CHAPTER 3. AFFECTED ENVIRONMENT

This chapter describes the existing environmental and socioeconomic characteristics of the Savannah River Site (SRS) and the nearby region that the proposed action or its alternatives (described in Chapter 2) could affect. It provides the environmental bases against which the U.S. Department of Energy (DOE) has assessed the environmental consequences described in Chapter 4.

The activities that DOE describes in this environmental impact statement (EIS) would occur on the SRS, primarily in industrialized areas (for example see Figure 2-13). The only exception would involve the transportation of spent nuclear fuel or waste between SRS areas.

The industrialized areas consist primarily of buildings, paved parking lots, and graveled areas. There are grassed areas around some buildings, and there is vegetation along drainage ditches, but most of the industrialized areas have little or no vegetation.

As discussed in Section 2.4.2, DOE has identified three candidate host sites for the potential construction of a Transfer and Storage Facility. These sites are the east side of L Area inside the facility fence (see Figure 2-8), the southeast side of C Area inside the facility fence (see Figure 2-13), and the northeast side of P Area (see Figure 2-14). DOE also could construct a new Transfer, Storage and Treatment Facility at any of these three sites or in F or H Area. Finally, facilities to implement the New Processing Technology options could be located inside a reactor building, such as Building 105-L.

3.1 Geologic Setting and Seismicity

The SRS is in west-central South Carolina, approximately 100 miles from the Atlantic coast (Figure 3.1-1). It is on the Aiken Plateau of the Upper Atlantic Coastal Plain about 25 miles (40 kilometers) southeast of the Fall Line which 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 (Figure 3.1-1). The Aiken Plateau is the subdivision of the Coastal Plain that includes the location of the SRS. The plateau extends from the Fall Line to the oldest of several scarps incised in the Coastal Plain sediment. The Plateau surface is highly dissected and characterized by broad interfluvial areas with narrow steep-sided valleys. It is generally well drained, although poorly drained depressions (called Carolina bays) occur (DOE 1995a). At the Site, the plateau is underlain by 500 to 1,400 feet (150 to 420 meters) of sands, clays, and limestones of Tertiary and Cretaceous age. These sediments are underlain, in turn, by sandstones of Triassic age and older metamorphic and igneous rocks (Arnett and Mamatey 1996). Because of the proximity of the SRS to the Piedmont Province, it has more relief than areas that are nearer the coast, with onsite elevations ranging from 89 to 420 feet (27 to 128 meters) above mean sea level.

The sediments of the Atlantic Coastal Plain (Figure 3.1-2) dip gently seaward from the Fall Line and range in age from Late Cretaceous to Recent. The sedimentary sequence thickens from essentially 0 at the Fall Line to more than 4,000 feet (1,219 meters) at the coast. Regional dip is to the southeast. Coastal Plain sediments underlying the SRS consist of sandy clays and clayey sands, although occasional beds of clean sand, gravel, clay, or carbonate occur (DOE 1995a). The formations of interest in C, F, H, L, and P Areas are part of the shallow (Floridan) aquifer system (Figure 3.1-2 and Table 3.1-1). Any contaminants could migrate to these formations and be carried by them to SRS streams.

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

Figure 3.1-2. Generalized geologic and aquifer units in SRS region.

Table 3.1-1. Soil formations of the Floridan aquifer system.[a]

Aquifer Unit	Formation	Description
Upper Three Runs Aquifer	"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, 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 course-grained quartz sand interbedded with clay. Dark, micaceous, lignitic sand also occurs. In northwestern part of SRS, this Formation is less silty and better sorted, with thinner clay interbeds.

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

3.1.2 SUBSURFACE FEATURES

EC | There are several fault systems off the Site northwest of the Fall Line (DOE 1990a). A more
TC | recent study of geophysical evidence (Wike, Moore-Shedrow, and Shedrow 1996) and an earlier study (Stephenson and Stieve 1992) identified the faults indicated on Figure 3.1-3. The earlier study identified the following faults – Pen Branch, Steel Creek, Advanced Tactical Training Area (ATTA), Crackerneck, Ellenton, and Upper Three Runs – under SRS. The one closest to the areas under consideration is the Steel Creek Fault, which passes through L Area and is approximately 1 mile (1.6 kilometers) northwest of P Area. The Upper Three Runs Fault, which is a Paleozoic fault that does not cut Coastal Plain sediments, passes approximately 1 mile (1.6 kilometers) from F Area. The lines shown on Figure 3.1-3 represent the projection of faults to the ground surface. The actual faults do not reach the surface, but rather stop several hundred feet below.

Based on the available information, none of the faults discussed in this section is capable, which means that it has not moved at or near the ground surface within the past 35,000 years or is associated with another fault that had moved in the past 35,000 years. (10 CFR 100 contains a more detailed definition of a capable fault.)

3.1.3 SEISMICITY

Two major earthquakes have occurred within 186 miles (300 kilometers) of SRS.

- The Charleston, South Carolina, earthquake of 1886 had an estimated Richter scale magnitude of 6.8; it occurred approximately 90 miles (145 kilometers) from the SRS area, which experienced an estimated peak horizontal acceleration of 10 percent of gravity (0.10*g*) (URS/Blume 1982).

- The Union County, South Carolina, earthquake of 1913 had an estimated Richter scale magnitude of 6.0 and occurred about 99 miles (160 kilometers) from the Site (Bollinger 1973).

Because these earthquakes are not associated conclusively with a specific fault, researchers cannot determine the amount of displacement resulting from them.

In recent years, three earthquakes occurred inside the SRS boundary as reported by local print and media and cited in DOE (1999a). | EC

- On May 17, 1997, with a Richter scale magnitude of 2.3 and a focal depth of 3.38 miles (5.44 kilometers); its epicenter was southeast of K Area.

- On August 5, 1988, with a local Richter scale magnitude of 2.0 and a focal depth of 1.66 miles (2.68 kilometers); its epicenter was northeast of K Area.

- On June 8, 1985, with a local Richter scale magnitude of 2.6 and a focal depth of 0.59 mile (0.96 kilometer); 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. Figure 3.1-3 shows the locations of the epicenters of these earthquakes.

Outside the SRS boundary, an earthquake with a Richter scale magnitude of 3.2 occurred on August 8, 1993, approximately 10 miles (16 kilometers) 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 (40 kilometers) northwest of the SRS], and on the Site (Aiken Standard 1993). | EC

3.2 Water Resources

3.2.1 SURFACE WATER RESOURCES

This section describes the surface water, and the quality of that water, in the area potentially af-

fected by the proposed action, including the Savannah River, Upper Three Runs, Fourmile Branch, and Steel Creek.

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

3.2.1.1 Savannah River

The Savannah River bounds SRS on its southwestern border for about 20 miles (32 kilometers), approximately 160 river miles (260 river kilometers) 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 (283 cubic meters) per second at SRS (DOE 1995a).

The Savannah River, which forms the boundary between Georgia and South Carolina, supplies potable water to a number of users. Upstream of SRS, the river supplies domestic and industrial water for Augusta, Georgia, and North Augusta, South Carolina. Approximately 130 river miles (210 river kilometers) 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 Savannah River receives sewage treatment plant effluent from Augusta, Georgia; North Augusta, Aiken, and Horse Creek Valley, South Carolina; and from a number of SRS operations through discharges to onsite streams. In addition, the Georgia Power Company's Vogtle Electric Generating Plant withdraws an average of 46 cubic feet (1.3 cubic meters) per second for cooling and returns an average of 12 cubic feet (0.35 cubic meter) per second of cooling tower blowdown. The Urquhart Steam Generating Station at Beech Island, South Carolina, withdraws approximately 265 cubic feet (7.5 cubic meters) per second for once-through cooling water (DOE 1995a).

On SRS, a swamp occupies the floodplain along the Savannah River for approximately 10 miles (17 kilometers); the swamp is about 1.5 miles (2.5 kilometers) wide. A natural levee separates the river from the floodplain. Figure 3.2-1 shows the 100-year floodplain of the Savannah River in the SRS vicinity and the floodplains of major tributaries that drain the Site (DOE 1995a).

3.2.1.2 SRS Streams

Five tributaries of the Savannah River -- Upper Three Runs, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs -- drain almost all of the SRS (Figure 3.2-1). Each stream originates on the Aiken Plateau in the Coastal Plain and descends 50 to 200 feet (15 to 60 meters) before discharging into the river. The streams, which historically received varying amounts of effluent from SRS operations, are not commercial sources of water. Their natural flows range from less than 10 cubic feet (1 cubic meter) per second in smaller streams such as Pen Branch to 240 cubic feet (6.8 cubic meters) per second in Upper Three Runs (DOE 1995a).

Upper Three Runs, Fourmile Branch, and Steel Creek are the streams closest to most SRS spent nuclear fuel management locations (see Figure 3.2-1). These streams also are closest to the areas where DOE is most likely to place new spent nuclear fuel facilities.

Upper Three Runs is a large, cool, blackwater stream in the northern part of SRS. It drains an area of approximately 210 square miles (545 square kilometers), and has an average discharge of 330 cubic feet (9.3 cubic meters) per second at its mouth. Upper Three Runs is approximately 25 miles (40 kilometers) long, with its lower 17 miles (28 kilometers) inside SRS boundaries. This creek receives more water from underground sources than other SRS streams and, therefore, has lower conductivity, hardness, and pH values. Upper Three Runs is the only major tributary on SRS that has never received thermal discharges from nuclear reactors (DOE 1995a).

Fourmile Branch is about 15 miles (24 kilometers) long and drains an area of approximately 22 square miles (57 square kilometers). At its headwaters, Fourmile Branch is a small blackwater stream that currently receives

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

impacts from SRS operations. The water chemistry in the headwater area is very similar to that of Upper Three Runs, with the exception of nitrate concentrations, which are an order of magnitude higher than those in Upper Three Runs (DOE 1995a). These elevated concentrations are probably the result of groundwater transport and outcropping from the F- and H-Area seepage basins. In its lower reaches, Fourmile Branch broadens and flows through a delta formed by the deposition of sediments. Although most of the flow through the delta is in one main channel, the delta has many standing dead trees, logs, stumps, and cypress trees that provide structure and reduce the water velocity in some areas. Downstream of the delta, the creek flows in one main channel and discharges primarily into the Savannah River at River Mile 152, while a small portion flows west and enters Beaver Dam Creek, a small onsite tributary of the Savannah River (DOE 1995a). EC

Steel Creek is about 9 miles (15 kilometers) long and, with Meyers Branch, drains an area of approximately 35 square miles (90 square kilometers) (DOE 1996a). Its headwaters originate near P Reactor. The creek flows southwest about 2 miles (3 kilometers) before it enters the headwaters of L Lake. Flow from the outfall of the L-Lake dam travels about 3 miles (5 kilometers) before entering the Savannah River swamp and then another 2 miles (3 kilometers) before entering the river.

Meyers Branch, the main tributary of Steel Creek, flows approximately 6 miles (10 kilometers) before entering Steel Creek. Meyers Branch is a small blackwater stream that has remained relatively undisturbed by SRS operations. The confluence of Meyers Branch and Steel Creek is downstream from the L-Lake dam. Steel Creek received intermittent thermal effluent from P and L Reactors from 1954 to 1964, and from L Reactor only from 1964 to 1968 (Halverson et al. 1997). Effluents from L and P Areas flow to L Lake and subsequently to Steel Creek through the L-Lake dam outfall. During water year 1996, flows in Steel Creek (downstream of the confluence with Meyers Branch) averaged 59.2 cubic feet (1.7 cubic meters) per second (DOE 1996a).

3.2.1.3 Surface-Water Quality

In 1996, releases of radionuclides from the SRS to surface waters amounted to 8,550 curies of tritium, 0.214 curie of strontium-89 and -90, and 0.05 curie of plutonium-239 (Arnett and Mamatey 1998a). Table 3.2-1 lists radioactive liquid releases by source for 1997; Table 3.2-2 lists radioactive liquid releases by outfall or facility and compares annual average radionuclide concentrations to DOE concentration guides (Figure 3.2-2 shows outfall and facility locations for radioactive surveillance). The resulting doses to a downriver consumer of river water from radionuclides released from the Site were 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 0.2 percent of the DOE dose standard from all pathways (DOE 1990b; Arnett and Mamatey 1998). TC TC

The South Carolina Department of Health and Environmental Control (SCDHEC) regulates the physical properties and concentrations of chemicals and metals in SRS effluents under the National Pollutant Discharge Elimination System (NPDES) program. SCDHEC, which also regulates biological water quality standards for SRS waters, has classified the Savannah River and SRS streams as "Freshwaters." In 1997, 99.9 percent of the NPDES water quality analyses on SRS effluents were in compliance with the SRS NPDES permit; only 7 of 5,758 analyses exceeded permit limits (Arnett and Mamatey 1998a). A comparison of 1997 Savannah River water quality analysis upstream and downstream of SRS showed no significant differences, and a comparison with historical data indicates that coliform data are within normal fluctuation for river water in this area and the overall exceedances decreased in number from 1996 (Arnett and Mamatey 1998a). Table 3.2-3 summarizes the water quality of Fourmile Creek, Steel Creek, and Upper Three Runs for 1996. TC TC

Table 3.2-1. Annual liquid releases by source for 1997 (including direct and seepage basin migration releases).[a]

		Curies					
Radionuclide[b]	Half-life (years)	Reactors	Separations[c]	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[d]	29.1	6.46×10^{-2}	1.40×10^{-1}		5.09×10^{-3}	4.10×10^{-3}	2.14×10^{-1}
I-129[e]	1.6×10^{7}		7.82×10^{-2e}				7.82×10^{-2d}
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}
Pu-238	87.7	4.24×10^{-5}	9.57×10^{-4}		7.68×10^{-7}	1.78×10^{-6}	1.00×10^{-3}
Pu-239[f]	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.
a. Source: Arnett and Mamatey (1998a).
b. H = hydrogen (H-3 = tritium), Sr = strontium, I = iodine, Cs = cesium, U = uranium, Pu = plutonium, Am = americium, Cm = curium.
c. Includes separations, waste management, and tritium facilities.
d. Includes unidentified beta.
e. Measured I-129 doses were not available for 1997. The value for separations emissions is from 1996.
f. Includes unidentified alpha.
TNX = a technology development facility adjacent to the Savannah River.
SRTC = Savannah River Technology Center.

TC

(Figure 3.2-3 shows stream water quality monitoring locations.)

Certain technologies, including those considered in this EIS, generate liquid byproducts that are transferred to the F- and H-Area Tank Farms. Evaporator overheads from these tanks are condensed and treated at the F- and H-Area Effluent Treatment Facility (ETF). Waste concentrate from the ETF is disposed of in the Z-Area Saltstone Manufacturing and Disposal Facility and the decontaminated wastewater is discharged to Upper Three Runs through NPDES outfall H-16. These existing facilities are described in the *Interim Management of Nuclear Materials EIS* (DOE 1995b) and the *Defense Waste Processing Facility Supplemental EIS* (DOE 1994). Requirements for spent nuclear fuel processing are included in these documents and, therefore, this EIS considers those facilities and processed waste amounts to be part of the SRS baseline.

3.2.2 GROUNDWATER RESOURCES

3.2.2.1 Groundwater Features

In the SRS region, the subsurface contains two hydrogeologic provinces. The uppermost, consisting of a wedge of unconsolidated Coastal Plain sediments of Late Cretaceous and Tertiary age, is the Atlantic Coastal Plain Hydrogeologic Province. Beneath the sediments of the Atlantic Coastal Plain Hydrogeologic Province are rocks of the Piedmont Hydrogeologic Province. These rocks consist of Paleozoic igneous and metamorphic basement rocks and lithified mudstone, sandstone, and conglomerates of the Dunbarton basin of the Upper Triassic. Sediments of the Atlantic Coastal Plain Hydrogeologic Province are divided into three main

Table 3.2-2. Liquid radioactive releases by outfall/facility and comparison of annual average radionuclide concentrations to DOE derived concentration guides.[a]

Outfall or Facility	Radionuclide[b]	Quantity of Radionuclides Released during 1997 (Ci)	Average Effluent Concentration during 1997 (μCi/mL)	DOE DCGs[c] (μCi/mL)
C Area (C Reactor)				
C Canal	H-3 (oxide)	1.20	1.75×10^{-6}	2.00×10^{-3}
	Sr-89,90	Below MDL	ND	1.00×10^{-6}
	Cs-137	Below MDL	1.02×10^{-9}	3.00×10^{-6}
F Area (Separations and Waste Management)				
F-01	H-3 (oxide)	5.03×10^{-2}	2.54×10^{-7}	2.00×10^{-3}
	Sr-89,90	Below MDL	ND	1.00×10^{-6}
	Cs-137	Below MDL	1.32×10^{-9}	3.00×10^{-6}
F-012 (281-8F Retention Basin)	H-3 (oxide)	7.67×10^{-1}	9.83×10^{-6}	2.00×10^{-3}
	Sr-89,90	Below MDL	3.01×10^{-9}	1.00×10^{-6}
	Cs-137	158×10^{-3}	2.07×10^{-8}	3.00×10^{-6}
	H-3 (oxide)	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 (oxide)	1.32×10	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 (oxide)	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 (oxide)	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}

TC

Table 3.2-2. (continued).

Outfall or Facility	Radionuclide[b]	Quantity of Radionuclides Released during 1997 (Ci)	Average Effluent Concentration during 1997 (μCi/mL)	DOE DCGs[c] (μCi/mL)
H Area (Separations and Waste Management)				
Fourmile Branch-1C (H-Area Effluent)	H-3 (oxide)	3.85×10	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-3 (oxide)	4.96×10^{-1}	1.23×10^{-5}	2.00×10^{-3}
	Sr-89,90	3.48×10^{-6}	5.40×10^{-10}	1.00×10^{-6}
	Cs-137	2.15×10^{-6}	7.15×10^{-10}	3.00×10^{-6}
	U-234	2.77×10^{-6}	8.54×10^{-11}	6.00×10^{-7}
	U-235	9.84×10^{-9}	8.61×10^{-12}	6.00×10^{-7}
	U-238	2.07×10^{-6}	6.58×10^{-11}	6.00×10^{-7}
	Pu-238	5.09×10^{-7}	2.45×10^{-11}	4.00×10^{-8}
	Pu-239	8.93×10^{-8}	6.37×10^{-12}	3.00×10^{-8}
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}
H-018 (200-H Cooling Basin)	H-3 (oxide)	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^{-3}	3.71×10^{-7}	3.00×10^{-6}
HP-15 (Tritium Facility Outfall)	H-3 (oxide)	1.74×10	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 (oxide)	2.43×10	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}
TC McQueen's Branch at Rd F	H-3 (oxide)	120×10^{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 (ETF[e] Outfall at Rd C)	H-3 (oxide)	3.82×10^{2}	(f)	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}
L Area (L Reactor)				
L-007	H-3 (oxide)	6.02×10	3.38×10^{-7}	2.00×10^{-3}
	Sr-89,90	Below MDL	1.16×10^{-10}	1.00×10^{-6}
	Cs-137	Below MDL	4.53×10^{-10}	3.00×10^{-6}
P Area (P Reactor)				
P-013A	H-3 (oxide)	7.18×10^{-1}	2.96×10^{-4}	2.00×10^{-3}
	Sr-89,90	5.25×10^{-6}	3.47×10^{-9}	1.00×10^{-6}
	Cs-137	2.38×10^{-4}	9.86×10^{-8}	3.00×10^{-6}
P-019A (P-Area Canal Par Pond)	H-3 (oxide)	3.25×10^{-1}	5.41×10^{-7}	2.00×10^{-3}
	Sr-89,90	Below MDL	3.03×10^{-10}	1.00×10^{-6}
	Cs-137	Below MDL	ND	3.00×10^{-6}

a. Source: Arnett and Mamatey (1998a).
b. H = hydrogen (H-3 = tritium), Sr = strontium, I = iodine, Cs = cesium, U = uranium, Pu = plutonium, Am = americium, Cm = curium.
c. 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.
d. MDL = minimum detectable level.
e. ETF = Effluent Treatment Facility.
f. Outfall concentrations for tritium exceed the DCG guidelines. DOE Order 5400.5 exempts tritium from "best available technology" requirements because there is no practical technology available for removing tritium from dilute liquid waste streams.

ND = not detected.

Figure 3.2-2. Radiological surface-water sampling locations.

Table 3.2-3. SRS stream water quality (onsite downstream locations).[a]

Parameter[b]	Units	Fourmile Branch (FM-6) average	Steel Creek (SC-4) average	Upper Three Runs (U3R-4) average	Water Quality Criterion[c], MCL[d], or DCG[e]
Aluminum	Mg/L	0.200[f]	0.018	0.274[f]	0.087
Cadmium	Mg/L	ND[g]	ND	ND	0.00066
Calcium	Mg/L	2.94	2.53	1.62	NA[h]
Cesium-137	PCi/L	NR[i]	NR	NR	120[e]
Chromium	mg/L	ND	ND	ND	0.011
Copper	mg/L	0.015[f]	0.028[f]	0.036[f]	0.0065
Dissolved oxygen	mg/L	7.9	8.73	8.2	≥5
Iron	mg/L	0.69	0.349	0.586	1
Lead	mg/L	ND	ND	ND	0.0013
Magnesium	mg/L	0.659[f]	0.854[f]	0.385[f]	0.3
Manganese	mg/L	0.055	0.048	0.026	1
Mercury	mg/L	ND	0.0002	ND	0.000012
Nickel	mg/L	0.01	0.01	0.012	0.088
Nitrate (as nitrogen)	mg/L	1.36	0.16	0.24	10[d]
pH	pH	6.31	6.32	6.3	6-8.5
Plutonium-238	pCi/L	NR	NR	NR	1.6[e]
Plutonium-239	pCi/L	NR	NR	NR	1.2[e]
Sodium	mg/L	6.8	1.89	1.58	NA
Strontium-89,90	pCi/L	NR	NR	NR	8[d]
Suspended solids	mg/L	8.08	5.2	14.1	NA
Temperature[j]	°C	18.1	18.6	17.3	32.2
Total dissolved solids	mg/L	355.6	48	36	500[k]
Tritium	pCi/L	NR	NR	NR	20,000[d]
Uranium-234	pCi/L	NR	NR	NR	20[e]
Uranium-235	pCi/L	NR	NR	NR	24[e]
Uranium-238	pCi/L	NR	NR	NR	24[e]
Zinc	mg/L	0.041	0.040	0.028	0.059

a. Source: Arnett and Mamatey (1997).
b. Parameters DOE routinely measures as a regulatory requirement or as part of ongoing monitoring programs.
c. Water Quality Criterion (WQC) is Aquatic Chronic Toxicity unless otherwise indicated.
d. MCL = Maximum Contaminant Level; State Primary Drinking Water Regulations.
e. DCG = DOE Derived Concentration Guides for Water (DOE Order 5400.5). DCG values are based on committed effective dose of 100 millirem per year; however, because drinking water MCL is based on 4 millirem per year, value listed is 4 percent of DCG.
f. Concentration exceeded WQC; however, these criteria are for comparison only. WQCs are not legally enforceable.
g. ND = Not Detected.
h. NA = Not Applicable.
i. NR = Not Reported.
j. Shall not be increased more than 2.8°C (5°F) above natural temperature conditions or exceed a maximum of 32.2°C (90°F) as a result of the discharge of heated liquids unless appropriate temperature criterion mixing zone has been established.
k. Secondary MCL; State Primary Drinking Water Regulations.

Figure 3.2-3. SRS streams and Savannah River water quality sampling locations.

aquifer systems, the Floridan Aquifer System, the Dublin Aquifer System, and the Midville Aquifer System as shown in Figure 3.1-2 (Aadland, Gellici, and Thayer 1995). Each aquifer system is divided from the others by two confining systems, the Meyers Branch Confining System and the Allendale Confining System, as shown in Figure 3.1-2.

Groundwater within the Floridan system (the shallow aquifer beneath the Site) flows slowly toward SRS streams and swamps and into the Savannah River at rates ranging from inches to several hundred feet per year. The depth to which onsite streams cut into 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. 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 from the lower unit to the overlying unit.

Groundwater flow in the shallow aquifer (Floridan) system is vertically downward in the divide areas between surface water drainages due to the decreasing hydraulic head with increasing depth. In areas along the lower reaches of most of the Site streams, groundwater moves vertically upward from deeper aquifers to the shallow aquifers. In these areas hydraulic heads increases with depth.

In the vicinity of these streams, the vertical upward flow occurs across the Crouch Branch Confining Unit/Gordon Confining Unit. At these locations any contaminants in the overlying aquifer system are prevented from migrating into deeper aquifers by the prevailing hydraulic gradient and the low permeability of the confining unit. Horizontal groundwater flow occurs at the M-Area metallurgical laboratory (to the west-northwest in the shallow aquifer and subsequent flow to the south toward Upper Three Runs in the intermediate aquifer), K-Area Disassembly Basin (toward Pen Branch and L Lake), P-Area Disassembly Basin (toward Steel Creek), F Canyon (toward Upper Three Runs and Fourmile Branch), and H Canyon (toward Upper Three Runs and its tributaries).

3.2.2.2 Groundwater Use

Groundwater is a domestic, municipal, and industrial water source throughout the Upper Coastal Plain. Domestic water supplies come primarily from the shallow aquifers including the Gordon Aquifer and the Upper Three Runs Aquifer (water-table aquifer). Most municipal and industrial water supplies in Aiken County are from the Cretaceous intermediate to deep aquifer units. In Barnwell and Allendale Counties some municipal water supplies are from the Gordon Aquifer and overlying units that thicken to the southeast. At SRS, most groundwater production for domestic and process water comes from the intermediate/deep aquifers (i.e., the Crouch Branch and McQueen Branch Aquifers), with a few lower-capacity process water wells pumping from the shallower Gordon Aquifer.

Every major operating area at SRS has groundwater wells; total groundwater production ranges from 9 to 12 million gallons (34,000 to 45,000 cubic meters) per day, similar to the volume pumped for industrial and municipal production within 10 miles (16 kilometers) of the Site (Arnett and Mamatey 1996).

From October 1995 to September 1996, the total groundwater withdrawal rate for C, F, H, P, and L Areas was approximately 4 million gallons (15,130 cubic meters) per day. Groundwater in C Area comes from two domestic wells that produced approximately 220,000 gallons (830 cubic meters) per day. Groundwater in F Area is pumped from four process production and two domestic wells. The total F-Area groundwater production rate from October 1995 to September 1996 was approximately 1.58 million gallons (5,981 cubic meters) per day. During the same period, wells in H, L, and P Areas produced ap-

proximately 1.9 million gallons (7,190 cubic meters) per day, 140,000 gallons (530 cubic meters) per day, and 170,000 gallons (640 cubic meters) per day, respectively. H Area has two domestic wells and three process production wells; L Area has two domestic wells. Until recently, two P-Area groundwater wells were used for domestic purpose. At present, these wells are not being used for domestic or process production. SRS is implementing a consolidation program for domestic wells. When this program is complete, DOE might take the domestic wells in C, F, H, and L Areas out of service or use them only for process water (Wells 1997).

3.2.2.3 SRS Hydrogeology

The aquifers of interest for C, F, H, L, and P Areas are the Upper Three Runs and Gordon Aquifers. The Upper Three Runs (water table) Aquifer is defined by the hydrogeologic properties of the Tinker/Santee Formation, the Dry Branch Formation, and the Tobacco Road Formation (DOE 1996a). Table 3.1-1 lists these formations.

The Gordon Confining Unit (green clay), which separates the Upper Three Runs and Gordon Aquifers, consists of the Warley Hill Formation and the Blue Bluff Member of the Santee Limestone (Table 3.1-1). It is not a continuous clay unit, but consists of several lenses of green and gray clay that thicken, thin, and pinch out abruptly. Locally, beds of calcareous mud add to the thickness of the unit with minor interbeds of clayey sand or sand. The vertical hydraulic conductivity ranges from 1.1×10^{-6} foot (3.4×10^{-5} centimeter) to 0.16 foot (4.9 centimeters) per day and the horizontal conductivity ranges from 5.4×10^{-6} foot (1.6×10^{-5} centimeter) to 5.7×10^{-3} foot (0.17 centimeter) per day (Aadland, Gellici, and Thayer 1995). TC

The Gordon Aquifer consists of the Congaree, Fourmile, and Snapp Formations. Table 3.1-1 lists the soil descriptions for these formations. The Gordon Aquifer is partially eroded near the Savannah River and Upper Three Runs. This aquifer is recharged directly by precipitation in the outcrop area and at interstream drainage divides in and near the outcrop area, and by leakage from overlying and underlying aquifers. The northeast-to-southwest hydraulic gradient across SRS is consistent and averages 4.8 feet per mile (0.9 meter per kilometer). Based on pumping tests on 13 SRS wells, the average hydraulic conductivity is approximately 35 feet (10.7 meters) per day.

3.2.2.4 Groundwater Quality

Industrial solvents, metals, tritium, and other constituents used or generated on SRS have contaminated the shallow aquifers beneath 5 to 10 percent of the Site. In general, DOE does not use these aquifers for SRS operations or drinking water, although there are a few low-yield wells in the Gordon Aquifer. The shallow aquifer units discharge to SRS streams and eventually the Savannah River (Arnett and Mamatey 1997). TC

Most contaminated groundwater at SRS occurs beneath a few facilities; the contaminants reflect the operations and chemical processes performed at those facilities. At C Area, groundwater contaminants above regulatory or SRS guidelines include tritium and other radionuclides, bis (2-ethylhexyl) phthalate, carbon disulfide, lead, manganese, and chlorinated organics. At F and H Areas, contaminants above the guidelines include tritium and other radionuclides, metals, nitrates, sulfates, and chlorinated and volatile organics. At L Area, tritium, other radionuclides, carbon disulfide, chlorinated and volatile organics, and metals are in the groundwater at levels above the guidelines. Groundwater beneath the L-Area Disassembly Basin has been affected by metals, chlorinated organics, and tritium at levels above regulatory guidelines. Tables 3.2-4 through 3.2-8 list concentrations of individual analytes above regulatory or SRS guidelines for 1995 in C, F, H, L, and P Areas, respectively (WSRC 1995a). Figure 3.2-4 shows generalized groundwater contamination maximum values for analytes at or above regulatory or established SRS guidelines for the areas of concern.

