NA		X					Proposed Yucca Mountain, Nevada, site is currently under investigation.

Sources: DOE (1994, 1995b, 1997c); WSRC (1999d,f; 2000).

a. After alpha waste is assayed and separated from the transuranic waste, DOE plans to dispose of it as low-level or mixed low-level waste, so it is not addressed separately here.

b. 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.

c. This is the approximate capacity of a double vault. One single vault and one double vault have been constructed. Future vault design would be based on the selected salt processing alternative.

d. SRS is scheduled for WIPP certification audit in fall 2000 and SRS waste is scheduled to be shipped to WIPP in early 2001.

NA = not available, WIPP = Waste Isolation Pilot Plant.

The sludge portion of the HLW is currently being transferred to DWPF for immobilization in borosilicate glass. The treatment processes at DWPF are described in the *Final Supplemental Environmental Impact Statement for the Defense Waste Processing Facility* (DOE 1994). The salt portions of the HLW must be separated into high-radioactivity and low-radioactivity fractions before ultimate treatment. Alternatives for processing the salt portion of the SRS HLW is the subject of this SEIS.

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 2000). During waste removal, DOE will retrieve as much of the stored HLW as can be removed using the existing waste transfer equipment. The sludge portion of the retrieved waste will be treated in treatment facilities and vitrified at DWPF, as discussed in the 1999 SEIS. Processing of the salt portion of the retrieved waste is the subject of this SEIS.

3.9.4 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 disposal in a municipal sanitary landfill. Sanitary wastes 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. DOE also continues to operate the Burma Road Cellulosic and Construction Waste Landfill to dispose of demolition and construction debris.

3.9.5 HAZARDOUS WASTE

Hazardous waste is nonradioactive waste that SCDHEC regulates under RCRA and corresponding state regulations. Waste is hazardous if the EPA lists it as such or if it exhibits any of 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. 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 1995b).

3.9.6 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 1999b). 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.

Current SRS efforts for transuranic and alpha waste consist primarily of providing continued safe storage. After alpha waste is assayed and separated from the transuranic waste, DOE plans to dispose of the alpha waste onsite as low-level or mixed low-level waste. Eventually, DOE plans to ship the SRS transuranic and mixed transuranic waste to the Waste Isolation Pilot Plant in New Mexico for disposal.

3.9.7 HAZARDOUS CHEMICALS

The *Savannah River Site Tier II Emergency and Hazardous Chemical Inventory Report* for 1998 (WSRC 1999g) 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 and at individual facilities changes daily as a function of use and demand.

3.10 Energy and Utilities

Electricity. The South Carolina Electric and Gas Company (SCE&G) supplies SRS electric power needs via one 160-kilovolt and two 115-kilovolt-capacity transmission lines, with a combined available power of about 390 megawatts. The SRS D-Area Powerhouse, which was once operated by DOE to provide a portion of the Site's electricity needs, is now under lease to SCE&G, which in turn sells electricity to DOE. Current Site power demand is about 70 megawatts, with 30 percent of that total (about 22 megawatts) being delivered to H-Area facilities. The capacity of the H-Area power distribution network is 64 megawatts. A substation in H Area distributes electricity to S and Z Areas.

Steam. Steam production facilities at SRS include coal-fired powerhouses at A, D, and H Areas, and two package boilers, which use number 2 fuel oil, in K Area. DOE has privatized the D-Area Powerhouse, which provides most of the steam for SRS. SCE&G produces and sells steam to DOE. At present, steam generation occurs continuously at the A- and D-Area facilities (the H-Area powerhouse is maintained in a standby condition). The combined capacity of these steam production facilities is about 1.7 million pounds per hour, with the D-Area powerhouse representing 75 percent of that capacity (1.3 million pounds per hour). Average daily steam use is about 150,000 pounds per hour (excluding 30,000 pounds per hour use during winter).

Domestic and Process Water. During 1998, groundwater withdrawals at SRS for domestic and process uses totaled 5,345 billion gallons, or a daily average of 14,634 million gallons (10,162 gallons per minute). This demand represents about 91 percent of the lowest estimated production capacity (16 million gallons per day) of the aquifer. The 1998 average consumption of water in H- and S-Area facilities was about 1.023 and 0.049 million gallons per day, respectively. This water demand represents almost 7 percent of the total Site demand. The average demand for water is about 960 gallons per minute; the water supply capacity is about 3,450 gallons per minute, which is about 30 percent of the lowest estimated production capacity (16 million gallons per day) of the aquifer. The water demand imposed by the operation of S- and Z-Area facilities averages 50 gallons per minute (about 5 percent of the total Site demand); the associated system capacity is 200 gallons per minute.

Originally built to supply water from the Savannah River to the five SRS production reactors, the River Water System includes three pumphouses, two (1G and 3G) on the Savannah River, and one (6G) on Par Pond. Pumphouse 5G is also on the Savannah River, but has a separate piping system that supplies cooling water to the D-Area Powerhouse. Pumphouses 1G and 6G are no longer operating, but DOE has maintained the 1G pumphouse and system. The total design capacity of the 1G and 3G pumphouses is 400,000 gallons per minute. In 1997, DOE installed a 5,000-gallon-per-minute pump in Pumphouse 3G to save energy and costs. At present, only Pumphouse 3G is in use, withdrawing 5,000 gallons per minute from the Savannah River to supply small cooling loads in K and L Areas.

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