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

Analyte	Concentration	Regulatory Limit
Aluminum[b]	6,430 µg/L	50 µg/L[c]
Bis (2-ethylhexyl) phthalate	23 µg/L	6 µg/L[d]
Iron[b]	10,500 µg/L	300 µg/L[d]
Lead[b]	301 µg/L	50 µg/L[e]
Manganese[b]	254 µg/L	50 µg/L[c]
Carbon disulfide	74 µg/L	10 µg/L[f]
Trichloroethylene	1,580 µg/L	5 µg/L[d]
Tetrachloroethylene	174 µg/L	5 µg/L[d]
Dichloromethane	8.7 µg/L	5 µg/L[d]
Total organic halogens	972 µg/L	50 µg/L[f]
Tritium	2.4×10^{-2} µCi/mL	2.0×10^{-5} µCi/mL[d]
Thallium	3.5 µg/L	2 µg/L[d]
Thorium-234	6.8×10^{-7} µCi/mL	4.01×10^{-7} µCi/mL[g]

a. µg/L = micrograms per liter; µCi/mL = microcuries per milliliter.
b. Total recoverable.
c. EPA National Secondary Drinking Water Standards (WSRC 1995a).
d. EPA Primary Drinking Water Standards (WSRC 1995a).
e. SCDHEC Final Primary Drinking Water Standards (WSRC 1995a).
f. Drinking Water Standards do not apply. Criterion 10 times a recently published 90th percentile detection limit was used (WSRC 1995a).
g. EPA Proposed Primary Drinking Water Standard (WSRC 1995a).

3.3 Air Resources

3.3.1 GENERAL METEOROLOGY

Based on data collected from SRS meteorological towers from 1987 through 1991 (the latest quality-assured 5-year data set), maximum wind direction frequencies at the Site are from the northeast and west-southwest and the average wind speed is 8.5 miles per hour (3.8 meters per second). The average annual temperature at the Site is 64°F (17.8°C). The atmosphere in the region is unstable approximately 56 percent of the time, neutral 23 percent of the time, and stable about 21 percent of the time (Shedrow 1993). In general, as the atmosphere becomes more unstable, atmospheric dispersion of airborne pollutants increases and ground-level pollutant concentrations decrease.

3.3.2 SEVERE WEATHER

The SRS area experiences an average of 55 thunderstorm days a year, 50 percent of which occur in June, July, and August (Shedrow 1993). On average, lightning strikes six times a year on a square-kilometer area (Hunter 1990). The highest windspeed recorded at Bush Field (Augusta, Georgia) between 1950 and 1993 was 62 miles (100 kilometers) per hour (NOAA 1994).

From 1954 to 1983, 37 reported tornadoes occurred in a 1-degree square of latitude and longitude that includes SRS (WSRC 1993). This frequency of occurrence is equivalent to an average of about one tornado per year. Tornado statistics indicate that the average frequency of a tornado striking any single point on the site is TC

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

Analyte	Concentration (µg/L for metals and organics; µCi/mL for radioisotopes unless otherwise noted)	Regulatory limit (µg/L for metals and organics; µCi/mL for radioisotopes)
Aluminum[b]	95,900	50[c]
Beryllium[b]	10	4[d]
Bis (2-ethylhexyl) phthalate	190	6[d]
Cadmium[b]	243	5[d]
Copper[b]	1,210	1,000[d]
Chromium[b]	185	100[d]
Iron[b]	261,000	300[d]
Lead[b]	6,500	50[e]
Lithium[b]	249	50[f]
Manganese[b]	15,000	50[c]
Mercury[b]	5.4	2[e]
Nickel[b]	176	100[d]
Carbon tetrachloride	23	5[d]
Trichloroethylene	96	5[d]
Trichlorofluoromethane	80	10[f]
Tetrachloroethylene	42	5[d]
Dichloromethane	65	5[d]
1,2-dichloroethane	162	5[d]
Total organic carbon	18,600	10,000
Total organic halogens	148	50[f]
Nitrate as nitrogen	71,300	1,000[d]
Nitrate-nitrite as nitrogen	384,000	10,000[d]
Americium-241	9.9×10^{-8}	6.34×10^{-9}[g]
Cesium-137	4.4×10^{-7}	2.0×10^{-7}[h]
Cobalt[b]	665	40[f]
Curium-243/244	1.6×10^{-7}	8.3×10^{-9}[g]
Curium-245/246	9.9×10^{-8}	6.23×10^{-9}[g]
Iodine-129	7.2×10^{-7}	1.0×10^{-9}[h]
Lithium[b]	56	50[f]
Tritium	2.2×10^{-2}	2.0×10^{-5}[d]
Plutonium-238	2.3×10^{-8}	7.02×10^{-9}[g]
Radium-226	1.1×10^{-7}	2.0×10^{-8}[g,i]
Radium-228	3.1×10^{-7}	2.0×10^{-8}[g,i]
Nonvolatile beta	2.5×10^{-5}	5.0×10^{-8}[h]
Total alpha-emitting radium	1.6×10^{-7}	2.0×10^{-8}[g]
Gross alpha	2.5×10^{-6}	1.5×10^{-8}[d]
Strontium-89	7.1×10^{-7}	2.0×10^{-8}[h]
Strontium-90	7.4×10^{-6}	8.0×10^{-9}[d]
Thallium[b]	4.3	2.0[d]
Thorium-234	9.5×10^{-7}	4.01×10^{-7}[g]
Uranium-233/234	4.8×10^{-7}	1.38×10^{-8}[g]
Uranium-235	5.0×10^{-8}	1.45×10^{-8}[g]
Uranium-238	1.3×10^{-6}	1.46×10^{-8}[g]

a. Abbreviations: µg/L = micrograms per liter; µCi/mL = microcuries per milliliter.
b. Total recoverable.
c. EPA National Secondary Drinking Water Standard (WSRC 1995a).
d. EPA Final Primary Drinking Water Standard (WSRC 1995a).
e. SCDHEC Final Primary Drinking Water Standard (WSRC 1995a).
f. Drinking Water Standards do not apply. Criterion 10 times a recently published 90th percentile detection limit was used (WSRC 1995a).
g. EPA Proposed Primary Drinking Water Standard (WSRC 1995a).
h. EPA Interim Final Primary Drinking Water Standards (WSRC 1995a).
i. Radium-226/228 combined proposed Maximum Contaminant Level of 5.0×10^{-8} microcuries per milliliter.

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

Analyte	Concentration (µg/L for metals and organics; µCi/mL for radioisotopes)	Regulatory limit (µg/L for metals and organics; µCi/mL for radioisotopes)
Aluminum[b]	2,800	50[c]
Bis (2-ethylhexyl) phthalate	23	6[d]
Iron[b]	7,990	300[d]
Lead[b]	301	50[e]
Manganese[b]	91	50[c]
Trichloroethylene	1,580	50[c]
Total Organic Halogens	972	50[d]
Thallium[b]	4.0	2.0[d]
Tritium	2.4×10^{-2}	2.0×10^{-5}[d]
Thorium-234	6.8×10^{-7}	4.01×10^{-7}[g]

a. Abbreviations: µg/L = micrograms per liter; µCi/mL = microcuries per milliliter.
b. Total recoverable.
c. EPA National Secondary Drinking Water Standard (WSRC 1995a).
d. EPA Final Primary Drinking Standard (WSRC 1995a).
e. SCDHEC Final Primary Drinking Water Standard (WSRC 1995a).
f. Drinking Water Standards do not apply. Criterion 10 times a recently published 90th percentile detection limit was used (WSRC 1995a). TC
g. EPA Proposed Primary Drinking Water Standards (WSRC 1995a).

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

Analyte	Concentration (µg/L for metals and organics; µCi/mL for radioisotopes)	Regulatory limit (µg/L for metals and organics; µCi/mL for radioisotopes)
Aluminum[b]	320	50[c]
Boron[b]	1,590	300[d]
Iron[b]	14,100	300[d]
Lead[b]	58	50[e]
Manganese[b]	771	50[c]
Tetrachloroethylene	17	5[d]
Total Organic Carbon	3.5×10^{-6}	10,000[f]
Nitrate-nitrite as Nitrogen	268,000	10,000[d]
Thallium[b]	7.4	2.0[d]
Tritium	5.4×10^{-4}	2.0×10^{-5}[d]
Non-volatile Beta	1.7×10^{-6}	5.0×10^{-8}[g]

a. Abbreviations: µg/L = micrograms per liter; µCi/mL = microcuries per milliliter.
b. Total recoverable.
c. EPA National Secondary Drinking Water Standard (WSRC 1995a).
d. EPA Final Primary Drinking Water Standard (WSRC 1995a).
e. SCDHEC Final Primary Drinking Water Standard (WSRC 1995a).
f. Drinking Water Standards do not apply. Criterion 10 times a recently published 90th percentile detection limit was used (WSRC 1995a).
g. EPA Interim Final Primary Drinking Water Standards (WSRC 1995a).

Table 3.2-8. P-Area maximum reported groundwater parameters in excess of regulatory and SRS limits.[a]

Analyte	Concentration (μg/L for metals and organics)	Regulatory limit (μg/L for metals and organics)
Aluminum[b]	19,900	50[c]
Iron[b]	22,200	300[d]
Manganese[b]	419	50[c]
Carbon tetrachloride	11	5[d]
Trichloroethylene	24	50[d]
Tetrachloroethylene	8.4	5[d]
Total organic halogens	79	50[e]
Tritium	7.7×10^{-2} Ci/mL	2.0×10^{-5} μCi/mL
Strontium-90	1.7×10^{-6} Ci/mL	8.0×10^{-9} μCi/mL

a. Abbreviations: μg/L = micrograms per liter; μCi/mL = microcuries per milliliter.
b. Total recoverable.
c. EPA National Secondary Drinking Water Standard (WSRC 1995a).
d. EPA Final Primary Drinking Water Standard (WSRC 1995a).
e. Drinking Water Standards do not apply. Criterion 10 times a recently published 90th percentile detection limit was used (WSRC 1995a).

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2×10^{-4} per year or about once every 5,000 years (Weber et al. 1998). Since operations began in 1953, nine confirmed tornadoes have occurred on or near the Site. Nothing more than light damage occurred, with the exception of a tornado in October 1989 that caused considerable damage to forest resources in an undeveloped southeastern sector of the SRS (Shedrow 1993). From 1700 to 1992, 36 hurricanes crossed South Carolina, which resulted in a frequency of about one every 8 years (WSRC 1993). Because the SRS is about 100 miles (160 kilometers) inland, the winds associated with hurricanes have usually diminished below hurricane force [i.e., equal to or greater than a sustained wind speed of 75 miles per hour (33.5 meters per second)] before reaching the Site. Winds exceeding hurricane force have been observed only once at the SRS (Hurricane Gracie in 1959) (Shedrow 1993).

3.3.3 RADIOLOGICAL AIR QUALITY

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. This section references several of those documents, which contain additional information. The information enables comparisons of current data with potential releases, concentrations, and doses associated with each alternative.

In the SRS region, airborne radionuclides originate from natural sources (terrestrial and cosmic), worldwide fallout, and Site operations. DOE maintains a network of air monitoring stations on and around the Site to determine concentrations of radioactive particulates and aerosols in the air (Arnett and Mamatey 1998b). TC

Table 3.3-1 lists average and maximum atmospheric radionuclide concentrations at the SRS boundary and at background monitoring locations [100-mile (160-kilometer) radius] during 1997. Tritium is the only radionuclide from the SRS detected routinely in offsite air samples above background (control) concentrations (Cummins, Martin, and Todd 1990, 1991; Arnett et al. 1992; Arnett, Karapatakis, and Mamatey 1993, 1994; Arnett and Mamatey 1996; Arnett and Mamatey 1997; Arnett and Mamatey 1998b). Table 3.3-2 lists 1997 radionuclide releases from each major operational group of SRS facilities. All radiological impacts are within regulatory requirements. TC TC

Figure 3.2-4. Maximum reported groundwater contamination at Savannah River Site.

Table 3.3-1. Radioactivity in air at SRS boundary and at 100-mile (160-kilometer) radius during 1997 (picocuries per cubic meter).[a]

Location	Tritium	Gross alpha	Gross beta	Cobalt-60	Cesium-137	Strontium-89,90	Plutonium-238	Plutonium-239
Site boundary								
Average[b]	11	9.8×10^{-4}	0.015	5.7×10^{-4}	1.5×10^{-4}	8.0×10^{-5}	(c)	(c)
Maximum[d]	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	(c)	(c)	8.9×10^{-4}	6.9×10^{-6}	(c)
Maximum	5.4	0.0030	0.018	0.0073	0.0055	0.0019	4.2×10^{-5}	2.6×10^{-5}

TC

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

3.3.4 NONRADIOLOGICAL AIR QUALITY

The SRS is in the Augusta (Georgia) - Aiken (South Carolina) Interstate Air Quality Control Region. This region, which is designated a Class II area, is in compliance with National Ambient Air Quality Standards for criteria pollutants. Class II is the initial designation of any area that is not pristine; pristine areas include national parks or national wilderness areas. Criteria pollutants include sulfur dioxide, nitrogen oxides (reported as nitrogen dioxide), particulate matter (less than or equal to 10 microns in diameter), carbon monoxide, ozone, and lead (40 CFR 50).

DOE used the comprehensive emissions inventory data for 1996, which is the most recent available, to establish the baseline year for showing compliance with national and state air quality standards by calculating actual emission rates for existing sources of criteria pollutants. DOE based these emission rates on process knowledge, source testing, material balance, and EPA's Industrial Source Complex Air Dispersion Model.

SCDHEC has air quality regulatory authority over SRS. SCDHEC determines ambient air quality compliance based on air pollutant emissions and estimates of concentrations at the Site boundary based on atmospheric dispersion modeling. The SRS is in compliance with National Ambient Air Quality Standards for criteria pollutants and gaseous fluoride and with total suspended particulate standards, as required by SCDHEC Regulation R.61-62.5, Standard 2, "Ambient Air Quality Standards." Table 3.3-3 lists these standards and the results of the atmospheric dispersion modeling for baseline year 1996.

The SRS is in compliance with SCDHEC Regulation R.61-62.5, Standard 8, "Toxic Air Pollutants," which regulates the emission of 257 toxic air pollutants (WSRC 1994). DOE has identified emission sources for 139 of the 257 regulated air toxics; the modeled results indicate that the Site is in compliance with SCDHEC air quality standards. Table 3.3-4 lists toxic air pollutants that are the same as those the alternative actions described in this EIS would emit, and compares maximum downwind concentrations at the Site boundary for baseline year 1990, which is the most recent data available, to SCDHEC standards for toxic air pollutants.

Table 3.3-2. Radiological atmospheric releases by operational group for 1997.[a]

Radionuclide[b]	Half-life	Reactors	Separations[c]	Reactor materials	Heavy water	SRTC[d]	Diffuse and fugitive[e]	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[f]	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}

TC

Table 3.3-2. (Continued).

Radionuclide[b]	Half-life	Reactors	Separations[c]	Reactor materials	Heavy water	SRTC[d]	Diffuse and fugitive[e]	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}	TC
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[g]	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}yr						1.8×10^{-5}	1.8×10^{-5}	
Cm-242	162.8 days						8.2×10^{-12}	8.2×10^{-12}	

Table 3.3-2. (Continued).

Radionuclide[b]	Half-life	Reactors	Separations[c]	Reactor materials	Heavy water	SRTC[d]	Diffuse and fugitive[e]	Total
		Curies released						
Particulates (continued)								
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}

a. Source: Arnett and Mamatey (1998a).
b. 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.
c. Includes F- and H-Area releases.
d. SRTC = Savannah River Technology Center.
e. Estimated releases from minor unmonitored diffuse and fugitive sources.
f. Includes unidentified beta emissions.
g. Includes unidentified alpha emissions.

TC

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

Pollutant	Averaging time	SCDHEC ambient standard ($\mu g/m^3$)[a]	Estimated SRS baseline concentration ($\mu g/m^3$)[b]
Criteria pollutants			
Sulfur dioxide (as SO_x)[c]	3-hr	1,300	1,200
	24-hr	365	350
	Annual	80	34
Total suspended particulates	Annual	75	67
Particulate matter (≤10 μm)[d]	24-hr	150	133
	Annual	50	25
Carbon monoxide	1-hr	40,000	10,000
	8-hr	10,000	6,900
Nitrogen dioxides (as NO_x)[e]	Annual	100	26
Lead	Calendar Quarterly mean	1.5	0.03
Ozone (as total VOCs)[f]	1-hr	235	NA[g]
Toxic/hazardous air pollutants			
Benzene	24-hr	150	3.9
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

TC

SO_x = oxides of sulfur; NO_x = oxides of nitrogen: VOCs = volatile organic compounds; NA = not available.

a. Source: SCDHEC Standard 2, "Ambient Air Quality Standards," and Standard 8, "Toxic Air Pollutants" (SCDHEC 1976).
b. Source: Hunter (1999). 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 on emissions for all oxides of sulfur (SO_x).
d. New NAAQS for particulate matter ≤2.5 microns (24-hour limit of 65 $\mu g/m^3$ and an annual average limit of 15 $\mu g/m^3$) will become enforceable during the life of this project.
e. Based on 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.
g. Ambient concentrations of VOCs, which are precursors to ozone, can be used to provide a highly conservative bounding estimate for ozone but should not be used for explicit assessments of compliance with the ozone standard. Not all the VOCs emitted will result in the formation of ozone, and there is no method to directly correlate the two quantities. For purposes of estimating ozone concentrations from all SRS operations, no value for total VOCs is provided since the estimate would be overly conservative.

Table 3.3-4. Estimated 24-hour average ambient concentrations at SRS boundary - toxic air pollutants regulated by South Carolina from SRS sources.[a]

Pollutant[b]	Concentration ($\mu g/m^3$)[c]	Regulatory standard ($\mu g/m^3$)	Concentration as a percent of standard (%)
Benzene	31	150	20.70
Hexane	0.07	200	0.04
Nitric acid	6.70	125	5.40
Sodium hydroxide	0.01	20	0.05
Toluene	1.60	2,000	0.08
Xylene	3.80	4,350	0.09

$\mu g/m^3$ = micrograms per cubic meter.

a. Source: WSRC (1994).

b. Pollutants listed include air toxics of interest in relation to spent nuclear fuel management alternatives. (Section 5.2 addresses the effects of all air toxics.)

c. Based on actual emissions from existing SRS sources plus maximum potential emissions for sources permitted for construction through December 1992.

DOE measures nonradiological air emissions from SRS facilities at their points of discharge by direct measurement, sample extraction and measurement, or calculation of the emissions using process knowledge. Using monitoring data and meteorological information, DOE estimates the concentration of certain pollutants at the Site boundary. The Site is in compliance with National Ambient Air Quality Standards.

TC | The Environmental Protection Agency approved revisions to the national ambient air quality standards for ozone and particulate matter that became effective on September 16, 1997. However, on May 14, 1999, in response to challenges filed by industry and others, the U.S. Court of Appeals for the District of Columbia Circuit issued a split opinion (2 to 1) directing
TC | 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 EPA has asked the U.S. Department of Justice to appeal this decision and take all judicial steps necessary to overturn the decision. Therefore, it is uncertain at this time when new ozone and particulate matter standards will become enforceable.

3.4 Ecological Resources

The U.S. Government acquired the land that became SRS in 1951. At that time, the Site was approximately two-thirds forested and one-third cropland and pastures. An extensive forest management program conducted by the Savannah River Natural Resources Management and Research Institute (SRI), which is part of the U.S. Forest Service, has converted many croplands and pastures to pine plantations. At present, more than 90 percent of the SRS is forested.

The Site provides more than 181,000 acres (734 square kilometers) of contiguous forested cover broken only by unpaved secondary roads, transmission line corridors in various stages of succession, a few paved primary roads, and scattered industrial facilities. Carolina bays, the Savannah River Swamp, and several relatively intact longleaf pine-wiregrass communities contribute to the biodiversity of the SRS and the entire region.

Under some of the alternatives described in Chapter 2, DOE proposes to construct and operate a Transfer and Storage Facility or a Transfer, Storage, and Treatment Facility at SRS to receive, characterize, condition, treat, package, and dry-store spent nuclear fuel before shipping it to

a geologic repository. If not located in an existing reactor building, the site for either of these facilities would cover approximately 15 acres (0.061 square kilometer), including the building footprint(s), construction area needs, and security requirements (WSRC 1996a).

As described in Chapter 2, this Transfer and Storage Facility or Transfer, Storage, and Treatment Facility would be in L Area (preferred site), C Area, or P Area. Facilities to implement the New Processing Technology Alternative also could be located inside a reactor building, such as Building 105-L.

The proposed site for any new facility in L Area is a ridge that runs southwest-to-northeast approximately 0.5 mile (0.8 kilometer) from the Steel Creek floodplain. The site, which is wholly within the developed portion of L Area, is bounded by L Reactor to the west, a rail spur (L Line) to the north, and paved access roads to the east and south. The area consists of buildings, paved areas, graveled areas, and mowed turf grasses. The site is inside 6-foot (1.8-meter) security fences and has negligible value as wildlife habitat.

An upland pine stand is immediately east of the proposed site, adjacent to the fenced area. The stand is primarily slash pines (*Pinus elliotti*) that the Forest Service planted in the mid-1950s, with small areas of long-leaf (*P. palustris*) and loblolly pine (*P. taeda*) planted in the 1940s (SRFS 1997). Understory species include black cherry (*Prunus serotina*), wax myrtle (*Myrica cerifera*) and yellow jessamine (*Gelsemium sempervirens*). SRI manages forested areas such as this for timber production and wildlife.

Wildlife characteristically found in SRS pine plantations include toads (i.e., the southern toad, [*Bufo terrestris*]), lizards (e.g., the eastern fence lizard, [*Sceloporus undulatus*]), snakes (e.g., the black racer, [*Coluber constrictor*]), songbirds (e.g., the brown-headed nuthatch [*Sitta pusilla*], and the pine warbler [*Dendroica pinus*]), birds of prey (e.g., the sharp-shinned hawk [*Accipiter striatus*]), and a number of mammal species (e.g., the cotton mouse [*Peromyscus gossypinus*]), the gray squirrel [*Sciurus carolinensis*], the opossum [*Didelphis virginiana*], and the white-tailed deer [*Odocoileus virginianus*]) (Sprunt and Chamberlain 1970; Cothran et al. 1991; Gibbons and Semlitsch 1991; Halverson et al. 1997).

The proposed site for a new facility in C Area is on a plateau that rises between the floodplains of Fourmile Branch to the north and Castor Creek to the south. The entire site is inside the developed portion of C Area, surrounded by security fencing. The area consists of buildings, paved areas, graveled areas, and mowed turf grasses. A paved access road, a railroad spur, and two transmission lines cross the site. It provides little or no wildlife habitat. The areas immediately north and south of the site are forested, primarily with long-leaf and loblolly pine planted in the 1950s. The shrub layer contains young oaks (*Quercus* spp.) black cherry, hawthorne (*Crataegus* sp.), wax myrtle, and bear-grass (*Yucca filamentosa*). The wildlife species listed for L Area occur in these woods as well.

The proposed facility site in P Area is a broad hilltop above the headwaters of Steel Creek (to the west), Meyers Branch (to the south), and Lower Three Runs/Par Pond (to the east). The western two-thirds of the area (adjacent to the P-Area fence) is meadow-like, comprised mostly of lawn grasses and a few common forbs, such as low hop clover (*Trifolium dubium*) and smooth vetch (*Vicia dasycarpa*). The remainder of the area is wooded, with trees that appear to have regenerated since P Area was developed in the early 1950s. The canopy layer is dominated by laurel oak (*Quercus laurifolia*), water oak (*Q. nigra*), blackjack oak (*Q. marilandica*), mockernut hickory (*Carya alba*), and long-leaf pine. In the sub-canopy and shrub layer, species such as *Q. laevis* (turkey oak), huckleberry (*Vaccinium stamineum*), and hawthorne are well represented. Wooded areas to the north and east of the site are predominantly slash pines that were planted in the 1950s and loblolly pines that were planted in the 1980s (SRFS 1997). Because it is regularly mowed, the grassy area provides lim-

ited wildlife habitat. The wooded areas presumably provide habitat for many of the wildlife species mentioned above.

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), short-nosed 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). None of these species is known to occur on or near the proposed facility sites in L, C, P, F, or H Areas, which are located on previously disturbed areas (SRFS 1996).

3.5 Socioeconomics

Approximately 90 percent of the 1995 SRS workforce lived in the SRS region of influence which includes Aiken, Allendale, Bamberg, and Barnwell Counties in South Carolina, and Columbia and Richmond Counties in Georgia. *Socioeconomic Characteristics of Selected Counties and Communities Adjacent to the Savannah River Site* (HNUS 1997) contains additional information on the economic and demographic characteristics of the six-county region.

3.5.1 EMPLOYMENT

Between 1980 and 1990, total employment in the six-county region increased from 181,072 to 241,409, an average annual growth rate of approximately 2.9 percent. The unemployment rates for 1980 and 1990 were 7.3 percent and 4.7 percent, respectively (HNUS 1997). In 1994, regional employment was 243,854, an increase of only 1 percent since 1990. Over the next 10-year period, employment in the region is projected to increase at an average rate of slightly less than 1 percent per year, reaching approximately 264,000 by 2004 (HNUS 1997).

The increase in employment in the 1980s was spurred in part by the buildup in employment at

the SRS during the middle and late years of the decade, and in part by the improved national economy. The flat increases in regional employment since 1990 are the result of the mild national recession from 1990 to 1992, followed by the decreases in SRS employment, discussed below.

At the beginning of fiscal year 1996, employment at SRS was 16,625, approximately 7 percent of regional employment, with an associated annual payroll of approximately $634 million. This represents a decrease of 6,726 in SRS employment since 1992 and an associated payroll reduction of $466 million from more than $1.1 billion. Site employment declined through attrition by approximately 950 jobs between the fall of 1995 and the fall of 1996 and by another approximately 850 jobs in early 1997 through involuntary separations. By March 1998, the SRS workforce was reported at 14,014 persons (DOE 1998).

3.5.2 POPULATION

Based on state and Federal agency surveys and trends, the estimated 1998 population in the region of influence 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 growth rate of about 6.5 percent between 1990 and 1998 (U.S. Bureau of the Census 1999). Columbia County, and to a lesser extent Aiken County, contributed to most of the growth due to in-migration from other region of influence counties and other states. Over the same period Bamberg and Barnwell counties experienced net outmigration. In 2000, the population in the six-county region is expected to be approximately 498,900. Over the next 10-year period, the regional population should grow at a projected rate of 1 to 2 percent per year, reaching approximately 533,400 by 2010. According to census data, in 1990 the estimated average number of persons per household in the six-county region was 2.72, and the median age of the population was 31.8 years (HNUS 1997).

3.5.3 COMMUNITY CHARACTERISTICS

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (February 11, 1994), directs Federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. Executive Order 12898 also directs the Administrator of EPA to convene an interagency Federal Working Group on Environmental Justice.

The Working Group has provided guidance to Federal agencies on criteria for identifying disproportionately high and adverse human health or environmental effects on minority and low-income populations (EPA 1998). In addition, the Council on Environmental Quality, in consultation with EPA and other Federal agencies, has developed guidance for identifying and addressing environmental justice concerns during the National Environmental Policy Act (NEPA) process (CEQ 1998). DOE has based the environmental justice analysis in this document on those guidance documents. Further, in coordination with the Working Group, DOE is developing internal guidance for implementing the Executive Order.

Potential offsite health impacts from the proposed action would result from releases to the air and to the Savannah River downstream of the SRS. For air releases, DOE performed standard population dose analyses on a 50-mile (80-kilometer) radius because reasonably foreseeable dose levels beyond that distance would be negligible. For liquid releases, the region of interest includes areas that draw drinking water from the river (Beaufort and Jasper Counties in South Carolina and Effingham and Chatham Counties in Georgia).

The analysis included data (U.S. Bureau of the Census 1990a,b) for populations in census tracts with at least 20 percent of their area in the 50-mile radius and all tracts from Beaufort and

Jasper Counties and Effingham and Chatham Counties, which are downstream of the Site. DOE used data from each census tract in this combined region to identify the racial composition of communities and the number of persons characterized by the U.S. Bureau of the Census as living in poverty. The combined region contains 247 census tracts, 99 in South Carolina and 148 in Georgia.

Tables 3.5-1 and 3.5-2 list racial and poverty characteristics, respectively, of the population in the combined region. Table 3.5-1 indicates a total population of more than 993,000 in the area. Of that population, approximately 618,000 (62.2 percent) are white. In the minority population, approximately 94 percent are African American; the remainder are small percentages of Asian, Hispanic, and Native American persons. Figure 3.5-1 shows the distribution of minorities by census tract areas in the SRS region.

Executive Order 12898 does not define minority populations. One approach to a definition is to identify communities that contain a simple majority of minorities (greater than or equal to 50 percent of the total community population). A second approach, proposed by EPA for environmental justice purposes, defines minority communities as those that have higher-than-average (over the region of interest) percentages of minority persons (EPA 1994). The shading patterns in Figure 3.5-1 indicate census tracts where (1) minorities constitute 50 percent or more of the total population, or (2) minorities constitute between 35 percent and 50 percent of the total population. For this analysis, DOE has adopted the second, more expansive, approach to identify minority communities.

The combined region has 80 tracts (32.4 percent) where minority populations constitute 50 percent or more of the total population. In an additional 50 tracts (13.5 percent), minorities constitute between 35 and 50 percent of the population. These tracts are distributed throughout the region, although there are more toward the south and in the immediate vicinities of Augusta and Savannah, Georgia.

Table 3.5-1. General racial characteristics of population in SRS region of interest.[a]

State	Total population	White	African American	Hispanic	Asian	Native American	Other	Minority	Percent minority[b]
South Carolina	418,685	267,639	144,147	3,899	1,734	911	355	151,046	36.08
Georgia	574,982	350,233	208,017	7,245	7,463	1,546	478	224,749	39.09
Total	993,667	617,872	352,164	11,144	9,197	2,457	833	375,795	37.82

a. Source: U.S. Bureau of the Census (1990a).
b. People of color population divided by total population.

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Table 3.5-2. General poverty characteristics of population in SRS region of interest.[a]

Area	Total population	Persons living in poverty[b]	Percent living in poverty
South Carolina	418,685	72,345	17.28
Georgia	574,982	96,672	16.81
Total	993,667	169,017	17.01

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

Low-income communities are those in which 25 percent or more of the population is characterized as living in poverty (EPA 1993). The U.S. Bureau of the Census defines persons in

poverty as those whose income is less than a "statistical poverty threshold." This threshold is a weighted average based on family size and the age of the persons in the family. The baseline threshold for the 1990 census was a 1989 income of $8,076 for a family of two.

Table 3.5-2 indicates that in the SRS region, more than 169,000 persons (17 percent of the population) are characterized as living in poverty. In Figure 3.5-2, shaded census tracts identify low-income communities. In the region, 72 tracts (29.1 percent) are low-income communities. These tracts are distributed throughout the region of analysis, but primarily to the south and west of SRS.

3.6 Cultural Resources

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

The archaeological research has provided considerable information about the distribution and content of archaeological and historic sites on SRS. Savannah River archaeologists have examined SRS land since 1974. To date they have examined 60 percent of the 300-square-mile (800-square kilometer) area and recorded more than 1,200 archaeological sites (HNUS 1997). Most (approximately 75 percent) of these sites are prehistoric.

The activities associated with the proposed action and alternatives for spent nuclear fuel management at SRS that could affect cultural

Figure 3.5-1. Distribution of minorities by census tract in SRS region of analysis.

Figure 3.5-2. Low-income census tracts in the SRS region of analysis.

resources are the use of one of the three sites for the proposed Transfer and Storage Facility or Transfer, Storage, and Treatment Facility.

The sites are in reactor areas (L, C, and P) within 100 to 400 yards (91 to 366 meters) of the reactor buildings. The Savannah River Archaeological Research Program has not examined any areas in and immediately around the reactors. Construction of these facilities took place before the enactment of Federal regulations to protect historic resources. Archaeological resources in the footprints of the three preferred sites would be unlikely to have survived reactor construction, although 1951 aerial photographs show that the C- and L-Area sites had homeplaces before the development of the SRS in the early 1950s (Sassaman 1997a,b).

The potential for prehistoric sites in the preferred locations is limited. The P-Area site is in archaeology site density Zone 2, which has moderate potential for prehistoric archaeological sites of significance. The L-Area site is in archaeological site density Zone 3, which has the least potential for prehistoric sites of significance. C Area is divided between Zones 2 and 3. However, in all cases, reactor construction activities probably destroyed or severely damaged any prehistoric deposits (Sassaman 1997a,b).

3.7 Public and Worker Health

3.7.1 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 millirem), and person-rem (which is the average individual doses times the population).

An individual's radiation exposure in the vicinity of SRS amounts to approximately 357 millirem per year, which is comprised of natural background radiation from cosmic, terrestrial, and internal body sources, radiation from medical diagnostic and therapeutic practices, weapons test fallout, consumer and industrial products, and nuclear facilities. Figure 3.7-1 shows the relative contributions of each source to people living near SRS. All radiation doses mentioned in this EIS are effective dose equivalents; internal exposures are committed effective dose equivalents.

Releases of radioactivity to the environment from SRS account for less than 0.1 percent of the total annual average environmental radiation dose to individuals within 50 miles (80 kilo-meters) of the Site. Natural background radiation contributes about 293 millirem per year, or 82 percent of the annual dose of 357 millirem received by an average member of the population within 50 miles of the Site. Based on national averages, medical exposure accounts for an additional 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 1987a).

Other nuclear facilities within 50 miles (80 kilometers) of SRS include a low-level waste disposal site operated by Chem-Nuclear Systems, Inc., near the eastern Site boundary and Georgia Power Company's Vogtle Electric Generating Plant, directly across the Savannah River from the Site. In addition, Carolina Metals, Inc., which is northwest of Boiling Springs in Barnwell County, processes depleted uranium.

South Carolina Nuclear Facility Monitoring - Annual Report 1992 (SCDHEC 1992) documents that the Chem-Nuclear and Carolina Metals 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 0.17 millirem to the maximally exposed individual at the plant boundary and a total population dose within a 50-mile (80-kilometer) radius of 0.057 person-rem (NRC 1996).

Figure 3.7-1. Major sources of radiation exposure in the vicinity of the Savannah River Site.

TC In 1997, releases of radioactive material to the environment from SRS operations resulted in a maximum individual dose of 0.05 millirem per year in the west-southwest sector of the Site boundary from atmospheric releases, and a maximum dose from liquid releases of 0.13 millirem per year, for a maximum total annual dose at the boundary of 0.18 millirem (Arnett and Mamatey 1998b). The maximum dose to downstream consumers of Savannah River water – 0.07 millirem per year – occurred to users of the Port Wentworth and the Beaufort-Jasper public water supplies (Arnent amd Mamatey 1998b).

In 1990 the population within 50 miles (80 kilometers) of the Site was approximately 620,100. The collective effective dose equivalent to that population in 1997 was 2.2 person-rem from atmospheric releases. The 1990 population of 65,000 people using water from the Cherokee Hill Water Treatment Plant near Port Wentworth, Georgia, and the Beaufort-Jasper Water Treatment Plant near Beaufort, South Carolina, received a collective dose equivalent of 2.4 person-rem in 1997 (Arnett and Mamatey 1998b). Population statistics indicate that cancer caused 23.2 percent of the deaths in the United States in 1994 (CDC 1998). If this percentage of deaths from cancer continues, 23.2 percent of the U.S. population will contract a fatal cancer from all causes. Thus, in the population of 620,100 within 50 miles of SRS, 143,863 persons will be likely to contract fatal cancers from all causes. The total 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)].

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3.7.2 PUBLIC NONRADIOLOGICAL HEALTH

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

3.7.3 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 (ALARA). Such a program must evaluate both external and internal exposures with the goal to minimize the total effective dose equivalent. An effective ALARA program 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 DOE worker exposure limits. DOE set administrative exposure guidelines at a fraction of the exposure limits to help enforce doses that are as low as reasonably achievable. For example, the current DOE worker exposure limit is 5,000 millirem per year, and the 1997 SRS ALARA administrative control level for the whole body is 500 millirem per year. Every year DOE evaluates the SRS ALARA administrative control levels and adjusts them as needed.

Table 3.7-1 lists maximum and average individual doses and SRS collective doses from 1989 to 1998. TC

Table 3.7-1. SRS annual individual and collective radiation doses.[a]

Year	Number with measurable dose	Average individual worker dose (rem)[b]	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

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a. Adapted from: DOE (1996b); WSRC (1997, 1998, 1999a).
b. The average dose includes only workers who received a measurable dose during the year.

3.7.4 WORKER NONRADIOLOGICAL HEALTH

Industrial hygiene and occupational health programs at the SRS deal with all aspects of worker health and relationship with the work environment. The objective of an effective occupational health program is to protect employees from hazards in their work environment. To evaluate these hazards, DOE uses routine monitoring to determine employee exposure levels to hazardous chemicals.

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

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 3.7-2 lists the estimated maximum and average annual concentrations of existing OSHA-regulated workplace pollutants modeled in and around existing SRS facilities. Estimated concentration levels for existing OSHA-regulated workplace pollutants are less than the OSHA Permissible Exposure Limits for all contaminants, with the exception of nitrogen dioxide (as nitrogen oxide) and nitric acid. The large nitrogen dioxide exceedance (a 15-minute average of 406 mg/m^3 compared to the OSHA Permissible Exposure Limit of 9 mg/m^{-3}) is based on modeling assumptions with maximum potential emissions for diesel units including back-up units operating at ground-level for limited periods (Stewart 1997). The nitric acid value also is based on maximum potential emissions related to conventional processing activities. Actual emissions are expected to be below regulatory limits.

DOE has established industrial hygiene and occupational health programs for the processes covered by this EIS and across the SRS to protect the health of workers from nonradiological hazards.

3.8 Waste and Materials

3.8.1 WASTE MANAGEMENT

This section describes the waste generation baseline that DOE uses in Chapter 4 to gauge the relative impact of each SNF management alternative on the overall production of waste at SRS and on DOE's capability to manage such waste.

Table 3.7-2. Estimated maximum annual concentrations (milligrams per cubic meter) of workplace pollutants regulated by Occupational Safety and Health Administration.[a]

Pollutant	OSHA PEL[b] (mg/m^3)	Time period	Concentrations (mg/m^3) Maximum 8-hour average	Concentrations (mg/m^3) Annual average
Carbon monoxide	55	8 hours	10	0.53
Nitrogen dioxide (as NO_x)	9	Ceiling limit[c]	406[d]	2.3
Total particulates	15	8 hours	0.95	0.06
Sulfur dioxide (as SO_x)	13	8 hours	0.63	0.05
Hexane	1,800	8 hours	1.5	0.08
Nitric acid	5	8 hours	11	0.34
Sodium hydroxide	2	8 hours	<0.01	<0.01
Xylene	435	8 hours	136	14.5

a. Source: Stewart (1997).
b. OSHA Permissible Exposure Limits (PEL).
c. Ceiling limits are permissible exposure limits that a facility cannot exceed at any time.
d. 15-minute average.

SRS generates six basic classes of waste – low-level radioactive, high-level radioactive, hazardous, mixed (low-level radioactive and hazardous), transuranic and alpha, and sanitary (nonhazardous, nonradioactive) – which this EIS considers because they are possible byproducts of SNF management. The following sections describe the waste classes. Table 3.8-1 lists projected total waste generation volumes for fiscal years 1999 through 2029 (a 30-year time period encompassing most of the time period of the scenarios addressed in this EIS). TC

Tables 3.8-2 through 3.8-4 provide an overview of the existing and planned facilities that DOE expects to use in the storage, treatment, and disposal of the various waste classes.

3.8.1.1 Low-Level Radioactive Waste

EC DOE Order 435.1 (Radioactive Waste Management) defines low-level radioactive waste as radioactive waste that cannot be classified as high-level waste, spent nuclear fuel, transuranic waste, or byproduct material, and that does not have any constituents that are regulated under the Resource Conservation and Recovery Act (RCRA).

At present, DOE uses a number of methods for treating and disposing of low-level waste at SRS, depending on the waste form and activity. Approximately 41 percent of this waste is low in activity and can be treated at the Consolidated Incineration Facility. In addition, DOE could volume-reduce these wastes by compaction, supercompaction, smelting, or repackaging (DOE 1995c). After volume reduction, DOE would package the remaining low-activity waste and place it in either shallow land disposal or vault disposal in E Area.

DOE places low-level wastes of intermediate activity and some tritiated low-level wastes in E Area intermediate activity vaults, and will store long-lived low-level waste (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.

3.8.1.2 Low-Level Mixed Waste

DOE Order 435.1 defines low-level mixed waste as low-level radioactive waste that contains material listed as hazardous under RCRA or that exhibits one or more of the following hazardous waste characteristics: ignitability, corrosivity, TC

reactivity, or toxicity. It includes such materials

Table 3.8-1. Total waste generation forecast for SRS (cubic meters).[a,b]

	Waste Class				
Inclusive Dates	Low-level	High-level	Hazardous	Mixed low-level	Transuranic and alpha
1999 to 2029	180,299	14,129	6,315	3,720	6,012

Source: Derived from Halverson (1999).

as tritiated mercury, tritiated oil contaminated with mercury, other mercury-contaminated compounds, radioactively contaminated lead shielding, equipment from the tritium facilities in H Area, and filter paper takeup rolls from the M-Area Liquid Effluent Treatment Facility.

As described in the *Approved Site Treatment Plan* (DOE 1996c), storage facilities for low-level mixed 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 as Clean Water Act-permitted tank systems. Several treatment processes described in the *Approved Site Treatment Plan* (DOE 1996c) exist or are planned for low-level mixed waste. These facilities, which are listed in Table 3.8-3, include the Consolidated Incineration Facility, the M-Area Vendor Treatment Process, and the Hazardous Waste/Mixed Waste Containment Building.

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

3.8.1.3 High-Level Waste

High-level radioactive waste is highly radioactive material from the processing of SNF that contains a combination of transuranic waste and fission products in concentrations that require permanent isolation. It includes both liquid waste produced by processing and solid waste derived from that liquid (DOE 1988).

At present, DOE stores high-level waste in carbon steel and reinforced concrete underground tanks in the F- and H-Area tank farms. The high-level waste undergoes volume reduction by evaporation, and the resulting high activity precipitate is incorporated in borosilicate glass at the Defense Waste Processing Facility Vitrification Facility. The remaining low-activity salt solution is treated and disposed of at the Saltstone Manufacturing and Disposal Facility. Both processes are described in the *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility* (DOE 1994).

DOE has committed to complete closure by 2022 of the 24 HLW tank systems that do not meet the secondary containment requirements in the Federal Facility Agreement (WSRC 1999a). 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. The salt portion of the retrieved waste (processed and treated) will be treated at one of the salt disposition facilities being evaluated in the High-Level Waste Salt Disposition Alternatives EIS (DOE 1999b) and either vitrified at DWPF or disposed as grout in Z Area.

3.8.1.4 Sanitary Waste

Sanitary waste is solid waste that is neither hazardous, as defined by RCRA, nor radioactive. It consists of salvageable material and material that is suitable for disposition in a municipal sanitary landfill. Sanitary waste streams include

Table 3.8-2. Planned and existing waste storage facilities.[a]

Storage facility	Location	Capacity	Original waste stream[b]						Status
			Low-level	High-level	Transuranic	Alpha[c]	Hazardous	Mixed Low-level	
Long-lived waste storage buildings	E Area	140 m^3/ bldg	X						One exists.
Containerized mixed waste storage	Buildings 645-2N, 643-29E, 643-43E, 316-M, and Pad 315-4M	4754 m^3						X	DOE plans to construct additional storage buildings, similar to 643-43E, as necessary.
Liquid mixed waste storage	DWPF Organic Waste Tank (S Area) SRTC Mixed Waste Tanks Liquid Waste Solvent Tanks (H Area) Burial Ground Solvent Tanks (E Area)	9531 m^3						X	The Burial Ground Solvent Tanks are currently undergoing closure. The H-Area Liquid Waste Solvent Tanks were constructed as a replacement.
High-level waste tank farms	F and H Area	(d)		X					50 underground tanks are currently used for storage[e].
Failed equipment storage vaults	Defense Waste Processing Facility (S Area)	300 m^3		X					Two exist; DOE plans approximately 12 additional vaults.
Glass waste storage buildings	Defense Waste Processing Facility (S Area)	2,286 canisters		X					One exists; a second is planned for construction in 2007.
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)	2,501 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.
Building 316-M	Building 316-M	117 m^3					X		Currently in use. No additional facilities are planned.
Transuranic waste storage pads	E Area	(f)			X	X		X	19 pads exist; 10 additional pads may be constructed by 2006.

DWPF = Defense Waste Processing Facility.
SRTC = Savannah River Technology Center.

a. Sources: DOE (1994, 1995a, 1995b, 1996a).
b. Sanitary waste is not stored at SRS, thus it is not addressed in this table.
c. Currently, alpha waste is handled and stored as transuranic waste.
d. Currently the High-level Waste Tanks contain approximately 130,600 m^3 of high-level waste. This is almost 90 percent of the usable capacity.
e. Twenty-three of these tanks do not meet secondary containment requirements and have been scheduled for waste removal.
f. Transuranic Pad storage capacities depends on the packaging of the waste and the configuration of packages on the pads.

Table 3.8-3. Planned and existing waste treatment processes and facilities.[a]

Waste Treatment Facility	Waste Treatment Process	Waste type							Status
		Low-level	High-level	Transuranic	Alpha[b]	Hazardous	Mixed low-level	Sanitary	
Consolidated Incineration Facility	Incineration	X				X	X		Began treating waste summer 1997
Offsite facility	Smelting	X							Currently ongoing
Defense Waste Processing Facility	Vitrification		X						Currently operational
Defense Waste Processing Facility	Stabilization						X		Currently operational
Replacement high-level waste evaporator[c]	Volume Reduction		X						Radioactive operation anticipated in March 2000
M-Area Vendor Treatment Facility	Vitrification						X		Undergoing Closure
Treatment at point of waste stream origin	Macroencapsulation						X		As feasible based on waste and location
Non-Alpha Vitrification Facility	Vitrification	X				X	X		Plan to begin operations in 2006
INEEL[d] Waste Engineering Development Facility	Amalgamation/ Stabilization						X		Developing shipping/ treatment schedules
Offsite facility	Offsite Treatment and Disposal					X			Currently ongoing
TC Offsite facility	Decontamination						X		Plan to begin shipment in FY2000
Various onsite and offsite facilities[e]	Recycle/Reuse	X				X	X	X	Currently ongoing
Alpha Vitrification Facility	Vitrification				X				Under evaluation as a potential process
Existing DOE facilities	Repackaging/ Treatment			X					Transuranic waste strategies are still being finalized
M-Area Air Stripper	Air Stripping					X			Currently operational
F- and H-Area Effluent Treatment Facility	Effluent Treatment	X							Currently operational

a. Sources: DOE (1994, 1995a, 1995b, 1996a); WSRC (1995a, 1995b, 1996b); and Odum (1995).
b. Currently, alpha waste is handled as transuranic waste. After it is assayed and separated, most will be treated and disposed of as low-level or mixed low-level waste.
c. Evaporation precedes treatment at the Defense Waste Processing Facility and is used to maximize high-level waste storage capacity.
d. Idaho National Engineering and Environmental Laboratory.
e. Various waste streams have components (e.g., silver, lead, freon, paper) that might be recycled or reused. Some recycling activities might occur onsite, while other waste streams are directed offsite for recycling. Some of the recycled products are released for public sale, while others are reused onsite.

Table 3.8-4. Planned and existing waste disposal facilities.[a]

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

RCRA = Resource Conservation and Recovery Act.
NA = Not Available.

a. Sources: DOE (1994, 1995a, 1995b, 1995c, 1996a, 1996c); WSRC (1995a and 1996b).
b. 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.
c. Various types of trenches exist including engineered low-level trenches, greater confinement disposal boreholes and engineered trenches, and slit trenches. The different trenches are designed for different waste types, are constructed differently, and have different capacities.
d. This is the approximate capacity of a double vault. One single vault and one double vault have been constructed. Future vaults are currently planned as double vaults.
TC e. SRS is scheduled for WIPP certification audit in 2000, after which WIPP could begin receiving SRS waste.

such items as paper, glass, discarded office material, and construction debris (DOE 1994).

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

3.8.1.5 Hazardous Waste

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

At present, DOE stores hazardous wastes in three buildings and on three solid waste storage pads that have RCRA permits. Hazardous waste is sent to offsite treatment and disposal facilities, and could be treated at the Consolidated Incineration Facility in the future. 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 1995c).

3.8.1.6 Transuranic and Alpha Waste

Transuranic waste contains alpha-emitting transuranic radionuclides (those with atomic weights greater than 92) that have half-lives greater than 20 years at activities exceeding 100 nanocuries per gram (DOE 1988). 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.

The SRS Waste Management EIS (DOE 1995c) describes the handling and storage of transuranic and alpha waste at the SRS. This consists primarily of providing continued safe storage until treatment and disposal facilities are available.

The *Strategic Plan for Savannah River Site Transuranic Waste* (WSRC 1996b) defines the future handling, treatment and disposal of the SRS transuranic and alpha waste stream. Eventually, DOE plans to ship the transuranic and mixed transuranic waste to the Waste Isolation Pilot Plant in New Mexico for disposal.

Before disposition, DOE plans to assay the wastes stored on the pads and segregate the alpha waste. Vitrification is an option for at least part of the mixed alpha waste (DOE 1996b). Following assay, DOE could dispose of much of the alpha waste as either mixed low-level or low-level waste.

3.8.2 HAZARDOUS MATERIALS

The *Savannah River Site Tier Two Emergency and Hazardous Chemical Inventory Report* for 1998 (WSRC 1999b) 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 [10,000 pounds (4,536 kilograms) for hazardous chemicals and 500 pounds (227 kilograms) or less for extremely hazardous substances]. Four of the 79 are extremely hazardous substances under the Emergency Planning and Community Right-to-Know Act of 1986. The actual number and quantity of hazardous chemicals present on the Site and at individual facilities changes daily as a function of use and demand. TC TC

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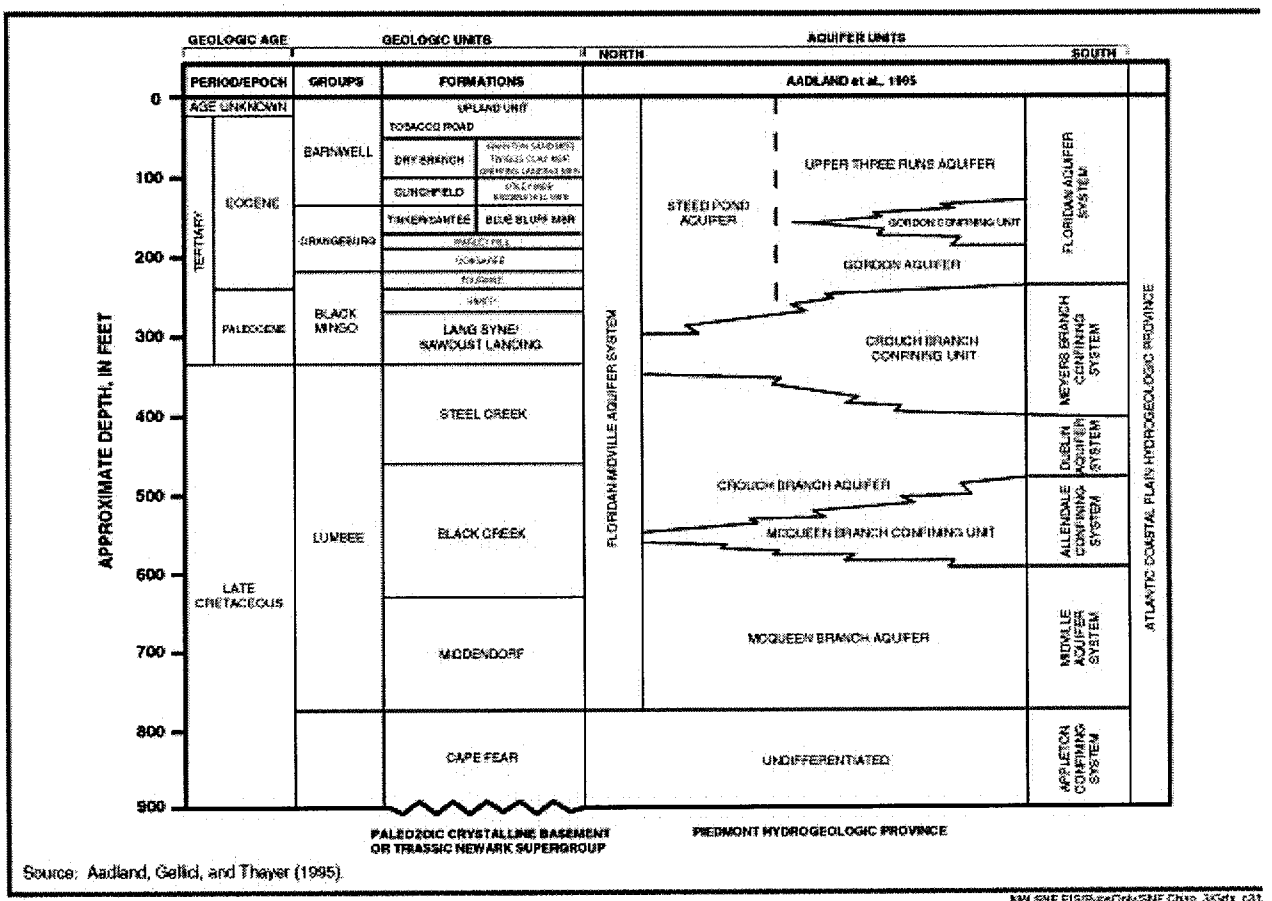

Source: Aadland, Gellici, and Thayer (1995).

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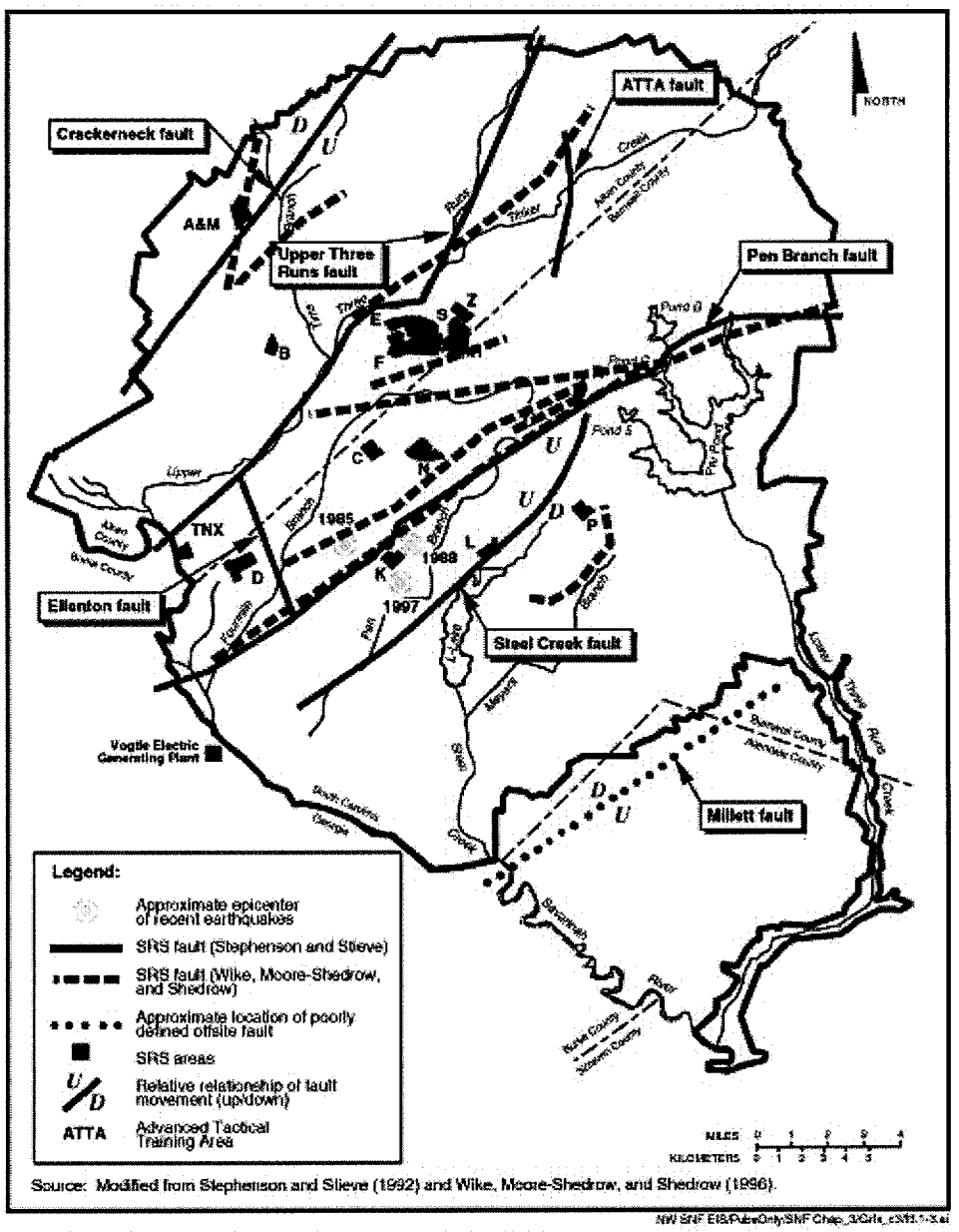
Figure 3.1-2. Generalized geologic and aquifer units in SRS region.



Source: Modified from Stephenson and Stieve (1992) and Wike, Moore-Shedrow, and Shedrow (1996).

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

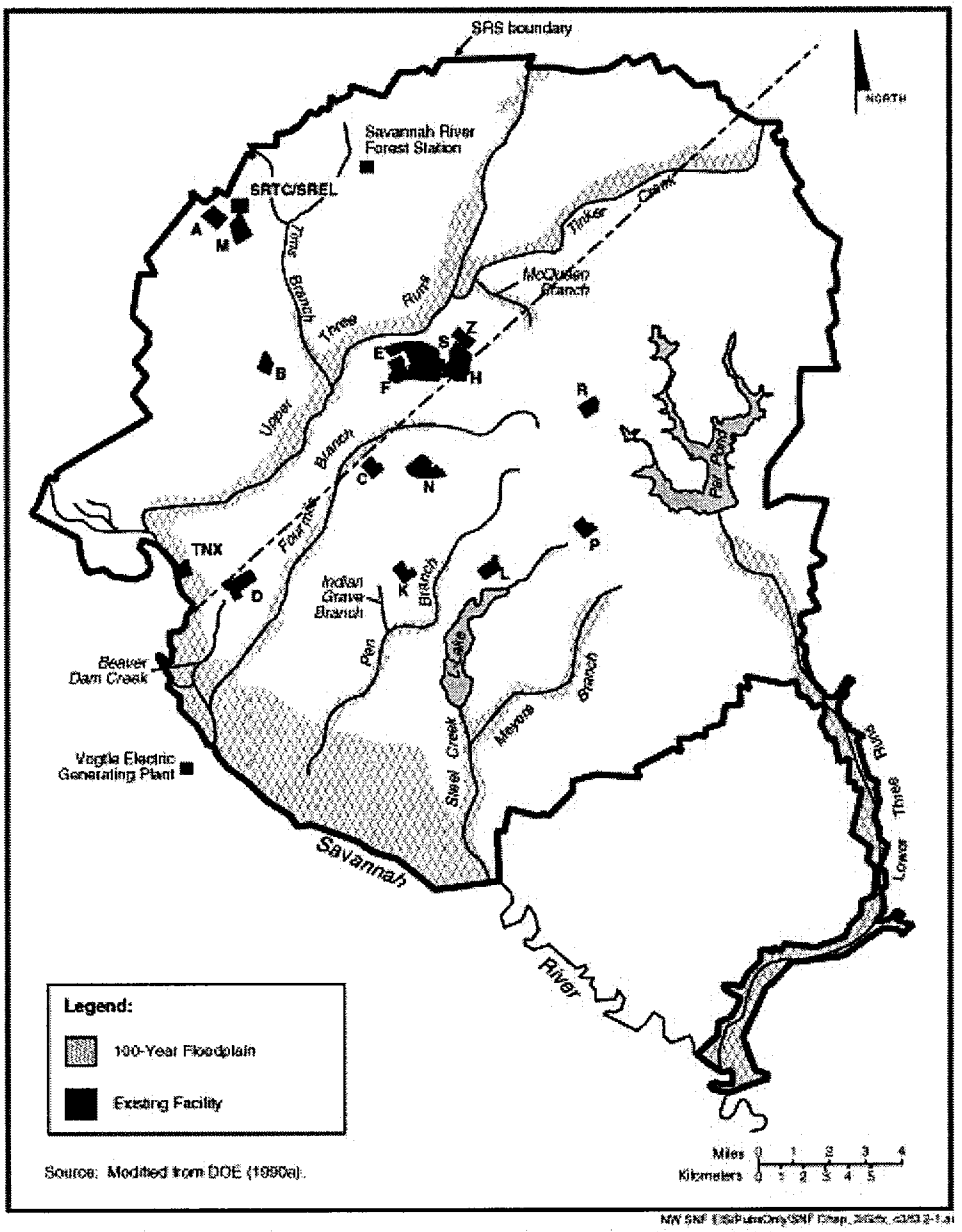

Figure 3.2-1. Savannah River Site, showing 100-year floodplain and major stream systems.

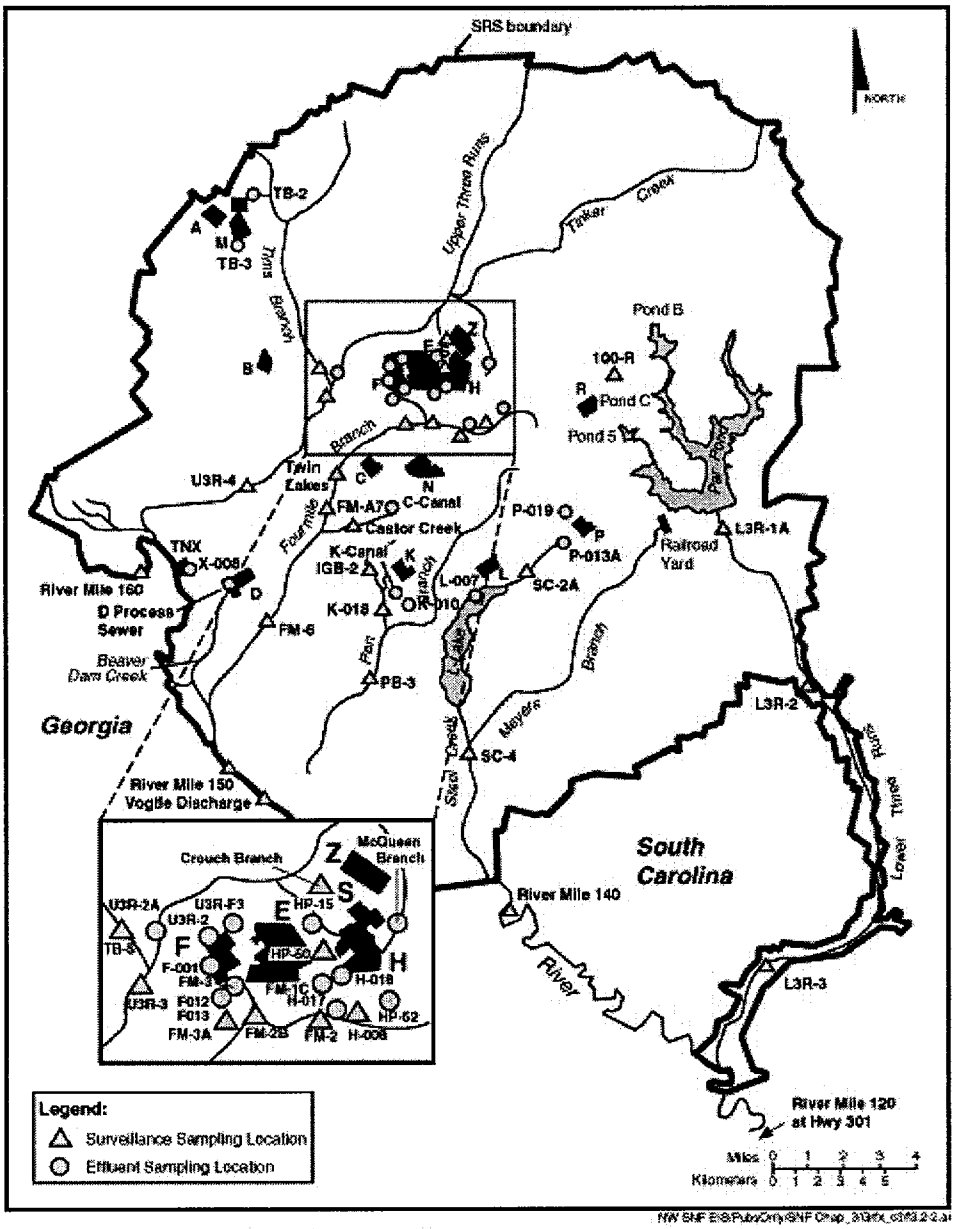

Figure 3.2-2. Radiological surface-water sampling locations.

Figure 3.2-3

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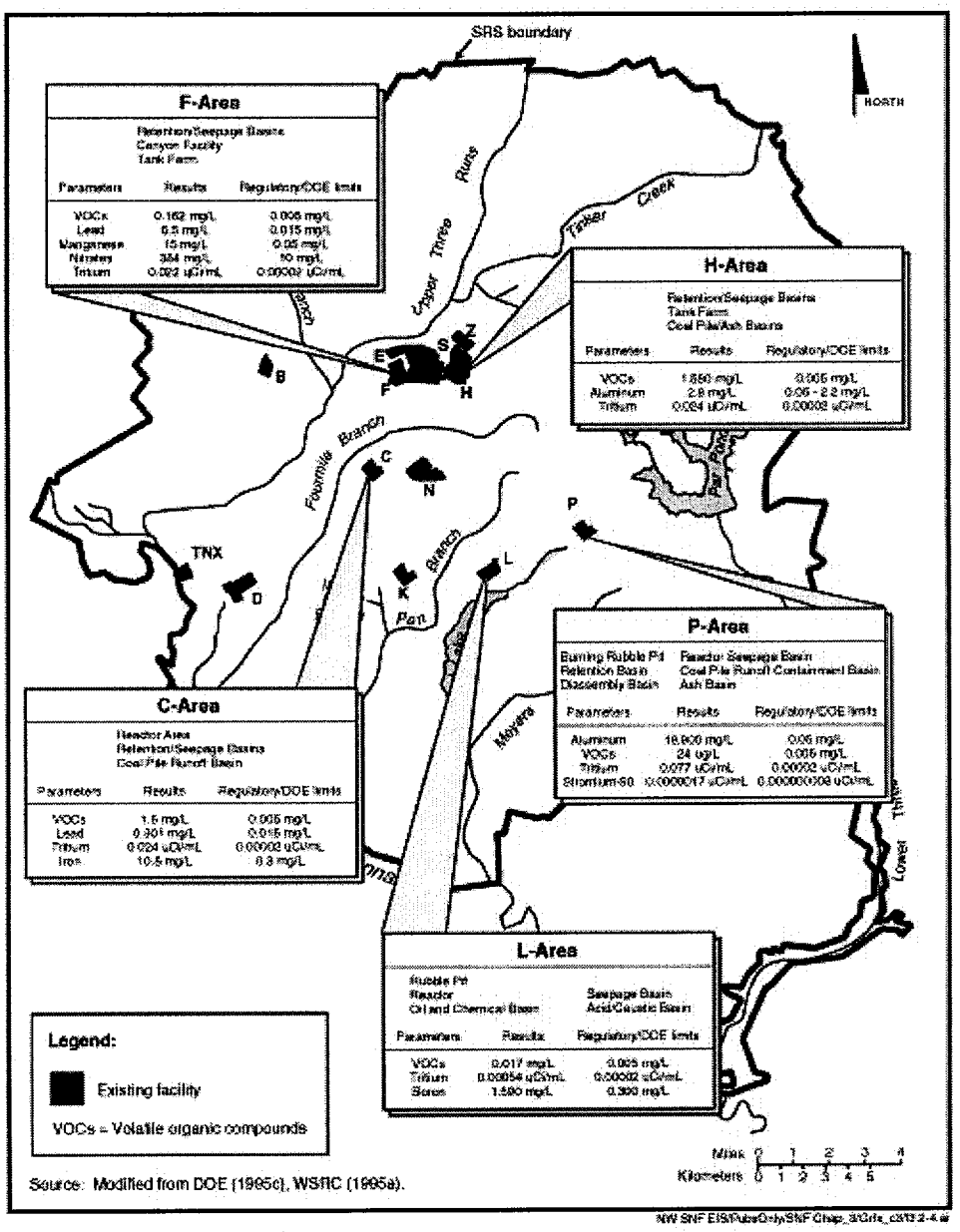

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Figure 3.2-4. Maximum reported groundwater contamination at Savannah River Site.

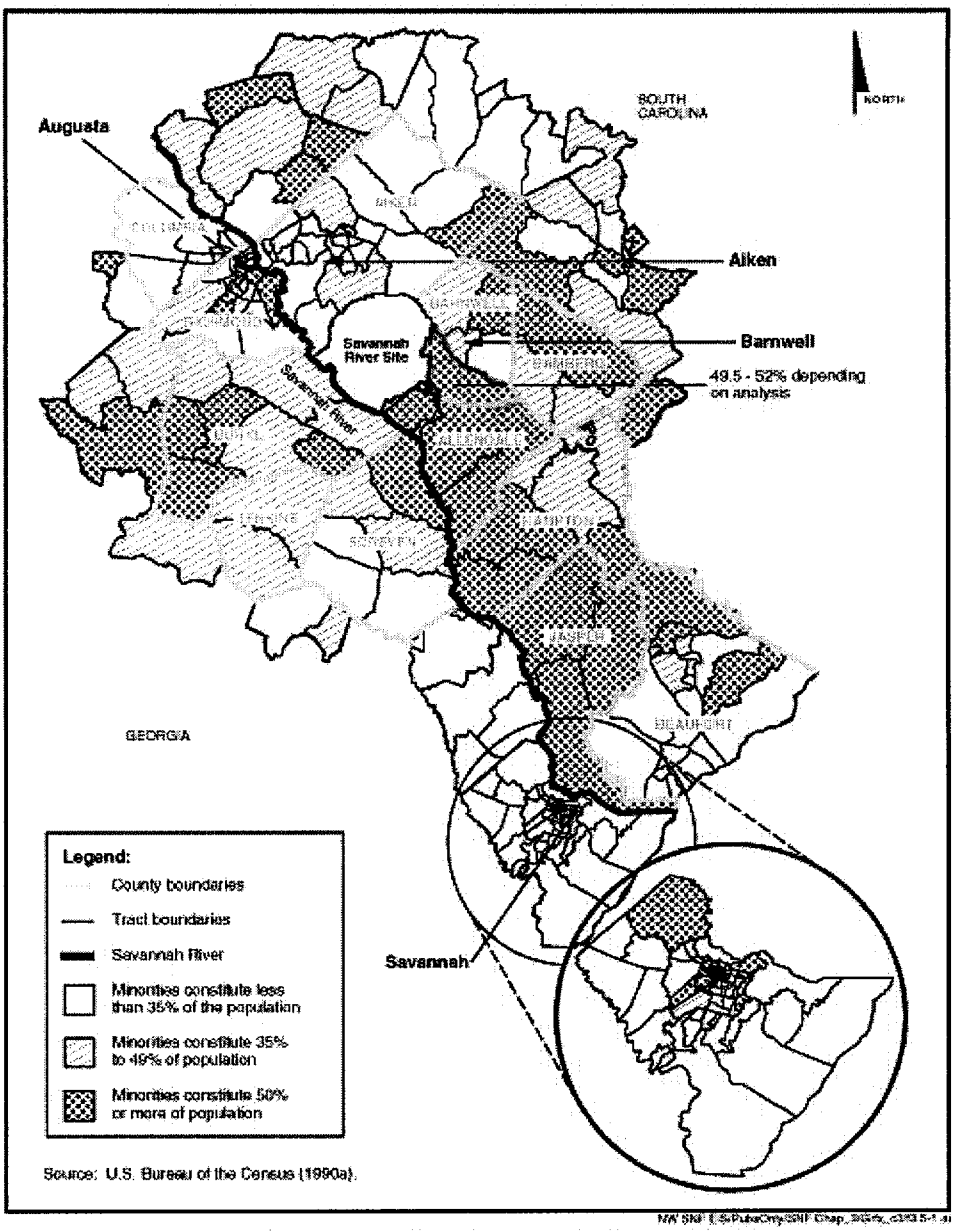
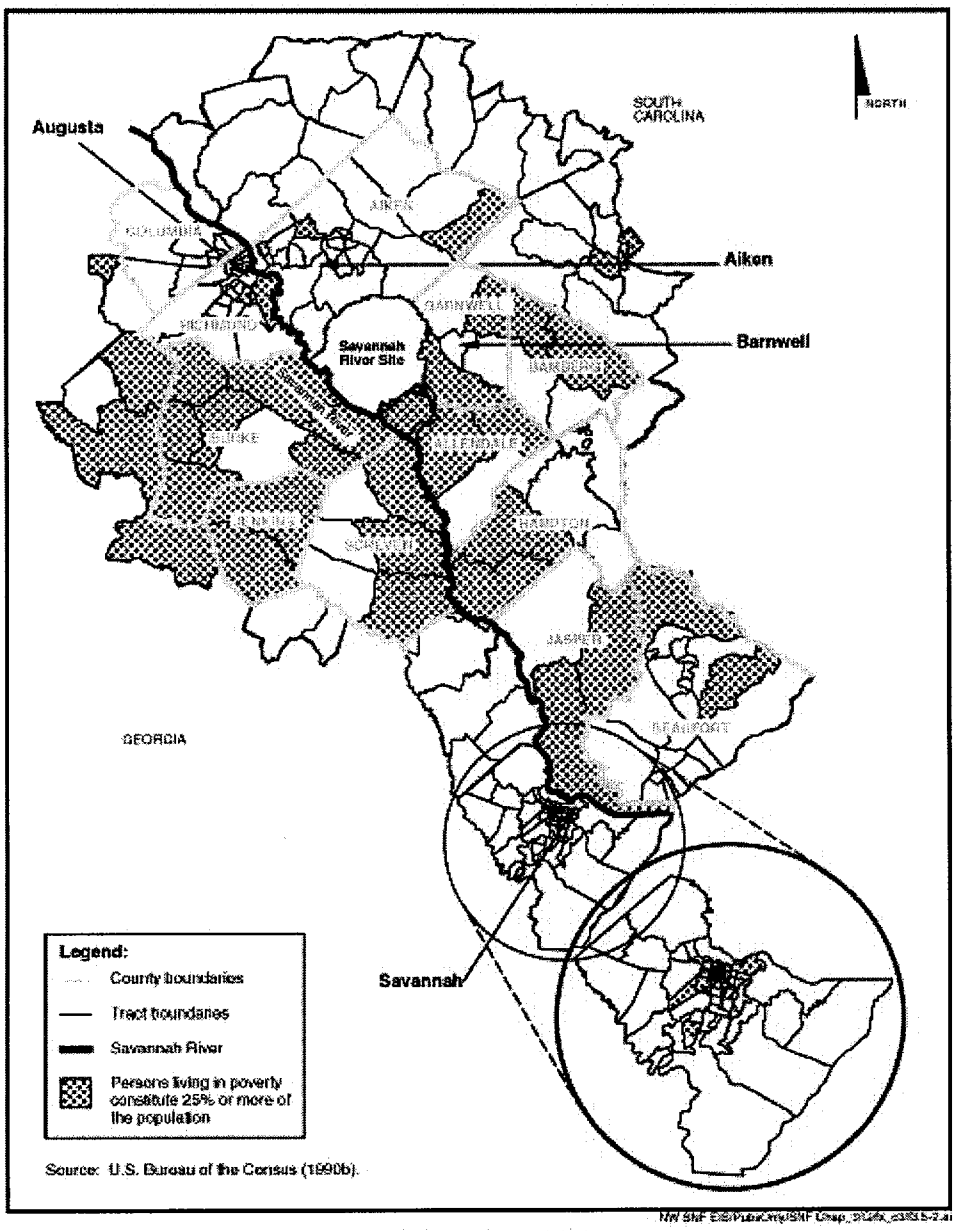


Figure 3.5-1. Distribution of minorities by census tracts in the SRS region of analysis.



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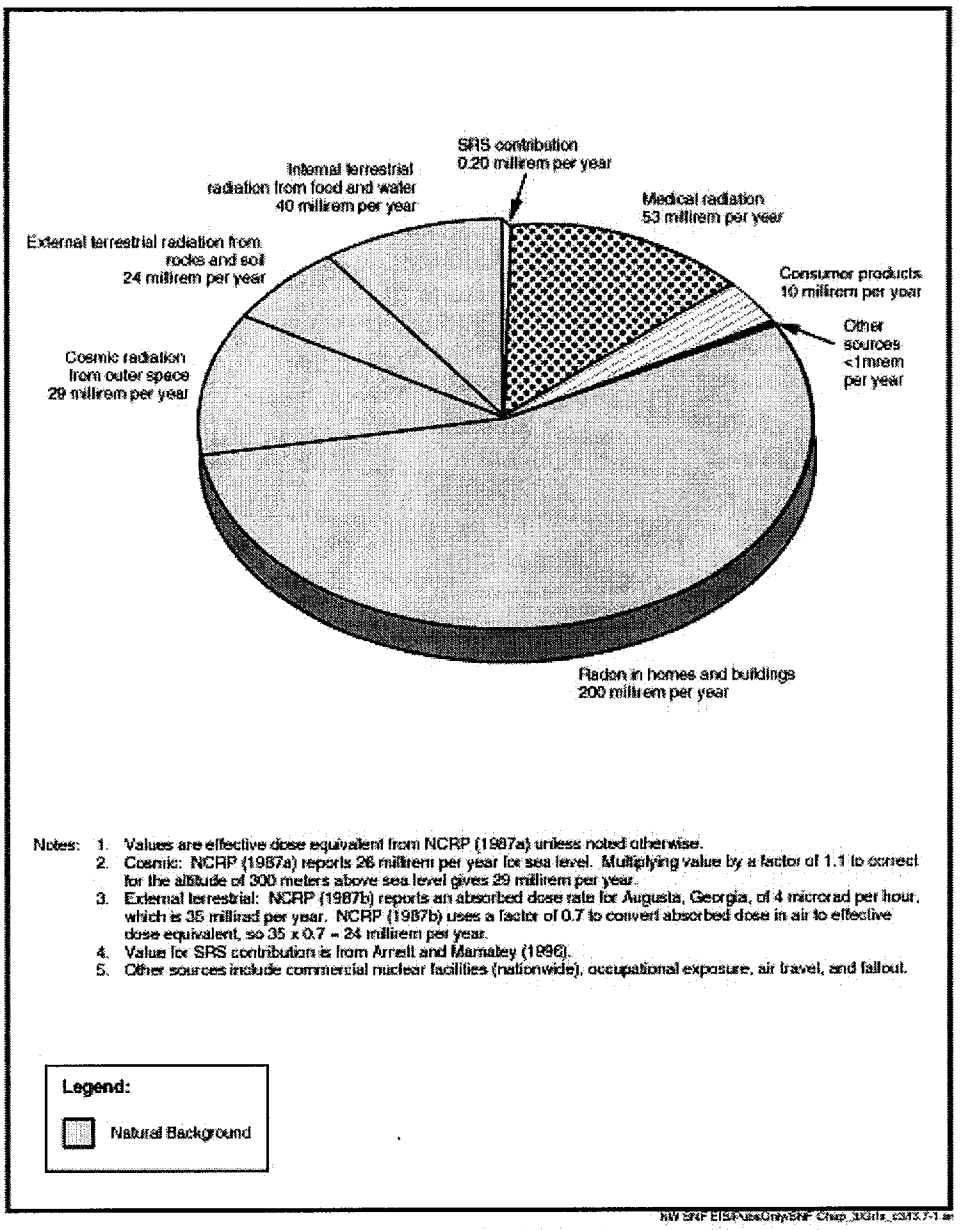

Figure 3.7-1. Major sources of radiation exposure in the vicinity of the Savannah River Site.

CHAPTER 4. ENVIRONMENTAL IMPACTS

This chapter describes potential environmental impacts from construction, operation, and accidents associated with the proposed action and its alternatives. Section 4.1 describes the operational impacts of each alternative within the scope of this environmental impact statement (EIS). Section 4.2 describes risks to members of the public and onsite workers from potential facility accidents associated with the management of spent nuclear fuel (SNF) at the Savannah River Site (SRS). Section 4.3 describes impacts that could result from construction activities associated with SNF management at SRS. The purpose of the information presented in this chapter is to provide comparisons among alternatives. For new facilities, this information is based on DOE's best estimates of these facilities' operational characteristics. These data are not intended to be used for safety analysis purposes or compared to safety documents such as a Safety Analysis Report.

As discussed in Section 2.3.2, the Department of Energy (DOE) has identified three candidate sites for the potential construction of a Transfer and Storage Facility or a Transfer, Storage, and Treatment Facility: (1) the east side of L Area inside the facility fence, (2) the southeast side of C Area inside the facility fence, and (3) the northeast side of P Area. In addition, the facility could be constructed on a site inside the F-Area or H-Area fence or in an existing reactor building such as Building 105-L.

In most instances, implementing the technology options described in Chapter 2 would result in the same or very similar environmental impacts, regardless of location. If, during the preparation of this EIS, analyses indicated that a technology option would produce different environmental impacts at one of the candidate sites, DOE analyzed the site that would have the greatest impact (the bounding site). The analysis of the atmospheric releases of radioactivity described in the air resources and public and worker health sections is based on the assumption that emissions from a Transfer and Storage Facility or Transfer, Storage, and Treatment Facility would occur in C Area. Releases from C Area would result in higher estimated radiation doses to members of the public than releases from L or P Area (i.e., C Area would result in doses to the maximally exposed offsite individual approximately 1.7 times higher than those in L Area and 1.1 times higher than those in P Area). All other impacts would be independent of location.

The impacts reported in this chapter are based on the entire SNF inventory described in Chapter 1 and Appendix C. However, as noted in Section 1.3, some foreign reactor operators may not participate in DOE's program of accepting U.S.-origin SNF. This reduction in receipts could potentially impact the amounts of fuel in Groups B, D, and E. Therefore, the amounts of fuel to be managed in those fuel groups could be less than the amounts assumed for the calculations in Chapter 4. DOE believes that annual impacts for normal operations, construction impacts, and accident impacts would be unaffected by modest reductions in the expected fuel inventory. The annual impacts are based on the maximum year's impacts; decreasing the foreign fuel shipments may lessen the number of years of fuel handling, conditioning, or treatment, but would not affect the maximum annual impact. SNF accidents usually involve small amounts of fuel and thus are insensitive to the total inventory. Construction impacts are similarly insensitive to the reduction in total fuel inventory that could occur. Eleven environmental impact measures are based on activities that occur over the entire period of analysis. These impacts would be sensitive to reductions in fuel receipts. Where applicable, the tables in this chapter explain how to adjust reported impacts for potentially reduced fuel receipts.

4.1 Impacts from Normal Operations

This section describes environmental impacts that could result from operational activities associated with SNF management at SRS for existing and new facilities. Because the only potential impacts to geologic and cultural resources would occur during construction (see Section 4.3), Section 4.1 does not consider geologic or cultural resource impacts. DOE does not anticipate a significant increase in employment due to the implementation of any technology options (Table 4.1-1). The existing site work force should be sufficient to provide the necessary operations and support personnel; therefore, there would be no socioeconomic impacts from operations under any technology.

Table 4.1-1. Estimated operational staffing for any of the technology options.

Technology option	Operations personnel	Support personnel	Total personnel
Melt and Dilute	200	200	400
Mechanical Dilution	175	175	350
Repackage and Prepare to Ship	75	75	150
Vitrification	317	317	634
Electrometallurgical	238	238	476
Conventional Processing	300	300	600
Continued Wet Storage	80	80	160

Source: Bickford et al. 1997.

DOE used the following process to estimate the impacts associated with new facilities/processes. First, DOE identified the facilities that would be needed to implement each of the technologies described in Chapter 2 (see Table 2-4). Next, DOE identified the major systems required within each facility for each technology. DOE then identified the energy sources, potential waste and effluent streams, and sources of potential radiation exposure associated with each of these major systems. These results were then compared to similar processes with which DOE has operational experience to determine the relative magnitude of the impact. These impacts were

presented as annual impacts; integrated impacts were then calculated as described below in Section 4.1.1.

DOE does not expect normal operations to have any appreciable impacts on ecological resources. Impacts would be limited to minor disturbances of animals in undeveloped areas adjacent to SNF management facilities caused by increased movement and noise from personnel, vehicles, and equipment. However, these impacts would be negligible under all proposed technology options because they would occur in areas where industrial activities already exist. Impacts to potential human receptors from normal releases of radioactive and nonradioactive contaminants to the environment would be small for any of the technologies under consideration (Section 4.1.1.3). Therefore, these releases would not be likely to produce measurable effects on nearby plant and animal communities or to accumulate in aquatic or terrestrial ecosystems.

4.1.1 IMPACTS OF TECHNOLOGY OPTIONS

This section describes the environmental impacts of each technology. The analysis covers the environmental impacts of actions over the 38-year period from 1998 through 2035 and presents both maximum annual impacts from these technologies and estimated total impacts over the entire period. For example, the discussions of water and air resources present maximum annual radiation doses to members of the public from liquid and airborne emissions associated with each technology and compares the resulting values to Federal limits. The section on public and worker health, on the other hand, presents radiation doses to members of the public from liquid and airborne emissions over the entire implementation period. The waste generation and utilities and energy sections also present impacts over the entire period of analysis (1998-2035).

To estimate total impacts, DOE identified the activities necessary to implement each technology, the amount of time required for each step (*phase*) of the technology option, and the annual impacts likely to occur during each phase. DOE summed the annual impacts over the entire duration of the phase, together with other phases needed to implement that option. For the Conventional Processing option, DOE used historic data for F- and H-Canyon operations to estimate the time needed to process the entire inventory of each type of fuel (McWhorter 1997). For the other technology options with a treatment phase, DOE used engineering judgments to estimate the duration of this phase for each fuel group. Appendix E describes the assumed durations for each phase. If annual impact data (i.e., utilities and energy, waste generation, and worker radiation dose) for each type of fuel were not available, DOE assumed that the fraction of the impact attributable to each type of fuel would be equal to the fraction of that fuel's fissile mass to the total fissile mass of SNF in the scope of this EIS. DOE derived the annual impact calculations from the available data (Bickford et al. 1997) based on the total radionuclide inventory for each type of fuel. Appendix C contains the radionuclide inventories, using a "reference fuel assembly" i.e., a conservative estimate of the radionuclide and curie content for an SNF assembly designed to bound the characteristics of fuel assigned to SRS. The engineering report that provides data upon which the impacts presented in this chapter are based (Bickford et al. 1997) is available for review at the DOE public reading room in Aiken, South Carolina.

4.1.1.1 Water Resources

This section describes the effects of normal operations associated with the technologies to SRS waters. All process water would come from groundwater. None of the technologies require much water to process the fuels. At most, less than 6,000 liters per year (equivalent to 1,585 gallons per year) would be required. The SRS annually withdraws more than 5×10^9 liters of groundwater (DOE 1997).

As discussed below, the only technology that would result in discharges of radionuclides or nonradioactive hazardous materials to surface water would be conventional processing. The

major sources of liquid effluents from facilities associated with conventional processing would be process cooling water and steam condensate that could contain small quantities of radionuclides and chemicals. Conventional processing would use wastewater treatment facilities and other equipment designed for full production (i.e., five production reactors, two separation facilities, and other industrial facilities) loads. Therefore, capacities would be sufficient to handle the liquid effluents and other secondary waste associated with conventional processing.

Liquid effluents associated with the SNF technologies would use existing wastewater treatment facilities and outfalls described in Section 3.2.1.3. Sanitary waste would be treated at the SRS Central Wastewater Treatment Facility (CSWTF) and discharged through an existing NPDES outfall (G-10). Because technology options would not increase the number of permanent SRS employees, the CSWTF treatment rates would not be affected, and it would continue to meet the requirements of the SRS NPDES permit.

DOE evaluated in the Programmatic SNF EIS (DOE 1995b) the potential impacts to groundwater from a direct leak to the subsurface from a breach in a storage pool during routine operations. Because basin water could contain some radionuclides but would not contain any toxic or harmful chemicals, the following evaluation addresses only the consequences of radionuclide releases. The analysis conservatively assumed a 5-gallon (19-liter) per-day leak as a result of secondary containment or piping failure at the Receiving Basin for Offsite Fuels, L-Reactor Disassembly Basin, or a new wet receipt basin in a Transfer and Storage Facility or a Transfer, Storage, and Treatment Facility. The analysis assumed further that the leak would go undetected for 1 month.

The reliability and sensitivity of the leak detection devices at a new wet receipt basin would be equal to or superior to those required by the U.S. Nuclear Regulatory Commission (NRC 1975) for SNF storage facilities in commercial nuclear power plants. Constant process monitoring, mass balance, and facility design (including double-walled containment of vessels and piping) also would be used by DOE to limit operational releases from a new wet receipt facility to near zero.

A leak from the Receiving Basin for Offsite Fuels, or the L-Reactor Disassembly Basin, could result in the introduction of radionuclide-contaminated water into the ground at depths as much as 44 feet (13.4 meters) below grade. Such a release would go directly to the uppermost aquifer (Upper Three Runs), which at SRS is not suitable for use as a drinking water source because of its low yield and the presence of contaminants. Any contaminants would move through the Upper Three Runs and Gordon aquifers and ultimately discharge to SRS streams. The processes governing the plume movement (i.e., the hydraulic conductivity, hydraulic gradient, and effective porosity of aquifers in F, H, and the Reactor Areas) and the processes resulting in the attenuation of contaminants and radionuclides (i.e., radioactive decay, trapping of particulates in the soil, ion exchange in the soil, and adsorption to soil particles) would mitigate impacts to surface- or groundwater resources. Localized contamination of groundwater in the surface aquifer could occur in the immediate vicinity of the storage facility. However, this aquifer is not used as a source of drinking water. DOE concludes that no radionuclide contamination of deeper confined aquifers that are sources of onsite or offsite drinking water would be likely to occur from a leak in a storage basin.

The aquifer used as the primary source for drinking water is separated from the shallower aquifers by a confining unit. The hydraulic pressure of the lower aquifer is greater than that of the overlying aquifer. Therefore, water flows from the lower to the upper aquifer. This upward flow would prevent the downward migration of released contaminants.

4.1.1.1.1 Radiological Impacts

With the exception of conventional processing which is the maximum impact alternative, none of the technologies proposed in this EIS is likely to result in measurable increases in radionuclides released to water (Bickford et al. 1997). No other proposed technology would have a process discharge to surface waters.

The prolonged storage of SNF in the basins (i.e., the No-Action Alternative) could lead to a higher rate of fuel failures and releases to basin water, but probably would not affect routine releases (i.e., those from national pollutant discharge elimination system [NPDES] permitted outfalls). DOE would maintain water quality by monitoring basin water, deionizing basin water using resin beds, and stabilizing leaking assemblies.

Calculations of radiological doses through water pathways based on these releases are supported by the use of LADTAPXL, a spreadsheet version of the LADTAP II computer code developed by the U.S. Nuclear Regulatory Commission (NRC) to estimate radiation doses associated with normal reactor system liquid effluent releases to individuals, populations, and biota (Hamby 1991). LADTAP II uses the models in NRC Regulatory Guide 1.109 (NRC 1977) to calculate doses received from water and fish ingestion and from recreational water activities. Parameters used to calculate dose for the maximally exposed individual are consistent with regularly published SRS environmental reports (e.g., Arnett and Mamatey 1996).

Any radionuclide releases to surface water resulting from the technologies would be to SRS streams that discharge to the Savannah River. For all technology options, the ingestion of fish contaminated with cesium-137 would contribute most of the exposure to both the maximally exposed individual and the population. Plutonium and uranium isotopes ingested with drinking water would be smaller contributors for the approximately 70,000 people served by water treatment plants near Port Wentworth, Georgia (60,000) and Beaufort, South Carolina (10,000) (Arnett and Mamatey 1996). Table 4.1-2 lists both the maximally exposed individual dose and the collective dose due to liquid releases to the 620,100-person population surrounding SRS. TC

Table 4.1-2. Estimated maximum incremental annual dose to hypothetical maximally exposed individual and 620,100-person population surrounding SRS due to liquid releases from Conventional Processing.

Fuel group	MEI dose (millirem)	Population dose (person-rem)
A. Uranium and Thorium Metal Fuels	4.2×10^{-5}	2.4×10^{-4}
B. Materials Test Reactor-Like Fuels	0.042	0.14
C. HEU/LEU Oxides and Silicides Requiring Resizing or Special Packaging	0.014	0.047
D. Loose Uranium Oxide in Cans	1.4×10^{-3}	4.7×10^{-3}
E. Higher Actinide Targets	NA	NA
F. Non-Aluminum-Clad Fuels	NA	NA

NA = Technology is not applicable to this fuel type.
HEU = Highly Enriched Uranium.
LEU = Low Enriched Uranium.
MEI = Maximally Exposed Individual.

4.1.1.1.2 Nonradiological Impacts

This assessment compared chemical releases with applicable water quality standards. These standards are based on the preservation of aquatic biota populations, human health, and aesthetics (i.e., taste and odor). Figure 3.2-1 shows that conventional processing activities would not occur in the 100-year floodplain. DOE would treat sanitary waste generated by any of the alternatives in this EIS in existing sewage treatment fa-

cilities; discharges from these facilities would continue to meet NPDES permit limits.

Activities associated with the New Packaging Technology options and all new treatment options under the New Processing Technology, including Melt and Dilute, Mechanical Dilution, Vitrification, and Electrometallurgical Treatment, would conform to current regulatory standards, and would not have nonradiological waterborne releases (Bickford et al. 1997). Under conventional processing, process cooling water treatment would result in releases of the following concentrations from F Area to Upper Three Runs:

- Nitrate - 40 micrograms per liter
- Ammonia - 30 micrograms per liter
- Manganese - 10 micrograms per liter
- Uranium - 20 micrograms per liter
- Nickel - 50 micrograms per liter
- Chromium - 20 micrograms per liter
- Aluminum - 200 micrograms per liter
- Copper - 10 micrograms per liter
- Zinc - 70 micrograms per liter

Similar or lower concentrations would be released from H Area with the exception of those for nitrate and ammonia, which would be 100 and 500 micrograms per liter, respectively.

Although proposed or final Federal drinking water standards do not apply to discharges, the SRS discharge concentrations would not exceed these standards. The discharges would also comply with South Carolina Water Quality Standards contained in South Carolina Regulation R.61-68. In general, the release concentrations would be no greater than those currently measured in Upper Three Runs and Fourmile Branch (Arnett 1996), with the exception of zinc and ammonia; however, zinc concentrations in the discharge would be only a small fraction of the South Carolina Water Quality Standards, which are based on the taste and odor of drinking water. Ammonia concentrations in the discharge (only H-Area releases would increase current stream concentrations) would be well within state standards. Lead, nickel, and chromium generally were not detected in Upper Three Runs and Fourmile Branch in 1995.

4.1.1.2 Air Resources

This section describes incremental air quality impacts from nonradiological and radiological emissions for the operation of each technology option for each fuel group; this description includes impacts to on- and offsite individuals and populations.

This analysis presents results in terms of ground-level air concentrations for nonradiological constituents and radiation dose for radionuclides because these are the best measures of potential adverse human health effects.

4.1.1.2.1 Nonradiological Emissions

DOE estimated nonradiological emission rates for each technology option (Bickford et al. 1997) and used them with the meteorological data described in Section 3.3.1 to estimate site boundary and noninvolved worker concentrations. This analysis assumed average meteorological conditions.

Onsite Concentrations

The purpose of this analysis is to estimate air concentrations to which SRS workers not involved in SNF management and related operations would be exposed. Atmospheric emissions would occur from F or H Area (conventional processing), L-Reactor Disassembly Basin and the Receiving Basin for Offsite Fuels (continued wet storage), and the Transfer and Storage Facility or Transfer, Storage, and Treatment Facility. To determine impacts to noninvolved workers, the analysis used a generic location 2,100 feet (640 meters) from the release in the direction of the plume of greatest concentration. The 2,100-foot criterion is based on NRC guidance. Also, the use of this distance ensures consistency between this and previous SRS EISs.

The analysis assumed that operational nonradiological releases would be from the same release stack as radiological releases. In addition, this EIS does not include onsite concentrations at distances greater than 2,100 feet; the analysis considered such concentrations and found that they would be less than those at 2,100 feet.

Tables F-1 through F-10 in Appendix F list estimated air concentrations above baseline (i.e., incremental increases) resulting from nonradiological atmospheric emissions associated with SNF fuel groups. No incremental atmospheric emissions above the baseline presented in Chapter 3 would be associated with Repackage and Prepare to Ship, the only option applicable to the non-aluminum-clad fuels. The air quality regulatory standards listed in Tables F-6 through F-10 in Appendix F are applicable to the Site boundary concentration from all SRS emissions. While these standards are included only for reference, all the incremental concentrations from SNF activities would be at least two orders of magnitude less than any of the corresponding standards except those for nitric acid, oxides of nitrogen, and gaseous fluorides emitted during conventional processing or vitrification of fuel Group B. The concentrations would range from less than 1 percent to about 55 percent of the offsite standard (for nitrogen oxides). If a new facility or a major modification to an existing facility were being considered, new permitting actions would be required as part of the Clean Air Act Title V permit compliance requirements. Under the current Title V permit, SRS would have to conduct a Prevention of Significant Deterioration review, since the nitrogen oxide levels exceed the 25 μm per cubic meter per year threshold of NO_2 for a Class II area. In addition, there would be a requirement for ambient monitoring to verify emission levels once the process began.

Offsite Concentrations

This analysis presents projected maximum offsite nonradiological incremental air concentrations in much the same way it presents the onsite concentrations. The estimated maximum incremental concentrations listed in Tables F-6 through F-10 in Appendix F would occur at the SRS boundary for emissions associated with SNF. The air quality regulatory standards listed in the tables are applicable to the Site boundary concentrations from all SRS emissions. All the incremental concentrations are at least three orders of magnitude less than any of the corresponding standards except those for oxides of nitrogen and gaseous fluorides emitted during conventional processing or vitrification. The concentrations ranged from less than 1 percent to about 2 percent of the offsite standard.

4.1.1.2.2 Radiological Emissions

DOE estimated airborne radionuclide emission rates for each technology option (Bickford et al. 1997), and used them with the meteorology data from Section 3.3.1 as inputs to the SRS com-

puter models MAXIGASP and POPGASP (Hamby 1994) to determine doses to onsite (noninvolved worker) and offsite (hypothetical maximally exposed individual) recipients and the surrounding population (620,000 persons) within a 50-mile (80-kilometer) radius of the center of the Site (Simpkins 1996). The analysis uses the meteorological data to determine annual average concentrations in air. The values presented in Tables 4.1-3, 4.1-4, and 4.1-5 represent current reactor-area emissions (including two SNF wet basins).

Onsite Doses

Atmospheric doses to the noninvolved worker represent the radiological exposures of a hypothetical worker who is nearby but not involved in SNF operations. Table 4.1-3 lists the estimated maximum incremental annual doses to noninvolved workers from atmospheric emissions of radionuclides for each viable technology option for each fuel group. The EPA limit of 10 millirem per year (40 CFR Part 61, Subpart H) is a point of comparison for these doses. (In fact, this limit is applicable to offsite individuals from sitewide airborne releases; see Chapter 5). The highest incremental dose to the noninvolved worker would be 0.27 millirem (from Melt and Dilute, Vitrification, or Electrometallurgical Treatment of Materials Test Reactor-like Fuels). Incremental doses to the noninvolved worker from all viable options would be 3 percent or less of the national emission standards for hazardous air pollutants (NESHAP) limit.

EC

There would be no pathways for exposure of personnel inside SNF management facilities from atmospheric releases of radioactivity. Section 4.1.1.3 discusses radiation doses to SNF management workers, including from in-facility airborne releases of radioactivity.

Offsite Doses

Atmospheric doses to the hypothetical maximally exposed offsite individual assume a person who resides at the SRS boundary at the point of maximum exposure. Every member of the public would have a dose less than that received by this individual. Table 4.1-4 lists the estimated maximum incremental annual dose to this individual from atmospheric emissions of radionuclides for each technology option for each fuel group. As with the doses to noninvolved workers, the NESHAP limit of 10 millirem per year (40 CFR Part 61, Subpart H) is a point of comparison. The maximum incremental annual dose from any technology option for a given fuel group would be 0.033 millirem per year (from Melt and Dilute, Vitrification, or Electrometallurgical Treatment of Materials Test Reactor-like Fuels), a factor of 300 less than the EPA limit.

Table 4.1-5 lists the estimated maximum incremental annual population dose (the collective dose to the entire population around SRS) for each viable option. The maximum incremental annual population dose from any option would be 1.2 person-rem per year (from Melt and Dilute, Vitrification, or Electrometallurgical Treatment of Materials Test Reactor-like Fuels).

4.1.1.3 Worker and Public Health

This section discusses potential radiological and nonradiological health effects to SRS workers and the surrounding public from the technology options for the management of SNF; it does not include impacts of potential accidents, which are discussed in Section 4.2. DOE based its calculations of health effects from the air- and waterborne radiological releases on (1) the dose to the hypothetical maximally exposed individual

Table 4.1-3. Estimated maximum incremental annual dose (millirem) to noninvolved worker from airborne releases.

Fuel group	Technologies							
	1	2	3	4	5	6	7	8
	Prepare for direct co-disposal	Repackage and prepare to ship	Melt and dilute	Mechanical dilution	Vitrification technologies	Electrometallurgical treatment	Conventional processing[a]	Continued wet storage
A. Uranium and Thorium Metal Fuels	0[b]	NA	5.3×10^{-4}	NA	5.3×10^{-4}	5.3×10^{-4}	3.2×10^{-4}	1.8×10^{-3}[c]
B. Materials Test Reactor-Like Fuels	0[b]	NA	0.27	0.013	0.27	0.27	0.09	0.083[c]
C. HEU/LEU Oxides and Silicides Requiring Resizing or Special Packaging	0[b]	NA	0.085	0.0043	0.085	0.085	0.029	0.02[c]
D. Loose Uranium Oxide in Cans	NA	NA	5.0×10^{-3}	NA	5.0×10^{-3}	5.0×10^{-3}	5.7×10^{-3}	4.7×10^{-3}[c]
E. Higher Actinide Targets	NA	0[b]	NA	NA	NA	NA	NA	6.7×10^{-4}[c]
F. Non-Aluminum-Clad Fuels	NA	0[b]	NA	NA	NA	NA	NA	NA

NA = Technology is not applicable to this fuel type.
HEU = Highly Enriched Uranium.
LEU = Low Enriched Uranium.

a. Annual impacts from Conventional Processing are lower because the amount of material processed annually by this technology is less than for other technologies. The annual impacts for Conventional Processing are based on operating one dissolver in a canyon. Impacts would double if the canyon was operated at full capacity (i.e., two dissolvers). Fuel processing of the entire SNF inventory would take over 20 dissolver-years using one dissolver and about 11 dissolver-years using two dissolvers. Processing all the fuel at full capacity in a new treatment facility would take about 7 years. Appendix E provides more information related to processing durations.

b. No incremental increase expected above SRS baseline radioactive emissions values reported in Chapter 3 because these options would not change the integrity of the fuel.

c. Reflects current reactor-area emissions (including two SNF wet basins).

Table 4.1-4. Estimated maximum incremental annual dose (millirem) to hypothetical maximally exposed offsite individual from airborne releases.

Fuel group	Technologies							
	1	2	3	4	5	6	7	8
	Prepare for direct co-disposal	Repackage and prepare to ship	Melt and dilute	Mechanical dilution	Vitrification technologies	Electrometallurgical treatment	Conventional processing[a]	Continued wet storage
A. Uranium and Thorium Metal Fuels	0[b]	NA	6.5×10^{-5}	NA	6.5×10^{-5}	6.5×10^{-5}	3.9×10^{-5}	2.6×10^{-4}[c]
B. Materials Test Reactor-Like Fuels	0[b]	NA	0.033	0.0016	0.033	0.033	0.011	0.012[c]
C. HEU/LEU Oxides and Silicides Requiring Resizing or Special Packaging	0[b]	NA	0.010	5.2×10^{-4}	0.010	0.010	3.5×10^{-3}	3.3×10^{-3}[c]
D. Loose Uranium Oxide in Cans	NA	NA	6.1×10^{-4}	NA	6.1×10^{-4}	6.1×10^{-4}	7.0×10^{-4}	6.9×10^{-4}[c]
E. Higher Actinide Targets	NA	0[b]	NA	NA	NA	NA	NA	9.9×10^{-5}[c]
F. Non-Aluminum-Clad Fuels	NA	0[b]	NA	NA	NA	NA	NA	NA

NA = Technology is not applicable to this fuel type.
HEU = Highly Enriched Uranium.
LEU = Low Enriched Uranium.

a. Annual impacts from Conventional Processing are lower because the amount of material processed annually by this technology is less than for other technologies. The annual impacts for Conventional Processing are based on operating one dissolver in a canyon. Impacts would double if the canyon was operated at full capacity (i.e., two dissolvers). Fuel processing of the entire SNF inventory would take over 20 dissolver-years using one dissolver and about 11 dissolver-years using two dissolvers. Processing all the fuel at full capacity in a new treatment facility would take about 7 years. Appendix E provides more information related to processing durations.

b. No incremental increase expected above SRS baseline radioactive emissions values reported in Chapter 3 because these options would not change the integrity of the fuel.

c. Reflects current reactor-area emissions (including two SNF wet basins).

Table 4.1-5. Estimated maximum incremental annual dose (person-rem) to the 620,100 person population surrounding SRS from airborne releases.

Fuel group	Technologies							
	1	2	3	4	5	6	7	8
	Prepare for direct co-disposal	Repackage and prepare to ship	Melt and dilute	Mechanical dilution	Vitrification technologies	Electrometallurgical treatment	Conventional processing[a]	Continued wet storage
A. Uranium and Thorium Metal Fuels	0[b]	NA	2.4×10^{-3}	NA	2.4×10^{-3}	2.4×10^{-3}	1.4×10^{-3}	9.5×10^{-3}[c]
B. Materials Test Reactor-Like Fuels	0[b]	NA	1.2	0.060	1.2	1.2	0.41	0.44[c]
C. HEU/LEU Oxides and Silicides Requiring Resizing or Special Packaging	0[b]	NA	0.38	0.019	0.38	0.38	0.13	0.12[c]
D. Loose Uranium Oxide in Cans	NA	NA	0.022	NA	0.022	0.022	0.026	0.025[c]
E. Higher Actinide Targets	NA	0[b]	NA	NA	NA	NA	NA	3.57×10^{-3}[c]
F. Non-Aluminum-Clad Fuels	NA	0[b]	NA	NA	NA	NA	NA	NA

NA = Technology is not applicable to this fuel type.
HEU = Highly Enriched Uranium.
LEU = Low Enriched Uranium.

a. Annual impacts from Conventional Processing are lower because the amount of material processed annually by this technology is less than for other technologies. The annual impacts for Conventional Processing are based on operating one dissolver in a canyon. Impacts would double if the canyon was operated at full capacity (i.e., two dissolvers). Fuel processing of the entire SNF inventory would take over 20 dissolver-years using one dissolver and about 11 dissolver-years using two dissolvers. Processing all the fuel at full capacity in a new treatment facility would take about 7 years. Appendix E provides more information related to processing durations.

b. No incremental increase expected above SRS baseline radioactive emissions values reported in Chapter 3 because these options would not change the integrity of the fuel.

c. Reflects current reactor-area emissions (including two SNF wet basins).

in the public; (2) the collective dose to the population within a 50-mile (80-kilometer) radius around the SRS (approximately 620,000 people); (3) the collective dose to workers involved in implementing a given alternative (i.e., the workers involved in SNF management activities); and (4) the dose to the maximally exposed noninvolved worker (i.e., SRS employees who may work in the vicinity of the SNF management facilities but are not directly involved in SNF work). All radiation doses mentioned in this EIS are effective dose equivalents; internal exposures are committed effective dose equivalents. This section presents total impacts for the entire length of time necessary to implement each technology, using the durations listed in Appendix E. The annual impacts attributable to each phase were multiplied by the duration of that phase. The impacts from all phases were summed to calculate the total impact for the technology. This discussion characterizes health effects as additional lifetime latent cancer fatalities likely to occur in the general population around SRS and in the population of workers who would be associated with the options.

4.1.1.3.1 Radiological Health Effects

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

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

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

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

DOE also has employed these concepts in estimating the effects of radiation exposure to a single individual. For example, consider the effects of exposure to background radiation over a lifetime. The number of latent cancer fatalities corresponding to an individual's exposure over a (presumed) 72-year lifetime at 0.3 rem per year would be 0.011 latent cancer fatality (1 person × 0.3 rem per year × 72 years × 0.0005 latent cancer fatality per person-rem).

This number should be interpreted in a statistical sense; that is, the estimated effect of background radiation exposure to the exposed individual is a 1.1-percent lifetime chance that the individual might incur a latent fatal cancer. Vital statistics on mortality rates for 1994 (CDC 1996) indicate that the overall lifetime fatality rate in the United States from all forms of cancer is about 23.4 percent (23,400 fatal cancers per 100,000 deaths).

These factors, which DOE uses in this EIS to relate radiation exposure to latent cancer fatalities, are based on the *Recommendations of the International Commission on Radiation Protection* (ICRP 1991). They are consistent with the factors used by the U.S. Nuclear Regulatory Commission in its rulemaking *Standards for Protection Against Radiation* (10 CFR Part 20). The factors apply if the dose to an individual is less than 20 rem and the dose rate is less than 10

rem per hour. At doses greater than 20 rem, the factors used to relate radiation doses to latent cancer fatalities are doubled. At much higher dose rates, prompt effects, rather than latent cancer fatalities, would be the primary concern.

In addition to latent cancer fatalities, other health effects could result from environmental and occupational exposures to radiation; these include nonfatal cancers among the exposed population and genetic effects in subsequent generations. Previous studies have concluded that these effects are less probable than fatal cancers as consequences of radiation exposure (ICRP 1991). Dose-to-risk conversion factors for nonfatal cancers and hereditary genetic effects (0.0001 per person-rem and 0.00013 per person-rem, respectively) are substantially lower than those for fatal cancers. This EIS presents estimated effects of radiation only in terms of latent cancer fatalities because that is the major potential health effect from exposure to radiation. Estimates of nonfatal cancers and hereditary genetic effects can be estimated by multiplying the radiation doses by the effects dose-to-risk conversion factors.

DOE expects minimal worker and public health impacts from the radiological consequences of managing SNF under any of the technology options, as well as Continued Wet Storage. However, some options would result in increased radiological releases. Public radiation doses include doses from airborne releases (Section 4.1.1.2) and liquid releases (Section 4.1.1.1). Table 4.1-6 lists incremental radiation doses estimated for the public (maximally exposed individual and collective population dose) and corresponding incremental latent cancer fatalities, for each fuel group and technology option.

The values in Tables 4.1-6 and 4.1-8 for the No-Action Alternative represent current reactor-area emissions (including two SNF wet basins) for the entire period of analysis. The values for the other alternatives would be incremental above these baseline values. Summing these baseline and incremental values would be conservative, however, because there would not be two SNF wet basins operating over the entire 38-year period of analysis.

DOE based estimated worker doses on past operating experience and the projected durations for implementation of the alternative actions (Bickford et al. 1997). For the maximally exposed worker, DOE assumed that no worker would receive an annual dose greater than 500 millirem from any option because SRS uses the 500-millirem value as an administrative limit for normal operations; that is, an employee who receives an annual dose approaching the administrative limit normally is reassigned to duties in a nonradiation area. (Note: If DOE privatized the Transfer and Storage Facility or treatment operations, the licensee would adopt NRC worker dose limits, and administrative limits could be subject to adjustment.) Tables 4.1-7 and 4.1-8 estimate radiation doses for the collective population of workers who would be directly involved in implementing the options and for the noninvolved worker (a worker not directly involved with implementing the option but located 2,100 feet [640 meters] from the SNF facility) for each fuel group and technology option. These tables also list the latent cancer fatalities likely attributable to the doses. TC

Of the fuels considered for treatment (all except higher actinide targets and non-aluminum clad fuel), the highest expected radiological health effects to the public generally would occur under conventional processing. The single exception would be fewer latent cancer fatalities predicted for the population from the conventional processing of uranium and thorium metal fuels (Table 4.1-6). For the noninvolved workers, the conventional processing of Groups C and D fuels would result in the greatest radiological health effects. No measurable incremental increases would be likely for the higher actinide targets or the non-aluminum-clad fuels for any option because the only options applied to those groups are repackaging and continued wet storage. The estimated collective dose for workers who would be directly involved in managing SNF (Table 4.1-7) depends largely on the difference in the number of workers involved in each option and

not on the difference in the amount of radioactivity.

Table 4.1-6. Radiation doses to the public and associated latent cancer fatalities for the entire period of analysis (1998-2035).[a]

		Technologies							
		1	2	3	4	5	6	7	8
Fuel Group	Parameter	Prepare for direct co-disposal	Repackage and prepare to ship	Melt and dilute	Mechanical dilution	Vitrification technologies	Electrometallurgical treatment	Conventional processing	Continued wet storage
A. Uranium and Thorium Metal Fuels	MEI[b] dose (millirem)	0[c]	NA	6.5×10^{-5}	NA	6.5×10^{-5}	6.5×10^{-5}	7.3×10^{-5}	0.01[g]
	MEI LCF[d,e]	0[c]	NA	3.2×10^{-11}	NA	3.2×10^{-11}	3.2×10^{-11}	3.6×10^{-11}	5.0×10^{-6}[g]
	Collective population dose (person-rem)	0[c]	NA	2.4×10^{-3}	NA	2.4×10^{-3}	2.4×10^{-3}	1.6×10^{-3}	0.36[g]
	Collective population LCF[f]	0[c]	NA	1.2×10^{-6}	NA	1.2×10^{-6}	1.2×10^{-6}	8.1×10^{-7}	1.8×10^{-4}[g]
B. Materials Test Reactor-Like Fuels	MEI[b] dose (millirem)	0[c]	NA	0.17	9.0×10^{-5}	0.17	0.17	0.54	0.46[g]
	MEI LCF[d,e]	0[c]	NA	8.5×10^{-8}	4.5×10^{-9}	8.5×10^{-8}	8.5×10^{-8}	2.7×10^{-7}	2.3×10^{-4}[g]
	Collective population dose (person-rem)	0[c]	NA	6.3	0.3	6.3	6.3	7.3	16.7[g]
	Collective population LCF[f]	0[c]	NA	3.1×10^{-3}	1.7×10^{-4}	3.1×10^{-3}	3.1×10^{-3}	3.7×10^{-3}	8.3×10^{-3}[g]
C. HEU/LEU Oxides and Silicides Requiring Resizing or Special Packaging	MEI[b] dose (millirem)	0[c]	NA	0.015	7.8×10^{-4}	0.015	0.015	0.12	0.12[g]
	MEI LCF[d,e]	0[c]	NA	7.3×10^{-9}	3.9×10^{-10}	7.3×10^{-9}	7.3×10^{-9}	6.2×10^{-8}	6.2×10^{-5}[g]
	Collective population dose (person-rem)	0[c]	NA	0.54	0.029	0.54	0.54	1.3	4.5[g]
	Collective population LCF[f]	0[c]	NA	2.7×10^{-4}	1.4×10^{-5}	2.7×10^{-4}	2.7×10^{-4}	6.5×10^{-4}	2.2×10^{-3}[g]
D. Loose Uranium Oxide in Cans	MEI[b] dose (millirem)	NA	NA	6.1×10^{-4}	NA	6.1×10^{-4}	6.1×10^{-4}	7.1×10^{-3}	0.026[g]
	MEI LCF[d,e]	NA	NA	3.0×10^{-10}	NA	3.0×10^{-10}	3.0×10^{-10}	3.6×10^{-9}	1.3×10^{-5}[g]
	Collective population dose (person-rem)	NA	NA	0.022	NA	0.022	0.022	0.075	0.95[g]
	Collective population LCF[f]	NA	NA	1.1×10^{-5}	NA	1.1×10^{-5}	1.1×10^{-5}	3.8×10^{-5}	4.7×10^{-4}[g]
E. Higher Actinide Targets	MEI[b] dose (millirem)	NA	0[c]	NA	NA	NA	NA	NA	3.7×10^{-3}[g]
	MEI LCF[d,e]	NA	0[c]	NA	NA	NA	NA	NA	1.9×10^{-6}[g]
	Collective population dose (person-rem)	NA	0[c]	NA	NA	NA	NA	NA	0.14[g]
	Collective population LCF[f]	NA	0[c]	NA	NA	NA	NA	NA	6.8×10^{-5}[g]
F. Non-Aluminum-Clad Fuels	MEI[b] dose (millirem)	NA	0[c]	NA	NA	NA	NA	NA	NA
	MEI LCF[d,e]	NA	0[c]	NA	NA	NA	NA	NA	NA
	Collective population dose (person-rem)	NA	0[c]	NA	NA	NA	NA	NA	NA
	Collective population LCF[f]	NA	0[c]	NA	NA	NA	NA	NA	NA

NA = Technology is not applicable to this fuel type.
HEU = Highly Enriched Uranium.
LEU = Low Enriched Uranium.

a. Potentially reduced fuel receipts could reduce the reported impacts. Scaling factors applied to these impact values should be applied specifically to each fuel group affected. For example, if the amount of fuel in Group B were reduced to 80 percent of the value reported in Table 1-1, then each value reported for Group B should be multiplied by 0.8.
b. MEI = Maximally Exposed Individual; i.e., a hypothetical member of the public whose location and habits result in exposure to the maximum dose from all pathways.
c. No incremental increase expected above SRS baseline radioactive emissions values presented in Chapter 3 because these options would not affect the integrity of the fuel.
d. LCF = latent cancer fatalities.
e. For an individual, the LCF value should be interpreted statistically; e.g., 1×10^{-9} = 1 chance in 1 billion to develop a fatal cancer.
f. For collective population, the LCF value should be interpreted as the number of cancers that could be expected in the population.

g. Reflects current reactor-area emissions (including two SNF wet basins) for the entire period of analysis.

Table 4.1-7. Number of radiation workers and collective worker radiation dose (person-rem) and associated latent cancer fatalities for the entire period of analysis (1998-2035).[a]

		Technologies							
		1	2	3	4	5	6	7	8
Fuel Group	Parameter	Prepare for direct co-disposal	Repackage and prepare to ship	Melt and dilute	Mechanical dilution	Vitrification technologies	Electrometallurgical treatment	Conventional processing	Continued wet storage
	Number of radiation workers[b]	75	38	100	88	159	119	150	40
A. Uranium and Thorium Metal Fuels	Collective worker dose (person-rem)	11	NA	12	NA	15	13	18	12
	LCF[c]	4.2×10^{-3}	NA	4.8×10^{-3}	NA	6.1×10^{-3}	5.2×10^{-3}	7.2×10^{-3}	4.9×10^{-3}
B. Materials Test Reactor-Like Fuels	Collective worker dose (person-rem)	480	NA	530	520	680	580	1,300	560
	LCF	0.19	NA	0.21	0.21	0.27	0.23	0.50	0.22
C. HEU/LEU Oxides and Silicides Requiring Resizing or Special Packaging	Collective worker dose (person-rem)	140	NA	150	150	190	160	600	150
	LCF	0.054	NA	0.059	0.059	0.075	0.064	0.24	0.060
D. Loose Uranium Oxide in Cans	Collective worker dose (person-rem)	NA	NA	31	NA	40	34	170	32
	LCF	NA	NA	0.012	NA	0.016	0.014	0.069	0.013
E. Higher Actinide Targets	Collective worker dose (person-rem)	NA	3	NA	NA	NA	NA	NA	5
	LCF	NA	1.3×10^{-3}	NA	NA	NA	NA	NA	1.8×10^{-3}
F. Non-Aluminum Clad Fuels	Collective worker dose (person-rem)	NA	26	NA	NA	NA	NA	NA	NA
	LCF	NA	0.011	NA	NA	NA	NA	NA	NA

NA = Technology is not applicable to this fuel type.
HEU = Highly Enriched Uranium.
LEU = Low Enriched Uranium.

a. Potentially reduced fuel receipts could reduce the reported impacts. Scaling factors applied to these impact values should be applied specifically to each fuel group affected. For example, if the amount of fuel in Group B were reduced to 80 percent of the value reported in Table 1-1, then each value reported for Group B should be multiplied by 0.8.

b. Estimates of the number of radiation workers are based on past operating experience (Bickford et al. 1997).

c. LCF = latent cancer fatalities.

Table 4.1-8. Radiation doses to the maximally exposed noninvolved worker (at 640 meters) and associated latent cancer fatalities for the entire period of analysis (1998-2035).[a]

		Technologies							
		1	2	3	4	5	6	7	8
Fuel Group	Parameter	Prepare for direct co-disposal	Repackage and prepare to ship	Melt and dilute	Mechanical dilution	Vitrification technologies	Electrometallurgical treatment	Conventional processing	Continued wet storage
A. Uranium and Thorium Metal Fuels	Noninvolved worker dose (millirem)	0[c]	NA	5.3×10^{-4}	NA	5.3×10^{-4}	5.3×10^{-4}	3.2×10^{-4}	0.068[d]
	Noninvolved worker LCF[b]	0[c]	NA	2.1×10^{-10}	NA	2.1×10^{-10}	2.1×10^{-10}	1.3×10^{-10}	2.7×10^{-5}[d]
B. Materials Test Reactor-Like Fuels	Noninvolved worker dose (millirem)	0[c]	NA	1.4	0.074	1.4	1.4	1.3	3.1[d]
	Noninvolved worker LCF[b]	0[c]	NA	5.6×10^{-7}	2.9×10^{-8}	5.6×10^{-7}	5.6×10^{-7}	5.4×10^{-7}	1.3×10^{-3}[d]
C. HEU/LEU Oxides and Silicides Requiring Resizing or Special Packaging	Noninvolved worker dose (millirem)	0[c]	NA	0.12	6.3×10^{-3}	0.12	0.12	0.22	0.84[d]
	Noninvolved worker LCF[b]	0[c]	NA	4.8×10^{-8}	2.5×10^{-9}	4.8×10^{-8}	4.8×10^{-8}	8.6×10^{-8}	3.4×10^{-4}[d]
D. Loose Uranium Oxide in Cans	Noninvolved worker dose (millirem)	NA	NA	5.0×10^{-3}	NA	5.0×10^{-3}	5.0×10^{-3}	0.013	0.18[d]
	Noninvolved worker LCF[b]	NA	NA	2.0×10^{-9}	NA	2.0×10^{-9}	2.0×10^{-9}	5.0×10^{-9}	7.1×10^{-5}[d]
E. Higher Actinide Targets	Noninvolved worker dose (millirem)	NA	0[c]	NA	NA	NA	NA	NA	0.025[d]
	Noninvolved worker LCF[b]	NA	0[c]	NA	NA	NA	NA	NA	1.0×10^{-5}[d]
F. Non-Aluminum-Clad Fuels	Noninvolved worker dose (millirem)	NA	0[c]	NA	NA	NA	NA	NA	NA
	Noninvolved worker LCF[b]	NA	0[c]	NA	NA	NA	NA	NA	NA

NA = Technology is not applicable to this fuel type.
HEU = Highly Enriched Uranium.
LEU = Low Enriched Uranium.

a. Potentially reduced fuel receipts could reduce the reported impacts. Scaling factors applied to these impact values should be applied specifically to each fuel group affected. For example, if the amount of fuel in Group B were reduced to 80 percent of the value reported in Table 1-1, then each value reported for Group B should be multiplied by 0.8.
b. LCF = latent cancer fatalities; this number should be interpreted statistically.
c. No incremental increase expected above SRS baseline radioactive emissions values presented in Chapter 3, because these options would not affect the integrity of the fuel.
d. Reflects current reactor-area emissions (including two SNF wet basins) for the entire period of analysis.

The estimated number of latent cancer fatalities in the public listed in Table 4.1-6 can be compared to the projected number of fatal cancers (145,100) in the public around the SRS from all causes (as discussed in Section 3.7.1). Similarly, the estimated number of latent cancer fatalities in the worker population can be compared to the number in the worker population from all causes (approximately 23.4 per- cent; see Section 3.7.1). In all cases, the incremental impacts from the options would be negligible.

4.1.1.3.2 Nonradiological Health Effects

DOE evaluated the range of chemicals to which the public and workers would be exposed due to SNF management activities and expects minimal health impacts from nonradiological exposures. Section 4.1.1.1.1 discusses offsite chemical concentrations from air emissions. DOE estimated worker impacts and compared them to Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs) or ceiling limits for protecting worker health, and concluded that all impacts would be well below the limits.

OSHA limits (29 CFR Part 1910.1000) are time-weighted average concentrations that a facility cannot exceed during a prescribed duration of a 40-hour week. The facility cannot exceed OSHA ceiling concentrations during any part of the workday. These exposure limits refer to airborne concentrations of substances and represent conditions under which nearly all workers could be exposed day after day without adverse health effects. However, because of the wide variation in individual susceptibility, a small percentage of workers could experience discomfort from some substances at concentrations at or below the permissible limit. Table 4.1-9 summarizes the values of Permissible Exposure Limits that DOE compared to the data in Tables F-1 through F-5 in Appendix F.

4.1.1.4 Waste Generation

This section presents waste generation estimates for each technology option and fuel group that DOE considers in this EIS. Tables 4.1-10 through 4.1-13 list these estimates. For each technology option, this analysis considered three handling phases as potential sources of waste: wet storage (pretreatment storage), treatment or conditioning, and dry storage (post-treatment storage pending final disposition). The period and waste generation rate associated with each phase varied depending on the fuel group and the technology. As discussed above, DOE summed waste volumes from each phase; the values listed in the tables represent the total projected waste volumes for each technology option in a given fuel group.

DOE used the annual waste generation rates to calculate the estimates in the tables (Bickford et al. 1997); the rates are based on applicable current and past SRS operations or on process

Table 4.1-9. Permissible Exposure Limits (milligrams per cubic meter) of nonradiological air pollutants regulated by the Occupational Safety and Health Administration.[a]

Pollutant	Averaging time	OSHA PEL[b]
Carbon monoxide	8 hours	55
Nitrogen oxides	1 hour	9[c]
Sulfur dioxide	8 hours	13
Carbon dioxide	8 hours	9,000
Nitric acid	8 hours	5

a. Source: 29 CFR Part 1910.1000.
b. Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL).

c. OSHA ceiling limit not to be exceeded at any time during the workday.

Table 4.1-10. High-level waste generation for the entire period of analysis (1998-2035) (cubic meters).[a,b,c]

		Technologies							
		1	2	3	4	5	6	7	8
Fuel group	Parameter	Prepare for direct co-disposal	Repackage and prepare to ship	Melt and dilute	Mechanical dilution	Vitrification technologies	Electrometallurgical treatment	Conventional processing	Continued Wet storage
A. Uranium and Thorium Metal Fuels	Liquid high-level waste	10	NA	10	NA	10	10	170	36
	Equivalent DWPF canisters	<1	NA	<1	NA	<1	<1	3	<1
	Saltstone	26	NA	26	NA	26	26	430	97
B. Materials Test Reactor-Like Fuels	Liquid high-level waste	470	NA	450	470	450	450	7,700	1,700
	Equivalent DWPF canisters	8	NA	7	8	7	7	120	28
	Saltstone	1,250	NA	1,200	1,300	1,200	1,200	20,000	4,500
C. HEU/LEU Oxides and Silicides Requiring Resizing or Special Packaging	Liquid high-level waste	125	NA	120	130	120	120	2,100	450
	Equivalent DWPF canisters	2	NA	2	2	2	2	32	8
	Saltstone	330	NA	320	340	320	320	5,400	1,200
D. Loose Uranium Oxide in Cans	Liquid high-level waste	NA	NA	25	NA	25	25	450	96
	Equivalent DWPF canisters	NA	NA	<1	NA	<1	<1	7	2
	Saltstone	NA	NA	67	NA	67	67	1,100	260
E. Higher Actinide Targets	Liquid high-level waste	NA	4	NA	NA	NA	NA	NA	14
	Equivalent DWPF canisters	NA	<1	NA	NA	NA	NA	NA	<1
	Saltstone	NA	10	NA	NA	NA	NA	NA	36
F. Non- Aluminum-Clad Fuels	Liquid high-level waste	NA	30	NA	NA	NA	NA	NA	NA
	Equivalent DWPF canisters	NA	<1	NA	NA	NA	NA	NA	NA
	Saltstone	NA	80	NA	NA	NA	NA	NA	NA

DWPF = Defense Waste Processing Facility.
NA = Technology is not applicable to this fuel type.
HEU = Highly Enriched Uranium.
LEU = Low Enriched Uranium.

a. Except DWPF canisters.
b. To convert cubic meters to cubic yards, multiply by 1.308.
c. Potentially reduced fuel receipts could reduce the reported impacts. Scaling factors applied to these impact values should be applied specifically to each fuel group affected. For example, if the amount of fuel in Group B were reduced to 80 percent of the value reported in Table 1-1, then each value reported for Group B should be multiplied by 0.8.

knowledge for new treatment technologies. The operating history that was the basis for these estimates would maximize projected waste generation rates. As described in Section 3.8, the Site generates several types of waste (high-level, transuranic, mixed, hazardous, low-level, and sanitary). Wastes generated by SNF management activities would be comparable to wastes the SRS currently handles and would, therefore, not require unique treatment, storage, or disposal actions. This section does not consider sanitary waste, the production of which would be in direct proportion to the number of employees, because none of the technologies would increase the number of permanent Site employees.

DOE has implemented an aggressive waste minimization and pollution prevention program at SRS at the sitewide level and for individual organizations and projects. As a result, significant reductions have been achieved in the amounts of wastes discharged into the environment and sent to landfills, resulting in significant cost savings.

To implement a waste minimization and pollution prevention program at the SNF management facilities, DOE would characterize waste streams and identify opportunities for reducing or eliminating them. Emphasis would be placed on minimizing the largest waste stream, low-level L1-5 waste, through source reduction and recycling. Selected waste minimization practices could include: (1) process design changes to reduce the potential for spills and to minimize contamination areas, (2) decontamination of equipment to facilitate reuse, (3) recycling metals and other usable materials, especially during the construction phase of the project, (4) preventive maintenance to extend process equipment life, (5) modular equipment designs to isolate potential failure elements to avoid changing out entire units, and (6) use of non-toxic or less toxic materials to prevent pollution and minimize hazardous and mixed waste streams.

EC The following sections describe the differences in waste generation by waste type among the SNF management technologies considered in this EIS.

4.1.1.4.1 High-Level Waste

SRS reports high-level waste as liquid high-level waste, and in the related quantities of equivalent Defense Waste Processing Facility (DWPF) canisters and saltstone. The volume estimates for liquid high-level waste reported in Table 4.1-10 are for volumes as they leave the process and EC enter the high-level waste tanks. While it is necessary to consider this volume when evaluating the interim storage of high-level waste in the tank farms, the volume of liquid high-level waste is not meaningful when considering the storage and disposition of final waste forms. The liquid waste is evaporated and concentrated in the high-level waste tanks. The generation of secondary waste in the high-level waste tanks and DWPF, including waste generated as a result of activities described in this SNF EIS, is evaluated in the DWPF Supplemental EIS (DOE 1994). Therefore, capacity for management of SNF secondary waste in the tank farms and DWPF is provided within the scope of DWPF operations. DWPF canisters and saltstone are the product of liquid high-level waste treatment and evaporation and would be the basis for final storage and disposition considerations. Because the production of saltstone and DWPF canisters from a given liquid waste volume are generally proportional, this discussion applies equally to DWPF canisters and saltstone. For Conventional Processing, DWPF canisters would be the only product to be disposed in a geologic repository. TC

Conventional Processing is the only option that would generate significant quantities of high-level waste during the treatment phase. Each option would produce high-level waste during the wet storage phase and technologies such as melt and dilute, that require off-gas collection systems, would also produce high-level waste, but the quantity produced generally would be much lower than that associated with Conventional Processing. The waste generated during wet storage and new technology processing operations would not meet the formal definition of high-level waste (waste resulting from the processing of SNF), but would consist of such items as deionizer backwash and off-gas collection

products, which the SRS typically manages (or would manage) as high-level waste. The lengthy period associated with continued wet storage generally would make it the second largest producer of high-level waste. For the higher actinide targets, Conventional Processing was not considered, making Continued Wet Storage the greatest potential for high-level waste production. The volumes of high-level waste generated by the other options would vary depending on the duration of storage and the amount of fissile material in the fuel, but would be fairly comparable within a given fuel type and substantially less than the volumes associated with conventional processing. In addition, the condition of the fuel would influence the high-level waste generation rate (i.e., fuel in poor condition would result in higher generation of deionizer backwash).

Based on the capacities of the high-level waste tank farms and the current volume of high-level waste in storage (see Table 3.8-2), these projected high-level waste volumes probably would not require additional treatment and storage facilities beyond those currently available at SRS. DOE bases this conclusion on continued removal and treatment of the existing tank farm inventory. DWPF would be available to treat these projected high-level waste volumes.

4.1.1.4.2 Transuranic Waste

For all applicable fuel types, conventional processing would produce the largest volume of transuranic waste due to a higher generation rate and a longer processing time. Conventional processing of all applicable fuel groups would generate 3660 cubic meters of transuranic waste which is 29 percent of the total SRS transuranic waste generation forecast (Table 3.8-1). The next largest quantity that could be generated would be from the Vitrification and Electrometallurgical Treatments of all applicable fuel groups. Those technologies would generate 700 cubic meters of transuranic waste over the life of the project, which is less than 6 percent of the total SRS transuranic waste generation forecast. These two technologies would produce 9 to 37 percent of that produced by conventional processing, depending on the fuel group.

None of the treatment options associated with the higher actinide targets or non-aluminum-clad fuels would produce transuranic waste.

4.1.1.4.3 Hazardous/Low-Level Mixed Waste

For this EIS analysis, DOE grouped hazardous and low-level mixed wastes together because none of the options is likely to produce significant quantities of either.

The highest hazardous/low-level mixed waste generation rates would be associated with Vitrification and Electrometallurgical Treatments, followed by Mechanical Dilution. However, due to the longer time required to process the loose uranium oxide in cans, the Materials Test Reactor-like fuels, and the highly enriched uranium/low enriched uranium (HEU/LEU) oxides and silicides requiring resizing or special packaging, conventional processing would produce the largest volume of hazardous or mixed waste for those fuel groups. Vitrification and Electrometallurgical Treatments generally would produce the next largest quantities (35 to 88 percent of that produced by conventional processing, depending on the fuel group). For the uranium and thorium metal fuels, Vitrification and Electrometallurgical Treatments produce the largest quantities of hazardous/low-level mixed waste, followed by conventional processing. For applicable fuel groups, the Direct Disposal/Direct Co-Disposal technology would consistently produce the smallest quantities of hazardous or mixed waste. The waste volumes that continued wet storage or the Melt and Dilute technology would produce would be roughly comparable and generally intermediate among the technologies. For the higher actinide targets, the two technologies being considered (Repackage and Prepare to Ship and Continued Wet Storage) would produce small, comparable quantities of hazardous or mixed waste.

When all applicable technologies are considered, conventional processing would generate

the largest volume (264 cubic meters) of hazardous and low-level mixed waste, which is less than 1 percent of the 30-year forecast.

4.1.1.4.4 Low-Level Waste

The Direct Disposal/Direct Co-Disposal and Repackage and Prepare to Ship technology options would produce the least low-level waste. The Mechanical Dilution and Melt and Dilute options would produce intermediate quantities of low-level waste, between 9 and 37 percent of the maximum volume generated and within approximately 150 percent of the minimum volume, depending on the fuel group. For applicable fuel groups, conventional processing would produce the most low-level waste. In each case, continued wet storage would produce the next highest volume due to the combined effect of storage time and generation rate. When all applicable fuel groups are included, conventional processing would generate 138,200 cubic meters of low-level waste (29 percent of the SRS low-level waste 30-year forecast) and continued wet storage would generate 56,650 cubic meters (12 percent of the forecast). Of the two options being considered for the higher actinide targets, the Repackage and Prepare to Ship option would produce the smallest quantity of low-level waste, 32 percent of that estimated for Continued Wet Storage.

4.1.1.4.5 By-products of converting SNF into a waste form that is suitable for disposal in a geologic repository

With the exception of continued wet storage under the No-Action Alternative, the technology options would convert the fuels into a waste form that is likely to be suitable for permanent disposal in a geologic repository. The radioactive inventory in the final waste form would be substantially greater than 99 percent of the original fuel inventory. Very small amounts of residual radioactivity would remain in secondary low-level, hazardous/mixed low-level, and transuranic waste streams as illustrated in Figures 4.1-1 through 4.1-7. SRS would use the surplus capacity in existing waste management facilities to treat, store, dispose of, or recycle the secondary waste in accordance with applicable regulations.

The melt and dilute and vitrification technologies would release from the fuel matrix volatile fission products (primarily cesium) from the fuel matrix which would be recovered as illustrated in Figure 4.1-3 and Figure 4.1-5. Residual cesium, strontium, and plutonium from conventional processing (as well as volatile fission products from melt and dilute, and vitrification technology options) would be moved from the high-level waste tanks and separated into a high volume – low radioactivity salt stream and a low volume – high radioactivity slurry. The salt stream would be approximately 95 percent of the total (before separation) volume and the slurry would capture approximately 99.999 percent of the cesium, strontium, and plutonium activity (Choi 1992). The slurry would be encapsulated in glass and poured into canisters at the Defense Waste Processing Facility The canisters would be stored in a Glass Waste Storage Building for ultimate disposal in a geologic repository. The salt stream would be mixed into and solidified with concrete and disposed of in the Z-Area vaults.

4.1.1.4.6 Spent Fuel Canisters

DOE does not consider the SNF canisters resulting from alternate technology options to constitute a waste stream because they would be the end product of the new packaging options or new processing technology options being proposed. Nevertheless, the number of canisters is a useful measure of onsite storage space needed and the volume of the material that, after processing, could possibly be placed in a repository. Table 4.1-14 indicates the numbers of two types of canisters for the various technologies. The 17-inch canister would be used for co-disposal. The 24-inch canister would be used when the technology produces a vitrified product identical

Table 4.1-14. Numbers of spent fuel co-disposal and high-level waste canisters.

Technology	Co-Disposal or Direct Disposal canisters	24-inch high-level waste canisters
Prepare for direct co-disposal	1,400	NA[a]
Repackage and prepare to ship	NA[b]	1
Melt and dilute	400	10
Mechanical dilution[c]	630	10
Vitrification technologies[d]	1,350	10
Electrometallurgical treatment	–	90
Conventional processing[e]	–	150
Continued wet storage	–	41

a. NA = not applicable, since DOE would use Co-Disposal.
b. Canisters would not be required to transfer material to another site.
c. Values were calculated for the press and dilute technology.
d. Values represent dissolve and vitrify and glass material oxidation and dissolution system technologies. The plasma arc technology would produce 490 canisters.
e. Values are for conventional processing the entire SNF inventory.

to the DPWF high-level waste borosilicate glass. After conventional processing, the 24-inch canisters would be stored in DWPF's Glass Waste Storage Building. The number of high-level waste canisters (Table 4.1-14) includes the secondary waste stream components generated by the technologies reported in Table 4.1-10.

4.1.1.5 Utility and Energy Resources

This section describes the estimated utility and energy requirements associated with each technology option under consideration in this EIS. Water, electricity, steam, and diesel fuel would be required to support many of the options. Estimates of water use include domestic water supplies and makeup water for process operations or equipment cooling. Steam is used primarily to heat facilities. Fuel consumption is based on use of diesel generators for backup power. Electrical requirements include that for normal office consumption such as heating, cooling, ventilation, and office equipment, and for specialized process-related equipment. The process equipment and the associated electrical demands would vary from option to option. All technologies would require canister loading and welding equipment. For the Melt and Dilute technology, the resistive heating associated with melting would require additional electricity. For aqueous processing, electrical requirements would include the operation of canyon pumps, circulators or mixers, and denitriting equipment. For Vitrification, electrical equipment would be used for resistive heating and dissolution. For Electrometallurgical Treatment, electricity would be used for resistive melting of fuels, operation of an electrolytic bath for metal purification, final melting of the refined uranium product, and blending down with depleted uranium.

Tables 4.1-15 through 4.1-18 list estimated utility and energy requirements for the technology options applicable to each fuel group. For each option, this analysis considered three handling phases as potential sources of energy consumption: wet storage (pretreatment storage), treatment, and dry storage (post-treatment storage pending final disposition). The durations for these phases are provided in Appendix E. The period and utility use rate associated with each phase would vary depending on the fuel group and the option. As discussed above, DOE summed utility use from each phase; the values listed in the tables represent the total projected utility use for each option in a given fuel group.

DOE used annual utility consumption rates to calculate the estimates in the tables (Bickford et

al. 1997); the rates are based on applicable cur-

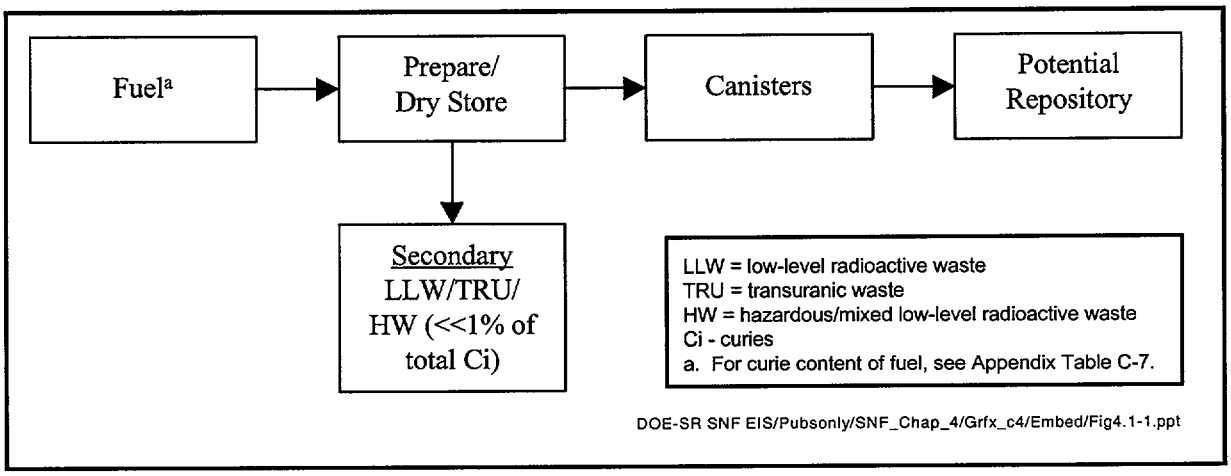

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Figure 4.1-1. Type and source of waste streams generated by the Prepare for Direct Co-Disposal technology option.

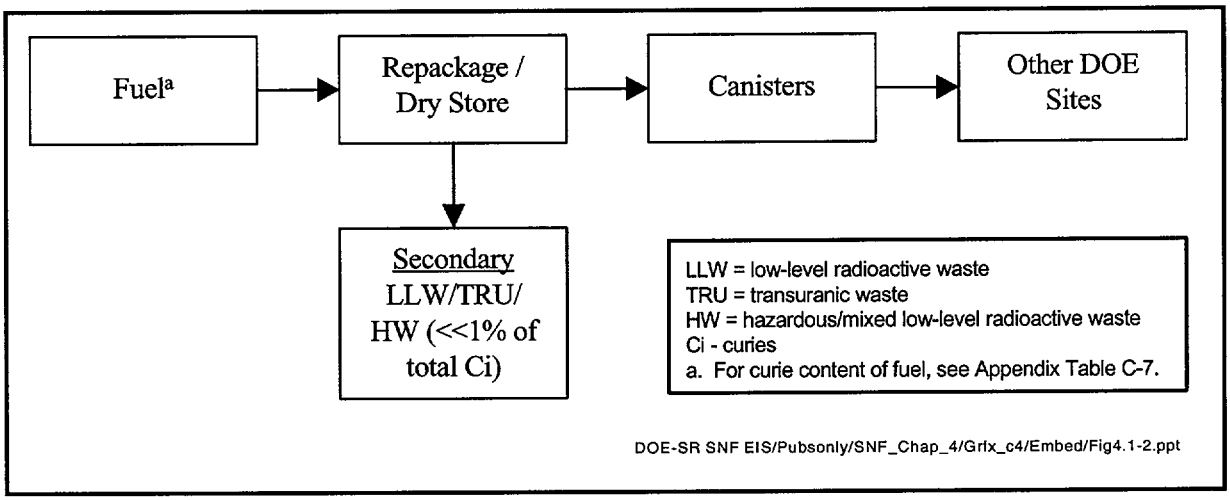

Figure 4.1-2. Type and source of waste streams generated by the Repackage and Prepare to Ship technology option.

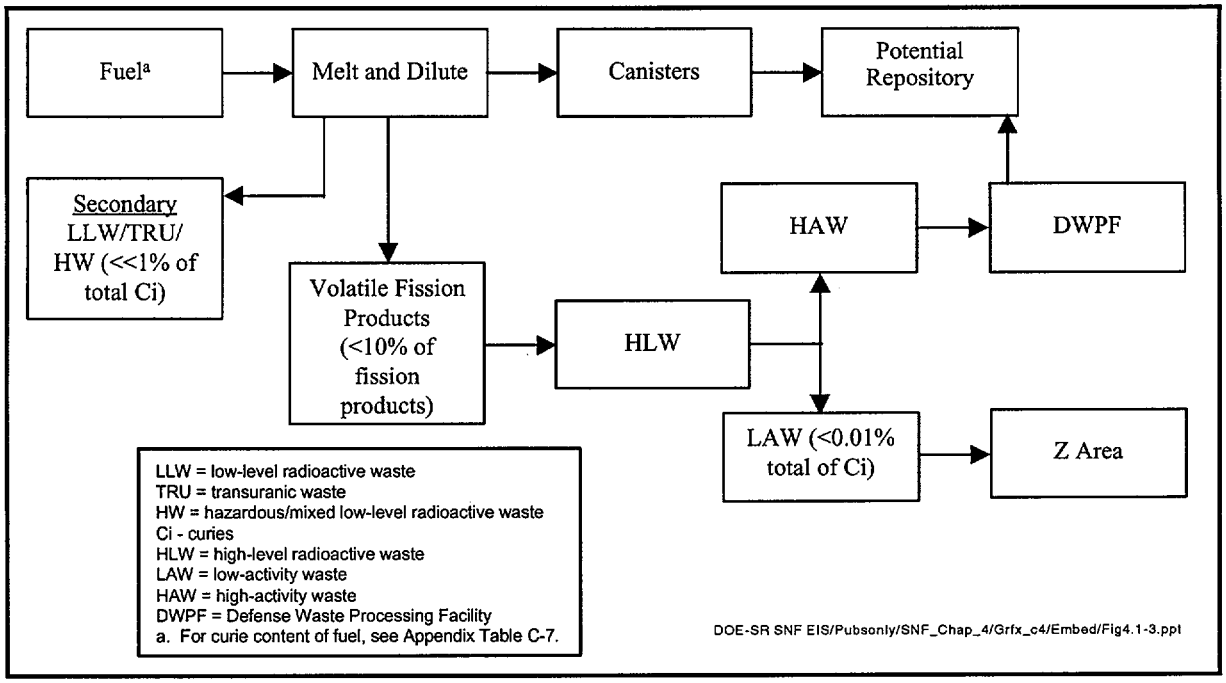

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Figure 4.1-3. Type and source of waste streams generated by the Melt and Dilute technology option.

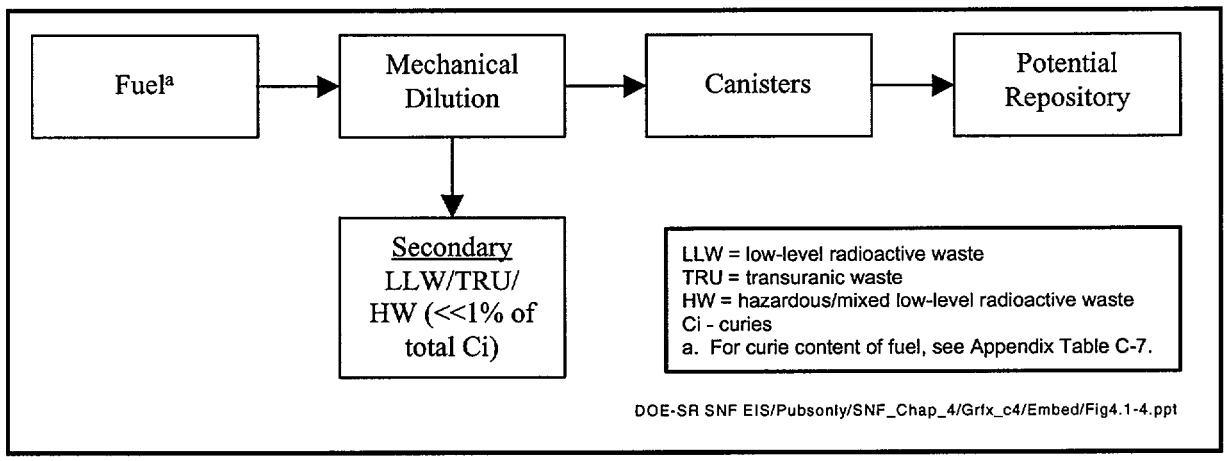

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Figure 4.1-4. Type and source of waste streams generated by the Mechanical Dilution technology option.

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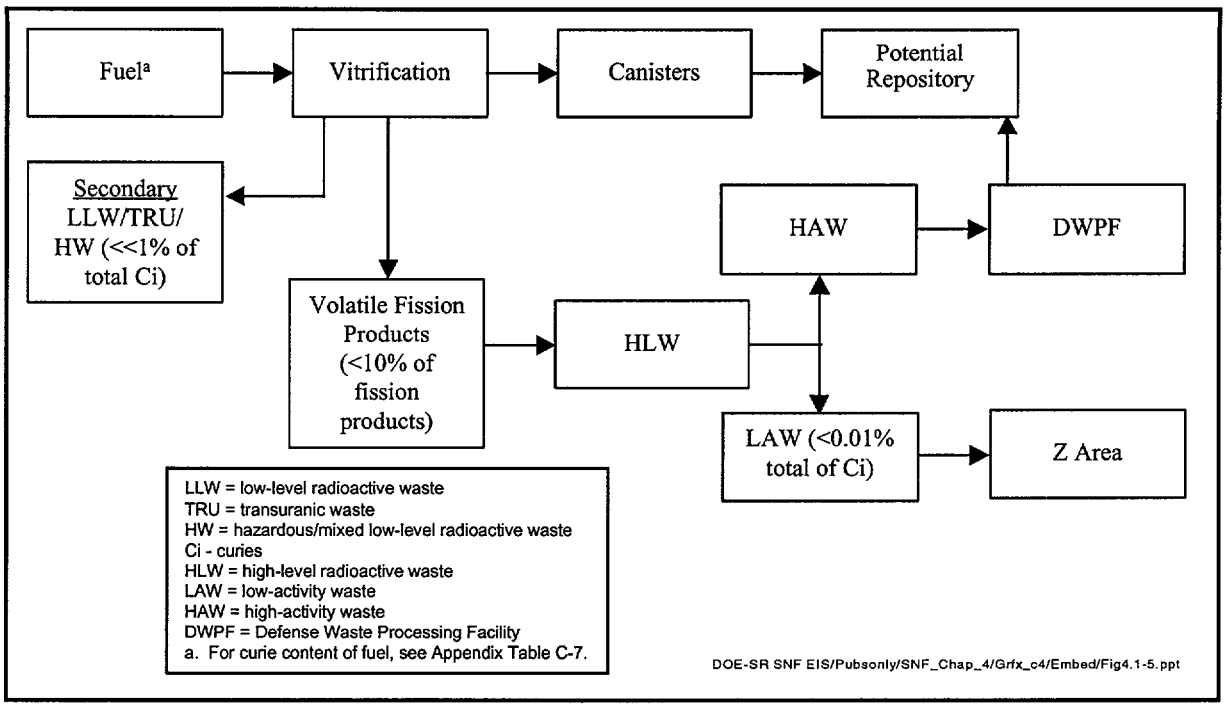

Figure 4.1-5. Type and source of waste streams generated by the Vitrification technology options.

EC

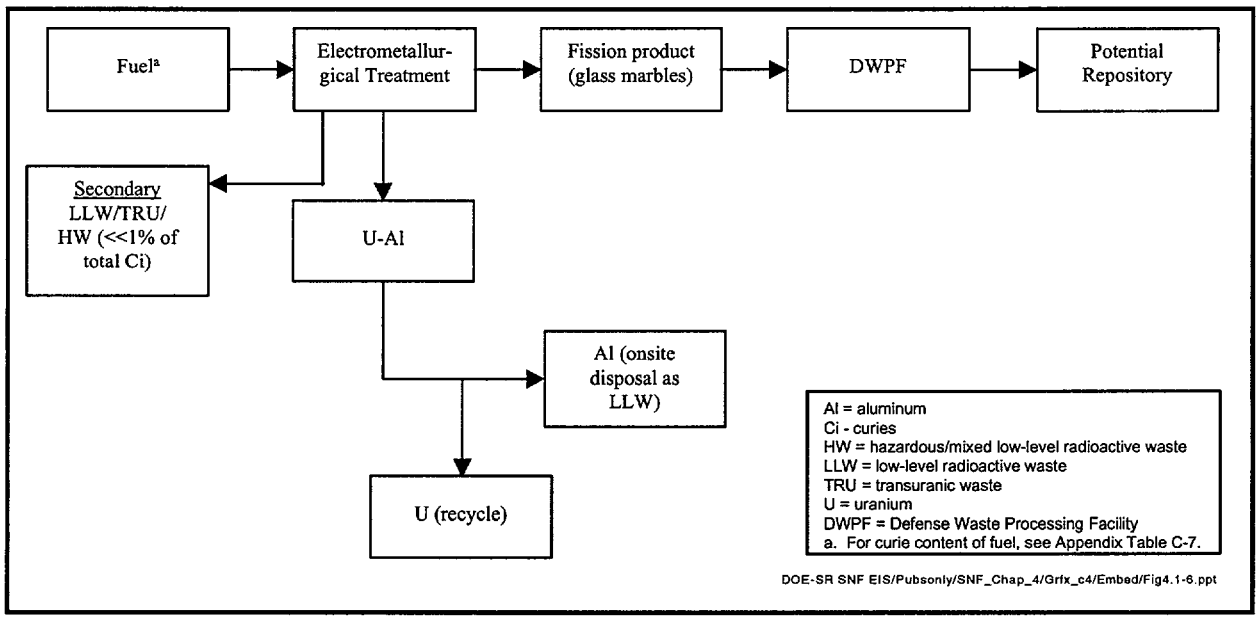

Figure 4.1-6. Type and source of waste streams generated by the Electrometallurgical Treatment technology option.

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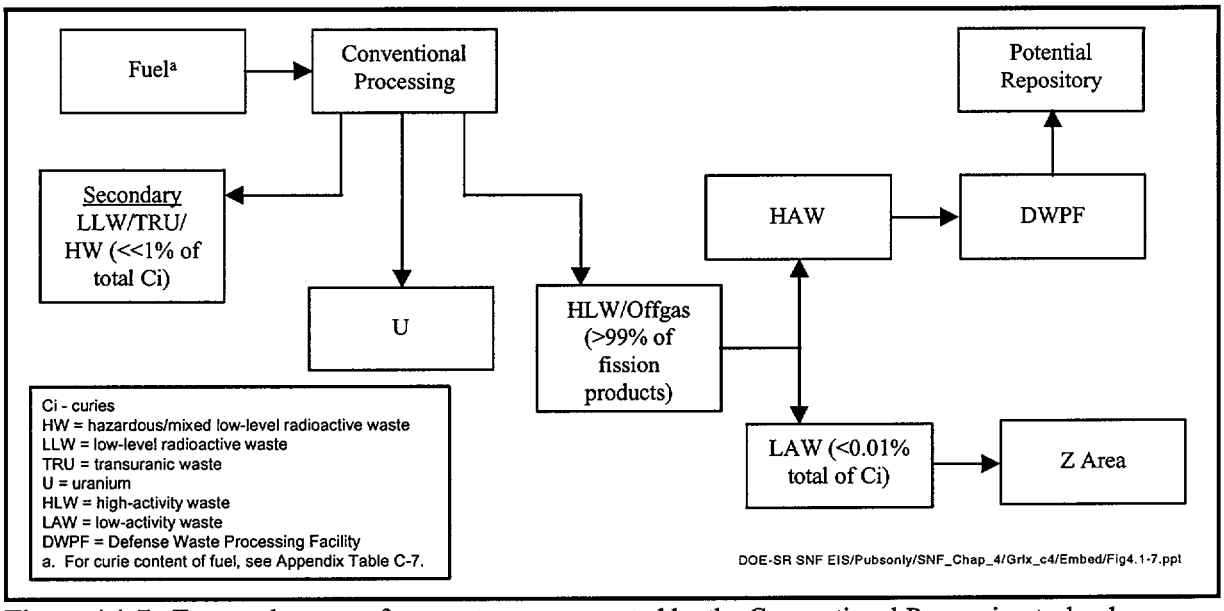

Figure 4.1-7. Type and source of waste streams generated by the Conventional Processing technology option.

rent and past SRS operations or on engineering judgments for new treatment technologies.

The following paragraphs describe estimated utility requirements for the options.

4.1.1.5.1 Water Use

Vitrification and Electrometallurgical Treatment would require the most water, followed by Conventional Processing. Total requirements for Vitrification and Electrometallurgical Treatment of all applicable fuel groups would be less than 6,000 liters per year, (the equivalent of 4.3 gallons per day) which is a minute portion (0.00001 percent) of groundwater withdrawal of more than 5×10^9 liters per year (DOE 1997). Due to the comparatively long period required to process the HEU/LEU oxides and silicides requiring resizing or special packaging (Fuel Group C) and the loose uranium oxide in cans (Fuel Group D), the Conventional Processing technology would require the greatest amount of water for those groups. For the higher actinide targets, Repackage and Prepare to Ship would require 67 percent of the water needed to support the only other option under consideration for that fuel group, Continued Wet Storage. In general, the Direct Disposal/Direct Co-Disposal, Melt and Dilute, Mechanical Dilution, and Repackage and Prepare to Ship technologies would require the least water for their applicable fuel groups, approximately 5 to 6 percent of the maximum requirement for a given group.

4.1.1.5.2 Electricity Use

Vitrification and Electrometallurgical Treatment would have the highest annual demand for electricity, followed by Conventional Processing. Differences in the time necessary to treat a fuel group under different options would affect total electricity requirements. Due to the longer period required to process the materials test reactor-like fuels (Fuel Group B), HEU/LEU oxides and silicides requiring resizing or special packaging (Fuel Group C), and loose uranium oxide in cans (Fuel Group D), Conventional Processing would require the most total electricity for those groups. For the higher actinide targets, Repackage and Prepare to Ship would require less than half the electricity needed to support continued wet storage. In general, for the appropriate fuel groups, the least electricity would be required to support Direct Co-Disposal and Mechanical Dilution.

Annually, the maximum impact alternative electrical demand is 23,600 megawatt-hours, which is approximately 3.5 percent of the current SRS annual usage of 660,000 megawatt-hours.

4.1.1.5.3 Steam Use

Where applicable, Conventional Processing would have the highest annual demand for steam. For higher actinide targets, Repackage and Prepare to Ship would require half the steam needed to support continued wet storage. In general, Direct Co-Disposal and Mechanical Dilution would require the least steam.

4.1.1.5.4 Diesel Fuel Use

For several options, DOE would use diesel fuel to support SNF treatment and storage. On an annual basis, Conventional Processing and Melt and Dilute would need the most diesel fuel. The least diesel fuel would be associated with the Vitrification and Electrometallurgical Treatment technologies, because both would require fuel only to support initial wet storage. The two options that DOE is considering for the higher actinide targets (Repackage and Prepare to Ship and Continued Wet Storage) would require comparable amounts of diesel fuel.

4.1.1.6 Environmental Justice

This section examines whether minority or low-income communities (as defined in Section 3.5.3) could receive disproportionately high and adverse human health and environmental impacts as a result of the actions described in this EIS. Even though DOE does not anticipate adverse health impacts from the options, it analyzed for the possibility of "disproportionately high and adverse human health or environmental effects on minority populations or low-income populations" (Executive Order 12898). Figures 3.5-1 and 3.5-2 show minority and low-income communities by census tract. This section discusses average radiation doses that individuals in those communities could receive and compares them to predicted doses that individuals in the other communities within the 80-kilometer- (50-mile) radius region could receive.

Figure 4.1-8 has SRS as the center of a circle with 22.5-degree sectors and concentric rings from 10 to 50 miles (16 to 80 kilometers) out from the center at 10-mile (16-kilometer) intervals. For this analysis, DOE calculated a fraction of the total population dose for each sector, laid the sector circle over the census tract map, and assigned each tract to a sector. If a tract fell in more than one sector, DOE assigned it to the sector with the largest dose value.

DOE analyzed impacts by comparing the per capita dose that each type of community would receive to doses other types of communities in the same ring would receive. To eliminate the possibility of diluting and masking impacts to a low-population community close to SRS with a high dose per person by including them with impacts to a high-population community farther from the Site, the analysis made comparisons in a series of concentric circles, the radii of which increase in 10-mile (16-kilometer) increments.

To determine the radiation dose received per person in each type of community, the analysis multiplied the number of people in each tract by that tract's dose value to obtain a total community population dose for each tract, summed these population doses in each concentric circle, and divided by the total community population in the circle to get a community per capita dose for each area of the circle. Because the per capita dose for communities (Table 4.1-19) would be constant for every alternative, the relative differences in impacts between communities would also be constant. Thus, Figure 4.1-9 and Table 4.1-19 indicate the distribution of per capita doses to types of communities in the 50-mile (80-kilometer) region. As shown in Figure 4.1-9, atmospheric releases would not disproportionately affect minority communities (population equal to or greater than 35 percent of the total population) or low income (equal to or greater than 25 percent of the total population) in the 50-mile region; that is, a comparison

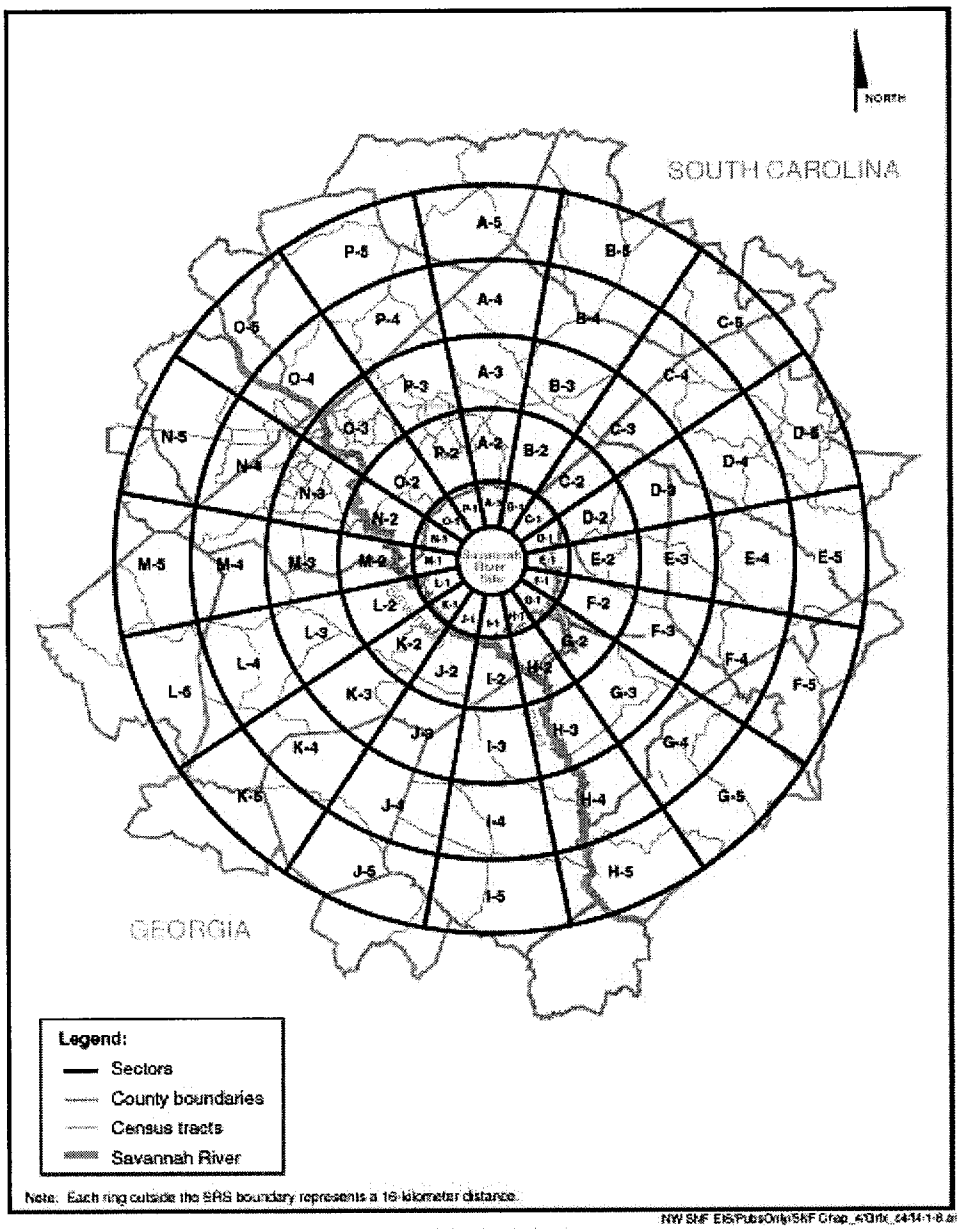

Figure 4.1-8. Annular sectors around the Savannah River Site.

Table 4.1-19. Estimated per capita annual dose (rem) for identified communities in 80-kilometer (50-mile) region.[a]

	Low income		Minorities			
Distance	Less than 25 percent of population (rem)	Equal to or more than 25 percent of population (rem)	Less than 35 percent of population (rem)	35 percent to 50 percent of population (rem)	Equal to or more than 50 percent of population (rem)	All communities (rem)
0-10 miles (0-16 km[b])	1.1×10^{-5}	1.0×10^{-5}	1.0×10^{-5}	1.2×10^{-5}	1.0×10^{-5}	1.1×10^{-5}
0-20 miles (0-32 km)	5.0×10^{-6}	5.0×10^{-6}	5.0×10^{-6}	7.0×10^{-6}	4.0×10^{-6}	5.0×10^{-6}
0-30 miles (0-48 km)	3.0×10^{-6}	3.0×10^{-6}	3.0×10^{-6}	3.0×10^{-6}	2.0×10^{-6}	3.0×10^{-6}
0-40 miles (0-64 km)	2.0×10^{-6}	2.0×10^{-6}	2.0×10^{-6}	3.0×10^{-6}	2.0×10^{-6}	2.0×10^{-6}
0-50 miles (0-80 km)	2.0×10^{-6}	2.0×10^{-6}	2.0×10^{-6}	2.0×10^{-6}	2.0×10^{-6}	2.0×10^{-6}

a. Per capita dose based on a population dose of 1 person-rem. Per capita doses for other population doses can be obtained by multiplying the values in this table by the population dose.
b. km = kilometers.

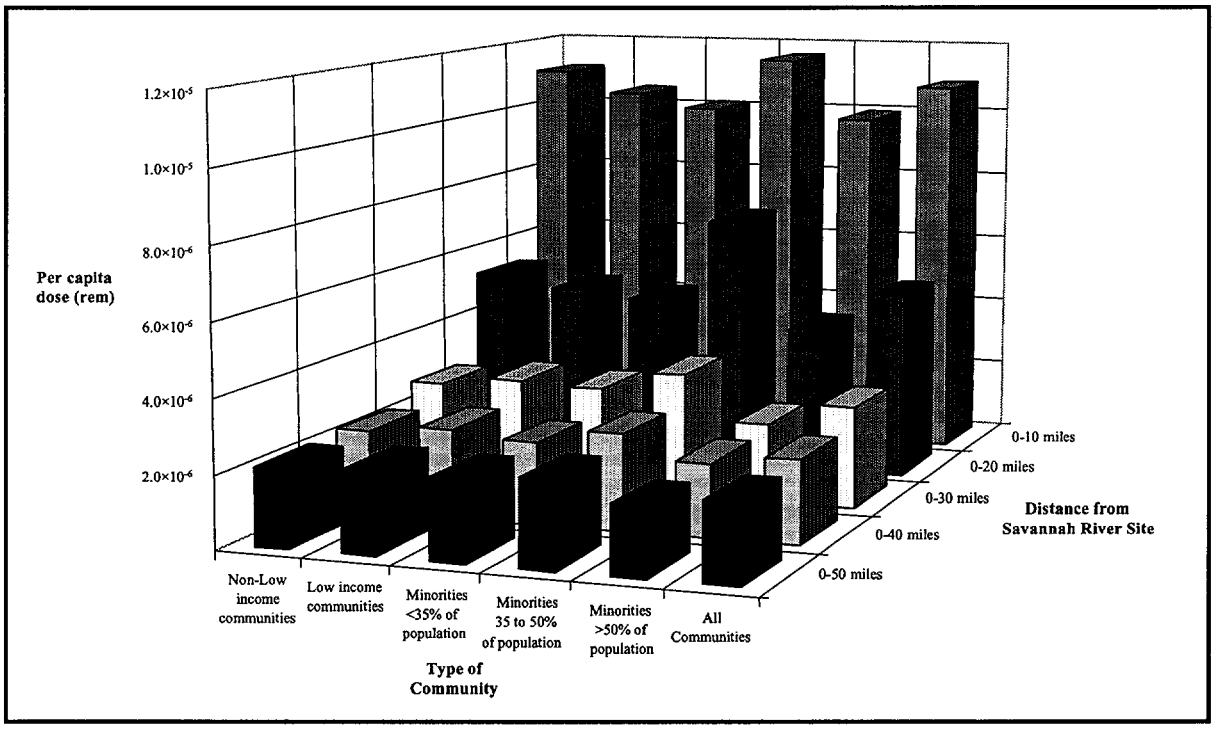

Figure 4.1-9. Distribution of a hypothetical unit population dose among SRS communities.

of per capita doses indicates that they do not vary greatly.

For example, DOE used an annual total population dose of 1 person-rem to prepare Figure 4.1-9 and its supporting data in Table 4.1-19. In comparison, the maximum annual total population dose of 0.56 person-rem for the maximum impact alternative (see Section 4.1.2) would result in 56 percent of the impact shown in Figure 4.1-9 and Table 4.1-19. For any other population dose, the per capita dose for communities can be determined by multiplying that population dose by the values listed in Table 4.1-19.

The distribution of carcinogenic and criteria pollutant emissions from routine operations and of criteria pollutants from construction activities would be essentially identical to those described for airborne radiological emissions because the distribution pathways would be the same. As a result, nonradiological emissions from any option would not cause disproportionate impacts on minority or low-income communities. Because nonradiological pollutant emissions would cause minimal impacts for any option, and because there would not be disproportionate distribution of these impacts among types of communities, environmental justice concerns would not be associated with the alternatives.

4.1.1.7 Transportation

This section discusses the potential radiological consequences of the onsite transportation of SNF and the potential consequences of transportation to a geologic repository. All onsite shipments (those that originate and terminate on SRS) would be by rail. Movements of SNF within an SRS area (e.g., H Area or F Area) are operational transfers, not onsite shipments. The potential consequences of shipping SNF from the SRS to a geologic repository are a conservative (based on worst-case number of shipments and mode of transportation) representation of impacts based on preliminary information. The full analysis of transportation impacts will be included in the EIS for a Geological Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (currently in preparation).

4.1.1.7.1 Onsite Incident-Free Transportation Analysis [SRS]

The analysis assumed a crew of four engineers for each shipment and that the external dose rate 6.6 feet (2 meters) from the shipping cask was 100 millirem per hour (HNUS 1994a), which is the SRS procedurally-allowed maximum dose rate during onsite fuel shipments. Actual receptor dose rates would depend on receptor distance from the shipping cask (39.4 feet [12 meters]). The duration of exposure would depend on the transport vehicle speed. In addition, vehicle crew time would depend on the distance of each shipment.

Table 4.1-20 summarizes the collective doses (person-rem) and health effects (latent cancer fatalities) associated with a single incident-free onsite shipment of SNF at SRS.

To determine the incident-free transportation dose for management of all SRS spent nuclear fuel, it is necessary to calculate the total dose over all shipments. DOE has estimated that it would take approximately 150 rail shipments to de-inventory the Receiving Basin for Offsite Fuels to the L-Area Disassembly Basin. This action would occur under all alternatives, including the No-Action Alternative. The radiation dose to the crew from these shipments is estimated to be approximately 0.57 person-rem, which could result in 2.3×10^{-4} latent cancer fatalities.

DOE has estimated that it would take approximately 300 rail shipments to transport the contents of the L-Area Disassembly Basin (including the fuel that was previously in the Receiving Basin for Offsite Fuels) to the Transfer and Storage Facility; the Transfer, Storage, and Treatment Facility; or the F- and H-Area Canyons. This action would occur under all alternatives, except the No-Action Alternative. Assuming the bounding location for the

Table 4.1-20. Collective doses and health effects for onsite incident-free SNF shipments.[a]

Shipment origin/destination	Crew dose per shipment (person-rem)	Number of LCFs[b] per shipment
		Crew
L Area/H Area	3.80×10^{-3}	1.52×10^{-6}
L Area/F Area	4.10×10^{-3}	1.64×10^{-6}
F Area/H Area	1.40×10^{-3}	5.60×10^{-7}
P Area/H Area	4.90×10^{-3}	1.96×10^{-6}
P Area/F Area	3.88×10^{-3}	1.55×10^{-6}
C Area/H Area	3.33×10^{-3}	1.33×10^{-6}
C Area/F Area	4.20×10^{-3}	1.68×10^{-6}

a. Derived from HNUS (1994a).
b. LCF = latent cancer fatality.

Transfer and Storage Facility or the Transfer, Storage, and Treatment Facility, the radiation dose to the crew from these shipments is estimated to be approximately 1.23 person-rem which could result in $4.9\text{x}10^{-4}$ latent cancer fatalities. Therefore, for the No-Action Alternative, the total radiation dose to the shipping crew would be approximately 0.57 person-rem, which could result in $2.3\text{x}10^{-4}$ latent cancer fatalities. For all other alternatives, the total radiation dose to the crew would be approximately 1.8 person-rem, which could result in $7.2\text{x}10^{-4}$ latent cancer fatalities.

4.1.1.7.2 Incident-Free Transportation Analysis [Geologic Repository]

DOE estimated the impacts of shipping SNF from SRS to a theoretical geologic repository in the Western United States (approximately 4,000 kilometers [2,500 miles] from SRS) by truck. TC This analysis assumes all shipments from SRS, approximately 1,400 (worst case among the alternatives), would be by truck because the impacts would bound the impacts of rail shipments. Because the transport of SRS spent fuel would use existing highways, it would represent a very small fraction of national highway traffic. Consequently, there would be negligible impacts on land use; air quality; hydrology; biological resources and cultural resources; socioeconomics; noise; aesthetics; utilities, energy, and materials; or waste management. The analysis of the potential impacts of transporting SRS spent nuclear fuel to the repository focuses on the potential radiological impacts to workers and the public.

DOE recognizes that it cannot predict with any certainty the specific routes that would be used to ship SNF to a repository. Nonetheless, the analysis uses current regulations governing highway shipments to select actual highway routes to estimate the potential environmental impacts of national transportation. TC Assumed distances within the various rural, suburban, and urban population zones can be found on Table 4.1-21.

Loading Operations

Prior to shipping the fuel, DOE would load it into NRC certified Type B shipping casks. The potential dose to involved workers from the loading operation would be less than that expected at a commercial nuclear facility because the radionuclide inventory of commercial fuel is higher than that of the DOE SNF. The dose would be further limited by worker rotation and other administrative controls. DOE expects any dose to uninvolved workers would be negligible because they would not have tasks that could result in radiation exposure. Likewise, DOE expects radiation exposure to the public would not occur because of the distance of the loading operations from the areas of public access.

Table 4.1-21. Incident-free radiological impacts of 1,400 offsite truck shipments of spent nuclear fuel to the proposed Yucca Mountain Geologic Repository.

Exposure group	Unit risk factors (person-rem kilometer)[a]			Kilometers traveled		
	Rural	Suburban	Urban	Rural	Suburban	Urban
Occupational	4.6×10^{-5}	1.0×10^{-4}	1.7×10^{-4}	3,292.6	570.2	65.9
Off-link[b]	1.2×10^{-7}	1.6×10^{-5}	1.1×10^{-4}	3,292.6	570.2	65.9
On-link[c]	5.0×10^{-6}	1.5×10^{-5}	1.5×10^{-4}	3,292.6	570.2	65.9
Stops	1.2×10^{-4}	1.2×10^{-4}	1.2×10^{-4}	3,292.6	570.2	65.9

	Collective dose (person-rem)			Total collective dose	LCF[d]
	Rural	Suburban	Urban		
Occupational	212	80	16	308	0.123
General population					
Off-link[b]	1	13	10	24	0.012
On-link[c]	23	12	14	49	0.024
Stops	553	96	11	660	0.330
General population total					0.366

a. The methodology, equations, and data used to develop the unit risk factors are discussed in Madsen et al. (1986) and Neuhauser and Kanipe (1992). Cashwell et al. (1986) contains a detailed explanation of the use of unit risk factors.
b. Off-link general population are persons within 800 meters (2,625 feet) of the highway.
c. On-link general population are persons sharing the highway.
d. LCF = latent cancer fatality.

Transportation to a Geologic Repository

To estimate the potential impacts of incident-free transportation of SNF to a repository, the analysis considered both the public and workers. Unit risk factors commonly used in a number of other DOE EISs were used to determine the potential person-rem exposure per kilometer for both workers and public. In the case of the general population, both off-link and on-link doses were calculated. The off-link dose could affect persons within 800 meters (2,625 feet) of the highway; the on-link dose could affect persons sharing the highway. Table 4.1-21 presents the potential incident-free radiological impacts from 1,400 shipments of SNF from the SRS to a theoretical geologic repository. As can be seen from the table, potential latent cancer fatalities could result in less than 1 additional death from radiation over the life of the shipments.

4.1.1.7.3 Onsite Transportation Accident Analysis [SRS]

DOE analyzed radiological impacts from potential accidents to the onsite maximally exposed individual from onsite rail shipments. The analysis calculated doses using the RADTRAN computer code (Neuhauser and Kanipe 1992) with site-specific meteorology, and calculated risk using site-specific rail accident rates and accident probabilities (HNUS 1994b).

The analysis assumed a release of the maximum reasonably foreseeable amount of radioactive material for the type of SNF shipped on SRS (HNUS 1994b). Radiological doses were modeled for three human receptor groups: the onsite worker population, members of the public residing near SRS, and the maximally exposed offsite individual. The consequences are expressed as excess latent cancer fatalities in each receptor group.

Table 4.1-22 summarizes the radiation doses resulting from the most severe reasonably foreseeable onsite transportation accident and associated latent cancer fatalities.

4.1.1.7.4 Transportation Accident Analysis [Geologic Repository]

EC | Potential impacts from accidents resulting from transporting SNF to a geologic repository are not quantified in this document but have been analyzed in the EIS for a Geologic Repository for Disposal of Spent Nuclear Fuel and High-Level EC | Radioactive Waste at Yucca Mountain, Nye County, Nevada. Previous EISs, including the Foreign Research Reactor Spent Fuel EIS (DOE 1996) and the Programmatic Spent Fuel EIS (DOE 1995b) analyzed the potential accident impacts of transporting SNF. The following discussions summarize the types of accidents that could be expected. Impacts are presented in Table 4.1-23.

Loading Operation

In general, accidents from loading operations could be caused by unplanned contact (bumping) during lifting or handling of casks, canisters, or fuel assemblies. Initiating events could include fires, explosions, earthquakes, cask tor nadoes, canister or basket drops, and loaded shipping drops. The Interim Management of Nuclear Materials at SRS EIS (DOE 1995a) assessed the radiological impacts from potential accidents associated with preparing, storing, and onsite shipment of some spent nuclear fuel.

Transportation to a Geologic Repository

Several types of accidents potentially could occur while transporting SNF. The first type of accident, resulting in the most radiological exposure to the public, assumes the breach of a shipping cask during an accident resulting in the release of a fraction of its contents to the air. This accident would be very unlikely. The second type of accident would involve truck wrecks that could result in non-radiological fatalities to workers or members of the public. The probability of an accident is dependent upon the number of shipments made and total miles traveled. | EC

4.1.2 IMPACTS OF THE ALTERNATIVES

As discussed in Chapter 2, none of the options for the management of SNF, except Continued Wet Storage, would address the requirements of all six fuel types. Therefore, DOE must consider combinations of technologies to satisfy the purpose and need identified in Chapter 1. This

Table 4.1-22. Impacts on SRS workers, maximally exposed offsite individuals, and offsite population from SNF transportation accidents on Savannah River Site.

Accident frequency	Worker dose (rem)	Probability of a worker LCF[b]	MEI[c] dose (rem)	Probability of a LCF to the MEI	Population dose (person-rem)	Population LCFs
1.28×10^{-4}	2.78	1.11×10^{-3}	2.2×10^{-5}	1.08×10^{-8}	0.16	8.21×10^{-5}

a. Source: DOE (1995a).
b. LCF = latent cancer fatality.
TC | c. MEI = maximally exposed individual.

Table 4.1-23. Truck transportation accident analysis impacts.

Radiological impacts				Traffic impacts		
Risk factor (person-rem/ shipment)[a]	Maximum number shipments	Total (person-rem)	Total LCFs	Risk factor (fatality/ shipment)[b]	Maximum number shipments	Total fatality
TC | 1.79×10^{-5}	1,400	0.025	1.25×10^{-5}	1.12×10^{-4}	1,400	0.16

LCF = latent cancer fatalities.
a. DOE (1996).
TC | b. Adapted from DOE (1999).

section provides the results of analyzing combinations of the technology options applicable to the fuel groups. Excluding continued wet storage, there are more than 700 combinations of technology options and fuel groups that could be analyzed. However, it would be impractical and unreasonable to do so. DOE has identified four sets of combinations for analysis as alternatives in this EIS (in addition to No Action) which it believes are representative. These four alternatives are the Minimum Impact Alternative, Direct Disposal Alternative, Preferred Alternative, and Maximum Impact Alternative. The data in Section 4.1.1 can be used to compile the impacts of other configurations of viable cases.

Continued wet storage for all fuel types is the No-Action Alternative. National Environmental Policy Act (NEPA) regulations require the evaluation of No Action, (which would not meet the purpose and need described in Chapter 1); however, it provides a baseline against which DOE can compare the action alternative combinations.

The second alternative, Minimum Impact, would result in the smallest environmental impacts to human health. It is also the environmentally-preferred alternative.

The third alternative is Direct Disposal. All fuel types that could be dry stored would be. Higher Actinide Targets and Non-Aluminum-Clad Fuels would be Repackaged and Prepared to Ship Offsite. Uranium and Thorium Metal Fuels and Loose Uranium Oxide in Cans would undergo conventional processing.

The fourth alternative is the Preferred Alternative. Melt and Dilute would be used to treat the Materials Test Reactor-like fuels, most of the HEU/LEU Oxides and Silicides Requiring Resizing or Special Packaging (Group C), and most of the Loose Uranium Oxide in Cans (Group D). Group A and the remaining Group C and Group D fuels (<10 percent of the material in these fuel groups) would be treated with conventional processing. Finally, the Higher Actinide Targets and the Non-Aluminum-Clad fuels would be Repackaged and Prepared to Ship offsite.

EC

The final alternative would apply the chemical processing option to all the fuel except the higher actinide targets and non-aluminum-clad SNF and probably would produce the greatest environmental impacts, and therefore, provides an upper bound. It is termed the Maximum Impact Alternative. Section 2.4 provides a complete description of the SNF management alternatives.

Tables 4.1-24 through 4.1-26 list the impacts of the five alternatives summed from the operational impacts of each appropriate technology presented in Section 4.1.1. The following sections describe the alternatives and the bases for their selection. The conclusions from Section 4.1.1.5 on environmental justice would apply to all the alternatives.

DOE based the values listed for annual radiation dose to the noninvolved worker, the offsite maximally exposed individual, and the 620,000-person population surrounding SRS on the sum of the annual doses for each technology-fuel group included in the alternative. Since the time intervals over which these annual doses would occur might not coincide, this method could overestimate the annual doses that actually would occur.

The values in Table 4.1-26 for health effects to the noninvolved worker, maximally exposed individual, and the offsite population for the No-Action Alternative represent current reactor area emissions (including two SNF wet basins) for the entire period of analysis. The values for the other alternatives would be incremental above these baseline values. Summing these baseline and incremental values would be conservative, however, because there would not be two SNF wet basins operating over the entire 38-year period of analysis.

Table 4.1-24. Estimated maximum incremental concentrations of nonradiological air pollutants for the noninvolved worker.

Pollutant	Averaging Time	Regulatory Standard[a]	No Action Alternative	Minimum Impact Alternative	Direct Disposal Alternative	Preferred Alternative	Maximum Impact Alternative
Toxic Pollutants (mg/m^3)							
Nitric acid	24-hour	5	0.03	0.02	2.75	2.62	7.95
1,1,1-Trichloroethane	24-hour	1,900	–	–	0.02	0.02	0.05
Benzene	24-hour	3.19	–	–	0.02	0.02	0.05
Ethanolamine	24-hour	6	0.03	0.02	0.02	0.02	0.03
Ethyl benzene	24-hour	435	–	–	0.01	0.01	0.02
Ethylene glycol	24-hour	None	0.03	0.02	0.02	0.02	0.03
Formaldehyde	24-hour	0.75	0.03	0.02	0.02	0.02	0.03
Glycol ethers	24-hour	80	0.03	0.02	0.02	0.02	0.03
Hexachloronaphthalene	24-hour	0.2	0.03	0.02	0.02	0.02	0.03
Hexane	24-hour	1,800	0.03	0.02	0.03	0.03	0.06
Manganese	24-hour	5	–	–	0.01	0.01	0.02
Mercury	24-hour	0.1	–	–	0.01	0.01	0.02
Methyl alcohol	24-hour	260	0.03	0.02	0.02	0.02	0.03
Methyl ethyl ketone	24-hour	590	0.03	0.02	0.02	0.02	0.03
Methyl isobutyl ketone	24-hour	410	–	–	0.01	0.01	0.02
Methylene chloride	24-hour	86.7	–	–	0.02	0.02	0.05
Napthalene	24-hour	50	0.03	0.02	0.02	0.02	0.03
Phenol	24-hour	19	–	–	0.01	0.01	0.02
Phosphorus	24-hour	0.1	–	–	0.01	0.01	0.02
Sodium hydroxide	24-hour	2.0	–	–	0.01	0.01	0.02
Toluene	24-hour	754	0.03	0.02	0.03	0.03	0.06
Trichloroethene	24-hour	537	–	–	0.01	0.01	0.02
Vinyl acetate	24-hour	None	–	–	0.01	0.01	0.02
Xylene	24-hour	435	0.03	0.02	0.05	0.05	0.10
Criteria Pollutants ($\mu g/m^3$)							
Nitrogen oxides	Annual	NA	–	0.05	38.2	36.4	111
Total Suspended Particulates (total dust)	8-hour	15	–	0.02	0.35	0.34	0.99
Particulate Matter (<10 μm)	8-hour	5	–	0.09	0.08	0.08	0.05
	24-hour	NA	–	0.99	0.86	0.87	0.62
Carbon monoxide	8-hour	55	0.03	0.25	1.81	1.82	4.78
	1-hour	NA	0.03	0.79	5.65	5.68	14.93
Sulfur dioxide	Annual	NA	–	0.02	0.04	0.04	0.08
	8-hour	13	–	0.02	0.31	0.30	0.86
	3-hour	NA	–	0.02	0.72	0.70	2.07
Gaseous fluorides	1-month	None	–	-	0.10	0.10	0.29
	1-week	NA	–	-	0.18	0.17	0.52
	24-hour	NA	–	-	0.55	0.52	1.59
	12-hour	NA	–	-	0.80	0.76	2.32
Ozone (as VOC)	1-hour	0.2	–	nc	nc	nc	nc

– = no air emission associated with this combination.
NA = not applicable.
nc = not calculated.
VOC = volatile organic compound.
a. 29 CFR 1910.1000, Subpart Z and OSHA 8-hour time-weighted averages.

Table 4.1-25. Estimated maximum incremental concentrations of nonradiological air pollutants at the Site boundary.

Pollutant	Averaging Time	Regulatory Standard[a]	No Action Alternative	Minimum Impact Alternative	Direct Disposal Alternative	Preferred Alternative	Maximum Impact Alternative	
Toxic Pollutants (mg/m^3)								
Nitric acid	24-hour	125	–	–	0.11	0.10	0.31	
1,1,1-Trichloroethane	24-hour	9,550	0.03	0.03	0.03	0.03	0.03	
Benzene	24-hour	150	–	–	0.01	0.01	0.02	
Ethanolamine	24-hour	200	0.03	0.03	0.03	0.03	0.03	
Ethyl benzene	24-hour	4,350	–	–	0.01	0.01	0.02	
Ethylene glycol	24-hour	650	0.03	0.03	0.03	0.03	0.03	
Formaldehyde	24-hour	15	0.03	0.03	0.03	0.03	0.03	
Glycol ethers	24-hour	+	0.03	0.03	0.03	0.03	0.03	
Hexachloronaphthalene	24-hour	1	0.03	0.03	0.03	0.03	0.03	
Hexane	24-hour	200	0.03	0.03	0.03	0.03	0.03	TC
Manganese	24-hour	25	–	–	0.01	0.01	0.02	
Mercury	24-hour	0.25	–	–	0.01	0.01	0.02	
Methyl alcohol	24-hour	1,310	0.03	0.03	0.03	0.03	0.03	
Methyl ethyl ketone	24-hour	14,750	0.03	0.03	0.03	0.03	0.03	
Methyl isobutyl ketone	24-hour	2,050	–	–	0.01	0.01	0.02	
Methylene chloride	24-hour	8,750	–	–	0.01	0.01	0.02	
Napthalene	24-hour	1,250	0.03	0.03	0.03	0.03	0.03	
Phenol	24-hour	190	–	–	0.01	0.01	0.02	
Phosphorus	24-hour	0.5	–	–	0.01	0.01	0.02	
Sodium hydroxide	24-hour	20	–	–	0.01	0.01	0.02	TC
Toluene	24-hour	2,000	0.03	0.03	0.03	0.03	0.03	
Trichloroethene	24-hour	6,750	–	–	0.01	0.01	0.02	
Vinyl acetate	24-hour	176	–	–	0.01	0.01	0.02	
Xylene	24-hour	4,350	0.03	0.03	0.03	0.03	0.03	
Criteria Pollutants ($\mu g/m^3$)								
Nitrogen oxide	Annual	100	0.03	0.02	1.17	1.12	3.36	
Total Suspended Particulates	Annual	75	0.03	0.02	0.02	0.02	0.02	
Particulate Matter (<10 μm)	Annual	50	–	–	0.01	0.01	0.02	
	24-hour	150	–	–	0.05	0.04	0.13	
Carbon monoxide	8-hours	10,000	0.03	0.07	0.49	0.50	1.31	
	1-hour	40,000	0.03	0.37	3.60	3.57	9.76	
Sulfur dioxide	Annual	80	–	0.02	0.02	0.02	0.02	
	24-hour	365	–	0.03	0.07	0.07	0.13	
	3-hour	1300	–	–	0.34	0.32	0.98	
Gaseous fluoride	1-month	0.8	–	–	0.01	0.01	0.02	
	1-week	1.6	–	–	0.02	0.01	0.04	
	24-hour	2.9	–	–	0.03	0.02	0.07	
	12-hour	3.7	–	–	0.05	0.04	0.13	
Ozone (as VOC)	1-hour	235	–	0.16	0.38	0.41	0.80	

– = no air emission associated with this option.
+ = no state standard.
VOC = volatile organic compound.
a. SCDHEC standard No. 2 (criteria pollutants) and No. 8 (toxic pollutants). TC

Table 4.1-26. Impacts from alternatives.[a]

Impact	No Action Alternative	Minimum Impact Alternative	Direct Disposal Alternative	Preferred Alternative[b]	Maximum Impact Alternative
Health Effects for the Entire Period of Analysis (1998-2035)[f]					
MEI[c] dose (millirem)	0.63[d]	6.1×10^{-4}	7.2×10^{-3}	0.19	0.67
MEI LCF[e] probability	3.1×10^{-7}[d]	3.0×10^{-10}	3.6×10^{-9}	9.5×10^{-8}	3.4×10^{-7}
Population dose (person-rem)	22.6[d]	0.022	0.077	6.9	8.7
Population LCFs (unitless)	0.011[d]	1.1×10^{-5}	3.8×10^{-5}	3.4×10^{-3}	4.4×10^{-3}
Collective worker dose (person-rem)	760	690	840	841	2,100
Collective worker LCFs (unitless)	0.30	0.28	0.34	0.33	0.84
Noninvolved worker dose (millirem)	4.25[d]	5.0×10^{-3}	0.02	1.53	1.53
Noninvolved worker LCF probability	1.7×10^{-6}[d]	2.0×10^{-9}	9.6×10^{-9}	6.1×10^{-7}	6.3×10^{-7}
Annual Radiological Air Emission Impacts					
Maximum annual MEI[d] dose (millirem)	0.02[d]	6.1×10^{-4}	7.4×10^{-4}	0.044	0.015
Maximum annual population dose (person-rem)	0.59[d]	0.022	0.027	1.6	0.56
Maximum annual noninvolved worker dose (millirem)	0.11[d]	5.0×10^{-3}	6.0×10^{-3}	0.36	0.12
Annual Radiological Liquid Emission Impacts					
Maximum annual MEI dose (millirem)	0	0	1.4×10^{-3}	4.2×10^{-5}	0.057
Maximum annual population dose (person-rem)	0	0	4.9×10^{-3}	2.4×10^{-4}	0.19
Waste Generation (cubic meters) for the Entire Period of Analysis (1998-2035)					
High-level waste					
Liquid	2,300	660	1,200	1,050	10,500
Equivalent DWPF canisters	38	11	20	17	160
Saltstone	6,100	1,800	3,200	2,700	27,000
Transuranic waste	0	15	360	563	3,700
Hazardous/low-level mixed waste	76	25	46	103	267
Low-level waste	57,000	20,000	31,000	35,260	140,000
Utilities and Energy Required for the Entire Period of Analysis (1998-2035)					
Water (millions of liters)	1,100	660	1,400	1186	8,000
Electricity (megawatt-hours)	46,000	27,000	81,000	116,000	600,000
Steam (millions of kilograms)	340	195	520	650	3,600
Diesel fuel (thousands of liters)	230	180	2,300	2760	22,000

a. In the event that fuel receipts are less than those reported in Chapter 1, the values in this table that report impacts over the entire period of analysis would be less. Instructions for scaling impacts are provided in the appropriate Chapter 4 tables that provide input to this table.
b. In the calculation of preferred alternative impacts, all the HEU/LEU oxides and silicides requiring resizing or special packaging have been accounted for in the melt and dilute technology even though a very small percentage would be conventionally processed. On the other hand, the loose-uranium-oxide-in-cans preferred alternative impacts do consider that 60 percent would be conventionally processed and the remaining 40 percent would be melted and diluted.
c. MEI = maximally exposed offsite individual.
d. Reflects current reactor-area emissions (including two SNF wet basins).
e. LCF = latent cancer fatality.
f. To calculate an annual impact, divide a number by 38. To calculate an impact for a given duration, multiply the annual impact by the duration in years. For example, the annual dose to the MEI from the preferred alternative would be 0.005 mrem (0.17/38). The estimated dose to the MEI until a storage facility would be operational (18 years from now) would be 0.040 mrem (0.005x8).

4.1.2.1 No-Action Alternative

Under the No-Action Alternative, SRS would continue to receive shipments of SNF from foreign research reactors, domestic research reactors, and other DOE sites. DOE would store the fuel in the L-Reactor Disassembly Basin or the Receiving Basin for Offsite Fuels, in addition to the currently stored SNF, under continued wet storage, and would ship the non-aluminum-clad fuel from these basins offsite. DOE would maintain the wet storage basins, performing upgrades as necessary to maintain proper water quality. The continued long-term underwater storage of aluminum-based SNF could lead to increased corrosion with increased environmental, health, and safety vulnerabilities. The No-Action Alternative consists of cases A8, B8, C8, D8, E8, and F8 (Table 4.1-27).

4.1.2.2 Minimum Impact Alternative

The identification of the Minimum Impact Alternative required both quantitative and quantitative analyses. The first step identified the minimum-impact technology for each fuel group for each analytical parameter (e.g., volume of high-level waste, air concentrations). However, the selection process often resulted in a combination of high and low impacts among parameters for a specific fuel group-technology combination cases; in other words, no clearly identified "best" or "worst" configuration was identified. Therefore, the second step was a qualitative examination of trends in configurations of cases that identified overall minimum impacts. Human health effects and environmental pollution impacts received slightly greater weight than consumption of natural resources or waste disposal space. In addition, impacts to the general public received slightly greater weight than those to SRS workers. The analysis indicates that cases A1, B1, C1, D3, E2, and F2 would provide minimum impacts (Table 4.1-28). Although other analysts could select different cases, DOE believes that the range of impacts from reasonable choices of minimum-impact scenarios would be small and that the impacts of this combination would be representative of the lower bound of impacts from the proposed action.

4.1.2.3 Direct Disposal Alternative

This alternative combines the New Packaging and the Conventional Processing Technologies. Materials Test Reactor-like fuels and HEU/LEU Oxides and Silicides (except the failed and sectioned fuels) would be treated using the Direct Disposal/Direct Co-Disposal technology and placed in the Transfer and Storage Facility with a minimum of treatment (e.g., cold-vacuum drying and canning). The repackaging of the higher actinide targets and non-aluminum-clad fuels in the Transfer and Storage Facility would use the Repackage and Prepare to Ship technology. The uranium and thorium metal fuel, loose uranium oxide in cans, and failed and sectioned fuel from the HEU/LEU Oxides and Silicides fuel group would be treated using the Conventional Processing Alternative to alleviate the potential health and safety vulnerabilities discussed in Section 2.4.3.2 and because this material probably would not be suitable for placement in a geologic repository if treated with the Direct Disposal/Co-Disposal option. Therefore, the Direct Disposal alternative consists of cases A7, B1, C1, D7, E2, and F2 (Table 4.1-29). TC

4.1.2.4 Preferred Alternative

DOE proposes to implement several of the technologies identified in Section 2.2 to manage spent nuclear fuel at SRS. These technologies are Melt and Dilute, Conventional Processing, and Repackage and Prepare to Ship. Each of these technologies would treat specific groups of spent nuclear fuel, as described below. The technology and fuel group combinations form DOE's Preferred Alternative in this EIS. The configuration of this preferred alternative is identified in Table 4.1-30.

Table 4.1-27. Fuel group and technology combination that compose the No-Action Alternative.

Fuel group	1 Prepare for Direct Co-Disposal	2 Repackage and Prepare to Ship	3 Melt and Dilute	4 Mechanical Dilution	5 Vitrification Technologies	6 Electro-metallurgical Treatment	7 Conventional Processing	8 Continued Wet Storage
A. Uranium and Thorium Metal Fuels	–	–	–	–	–	–	–	Yes
B. Materials Test Reactor-like Fuels	–	–	–	–	–	–	–	Yes
C. HEU/LEU Oxides and Silicides Requiring Resizing or Special Packaging	–	–	–	–	–	–	–	Yes
D. Loose Uranium Oxide in Cans	–	–	–	–	–	–	–	Yes
E. Higher Actinide Targets	–	–	–	–	–	–	–	Yes
F. Non-Aluminum-Clad Fuels[a]	–	–	–	–	–	–	–	Yes

a. The environmental impacts of this case were analyzed in the Programmatic SNF EIS (DOE 1995b).
HEU = highly enriched uranium.
LEU = low enriched uranium.

Table 4.1-28. Fuel group and technology combination that compose the Minimum Impact Alternative.

Fuel group	1 Prepare for Direct Co-Disposal	2 Repackage and Prepare to Ship	3 Melt and Dilute	4 Mechanical Dilution	5 Vitrification Technologies	6 Electro-metallurgical Treatment	7 Conventional Processing	8 Continued Wet Storage
A. Uranium and Thorium Metal Fuels	Yes	–	–	–	–	–	–	–
B. Materials Test Reactor-like Fuels	Yes	–	–	–	–	–	–	–
C. HEU/LEU Oxides and Silicides Requiring Resizing or Special Packaging	Yes	–	–	–	–	–	–	–
D. Loose Uranium Oxide in Cans	–	–	Yes	–	–	–	–	–
E. Higher Actinide Targets	–	Yes	–	–	–	–	–	–
F. Non-Aluminum-Clad Fuels[a]	–	Yes	–	–	–	–	–	–

a. The environmental impacts of this case were analyzed in the Programmatic SNF EIS (DOE 1995b).
HEU = highly enriched uranium.
LEU = low enriched uranium.

Table 4.1-29. Fuel group and technology combination that compose the Direct Disposal Alternative.

Fuel group	1 Prepare for Direct Co-Disposal	2 Repackage and Prepare to Ship	3 Melt and Dilute	4 Mechanical Dilution	5 Vitrification Technologies	6 Electro-metallurgical Treatment	7 Conventional Processing	8 Continued Wet Storage
A. Uranium and Thorium Metal Fuels	–	–	–	–	–	–	Yes	–
B. Materials Test Reactor-like Fuels	Yes	–	–	–	–	–	–	–
C. HEU/LEU Oxides and Silicides Requiring Resizing or Special Packaging	Yes	–	–	–	–	–	Yes[a]	–
D. Loose Uranium Oxide in Cans	–	–	Yes	–	–	–	Yes[b]	–
E. Higher Actinide Targets	–	Yes	–	–	–	–	–	–
F. Non-Aluminum-Clad Fuels[a]	–	Yes	–	–	–	–	–	–

a. For failed or sectioned Oak Ridge Reactor fuel, High-Flux Isotope Reactor fuel, and Tower Shielding Reactor fuel, Heavy Water Components Reactor fuel, and Mark-42 targets.
b. For Sterling Forest Oxide fuel.
c. The environmental impacts of this case were analyzed in the Programmatic SNF EIS (DOE 1995b).
HEU = highly enriched uranium.
LEU = low enriched uranium.

Table 4.1-30. Fuel group and technology combination that compose the Preferred Alternative.

Fuel group	1 Prepare for Direct Co-Disposal	2 Repackage and Prepare to Ship	3 Melt and Dilute	4 Mechanical Dilution	5 Vitrification Technologies	6 Electro-metallurgical Treatment	7 Conventional Processing	8 Continued Wet Storage
A. Uranium and Thorium Metal Fuels	–	–	–	–	–	–	Yes	–
B. Materials Test Reactor-like Fuels	–	–	Yes	–	–	–	–	–
C. HEU/LEU Oxides and Silicides Requiring Resizing or Special Packaging	–	–	Yes	–	–	–	Yes[a]	–
D. Loose Uranium Oxide in Cans	–	–	Yes	–	–	–	Yes[b]	–
TC | E. Higher Actinide Targets	–	–	–	–	–	–	–	Yes[c]
F. Non-Aluminum-Clad Fuels[c]	–	Yes	–	–	–	–	–	–

a. For failed or sectioned Oak Ridge Reactor fuel, High-Flux Isotope Reactor fuel, and Tower Shielding Reactor fuel, Heavy Water Components Test Reactor fuel, and Mark-42 targets.
b. For Sterling Forest Oxide fuel.
TC | c. The environmental impacts of this case were analyzed in the Programmatic SNF EIS (DOE 1995b).
HEU = highly enriched uranium.
LEU = low enriched uranium.
NA = not applicable; not decided in this EIS.

Table 4.1-31. Fuel group and technology combination that compose the Maximum Impact Alternative.

Fuel group	1 Prepare for Direct Co-Disposal	2 Repackage and Prepare to Ship	3 Melt and Dilute	4 Mechanical Dilution	5 Vitrification Technologies	6 Electro-metallurgical Treatment	7 Conventional Processing	8 Continued Wet Storage
A. Uranium and Thorium Metal Fuels	–	–	–	–	–	–	Yes	–
B. Materials Test Reactor-like Fuels	–	–	–	–	–	–	Yes	–
C. HEU/LEU Oxides and Silicides Requiring Resizing or Special Packaging	–	–	–	–	–	–	Yes	–
D. Loose Uranium Oxide in Cans	–	–	–	–	–	–	Yes	–
TC E. Higher Actinide Targets	–	Yes	–	–	–	–	Yes[a]	–
F. Non-Aluminum-Clad Fuels[b]	–	Yes	–	–	–	–	–	–

TC a. The environmental impacts of processing Mark-18 targets was analyzed in the Interim Management of Nuclear Materials Final Environmental Impact Statement (DOE 1995a).

b. The environmental impacts of this case were analyzed in the Programmatic SNF EIS (DOE 1995b).

HEU = highly enriched uranium.

LEU = low enriched uranium.

4.1.2.4.1 Melt And Dilute

DOE has identified the Melt and Dilute process as the preferred method of treating most (about 97 percent by volume or about 32,000 MTRE) of the aluminum-based SNF considered in this EIS. DOE will continue to pursue a research and development program leading to a demonstration of the technology in FY 2001 using full-size irradiated research reactor spent nuclear fuel assemblies. With a successful demonstration of the technology, DOE expects to have ready a treatment facility to perform production melt and dilute operations in FY 2008. DOE will ensure the continued availability of SRS conventional processing facilities until we have successfully demonstrated implementation of the Melt and Dilute treatment technology.

The fuel proposed for the preferred Melt and Dilute technology includes the Material Test Reactor-like fuel, most of the Loose Uranium Oxide in Cans fuel, and most of the HEU/LEU Oxide and Silicide fuel. Exceptions are the uranium and thorium fuel, failed and sectioned oxide and silicide fuel, some loose uranium oxide in cans fuel, the Higher Actinide Targets, and non-aluminum-clad fuel.

If DOE identifies any health or safety concerns involving any aluminum-based SNF prior to the melt and dilute facility becoming operational, DOE could use F and H Canyons to stabilize the material of concern, if the canyons were not decommissioned.

4.1.2.4.2 Conventional Processing

DOE has identified conventional processing to manage a relatively small volume of aluminum-based SNF at the SRS (about 3 percent by volume; less than 3,000 MTRE) that presents a potential health and safety vulnerability or is in a form that may be unacceptable for placement in a geologic repository. That SNF includes the Experimental Breeder Reactor-II fuel, the Sodium Reactor Experiment fuel, the Mark-42 targets and the core filter block from the Uranium and Thorium Metal fuel group; the failed or sectioned Tower Shielding Reactor, High Flux Isotope Reactor, Oak Ridge Reactor, and Heavy Water Components Test Reactor fuels and a Mark-14 target from the HEU/LEU Oxides and Silicides fuel group; and the Sterling Forest Oxide (and any other powdered/oxide fuel that may be received at SRS while H Canyon is still in operation) from the Loose Uranium Oxide in Cans fuel group.

4.1.2.4.3 Repackaging

DOE proposes to repackage the non-aluminum-clad fuel at SRS and transfer the material to dry storage. DOE would transfer the non-aluminum-clad fuel to that facility for storage pending offsite shipment. DOE expects transfer operations would begin in time to support closing the Receiving Basin for Offsite Fuels by 2007. Depending on receipt schedules for research reactor fuels and the operating schedule for the melt and dilute facility, DOE could deinventory the Receiving Basin for Offsite Fuels and move any remain fuel to the Building 105-L wet basin prior to packaging the fuel for dry storage.

The Preferred Alternative would include cases A7, B3, C3, D3, E2, and F2 (Table 4.1-30).

4.1.2.4.4 Continued Wet Storage

DOE proposed to maintain the higher actinide target fuel group in continued wet storage pending decisions on final dispositon.

4.1.2.5 Maximum Impact Alternative

This alternative provides the upper bound on the range of impacts from potential configurations. It would provide conventional processing for all SNF except the higher actinide targets and the non-aluminum-clad fuels selected for offsite shipment and deemed inappropriate for conventional processing. The higher actinide targets would be repackaged for potential offsite shipment and dry-stored until DOE made a decision regarding their disposition. The non-aluminum-clad fuels would be packaged for shipment and dry stored until they were ready for shipment to the Idaho National Engineering and Environmental Laboratory.

Analyses of the maximum impact alternative are conservative in that they assume that the entire SNF inventory would be processed in the canyons, which would produce the greatest impacts of all the treatment options. No credit is taken for discontinuing use of the canyons and processing some of the inventory in a new treatment facility. The Conventional Processing Alternative would include cases A7, B7, C7, D7, E2, and F2 (Table 4.1-31). DOE believes that this combination would provide an upper bound on impacts.

4.2 Accident Analysis

This section summarizes risks to the public and workers from potential accidents associated with the technology options for SNF management at the SRS.

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

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

- *External initiators* are independent of facility operations and normally originate outside the facility (aircraft crashes, nearby explosions, and toxic chemical releases at nearby facilities that affect worker performance); some can affect the ability of the facility to maintain confinement of hazardous materials because of structural damage.

- *Natural* phenomena initiators are natural occurrences that are independent of facility operations and of *events* at nearby facilities or operations (earthquakes, high winds, floods, lightning, snow). Natural phenomena initiators could affect external facilities, which could in turn affect other facilities and compound the progression of the accident.

Table 4.2-1 summarizes the estimated impacts to workers and the public from potential accidents for each SNF technology option. All the options would require the use of the Receiving Basin for Offsite Fuels and the L-Reactor Disassembly Basin. All except Continued Wet Storage would require the construction and operation of a Transfer and Storage Facility or a Transfer, Storage, and Treatment Facility.

The table lists the impacts of potential accidents in relation to the phases required to implement each option. They list only the accident with the worst impacts based on the maximally exposed offsite individual. Appendix D contains details of the impacts of other postulated accidents. Table 4.2-1 lists potential accident consequences as latent cancer fatalities, without consideration of the accident's probability. The calculation of latent cancer fatalities from population dose is performed in the same manner as for non-accident radiological health effects presented in section 4.1.1.3.1. TC

DOE estimated impacts to three receptors: (1) an uninvolved worker 2,100 feet (640 meters) from the accident location as discussed in DOE (1994), (2) the maximally exposed individual at the SRS boundary, and (3) the offsite population in an area within 50 miles (80 kilometers).

Many of the analysis results presented in Table 4.2-1 are substantially different from those given in the draft EIS. DOE has continued to conduct research and development, including accident analyses, to determine the feasibility of implementing technologies and the potential health and safety consequences of doing so. In some cases design changes have been TC

Table 4.2-1. Estimated maximum consequence accident for each technology.

Option	Accident Frequency	Consequences: Noninvolved Worker (rem)	Consequences: MEI (rem)	Consequences: Offsite Population (person-rem)	Consequences: Latent Cancer Fatalities
Continued Wet Storage (No Action)[a]					
RBOF (high wind-induced criticality)	Once in 26,000 years	13	0.22	12,000	6.2
L-Reactor basin (basin-water draindown)	Once in 500 years	0.014	0.016	(b)	(b)
Direct Co-Disposal					
Dry Storage phase (earthquake-induced criticality)	Once in 2,000 years	13	0.22	12,000	6.2
Repackage and Prepare to Ship					
Dry Storage phase (earthquake-induced criticality)	Once in 2,000 years	13	0.22	12,000	6.2
Conventional Processing					
Processing phase in F/H Canyons (coil and tube failure)	Once in 14,000 years	13	1.3	78,000	39
Melt and Dilute					
Dry Storage phase (earthquake-induced criticality)	Once in 2,000 years	13	0.22	12,000	6.2
Melt and dilute phase (earthquake induced spill with loss of ventilation)	Once in 200,000 years	30	0.5	21,000	10
Mechanical Dilution					
Dry Storage phase (earthquake-induced criticality)	Once in 2,000 years	13	0.22	12,000	6.2
Mechanical dilution phase (criticality with loss of ventilation)	Once in 33,000 years	0.71	0.074	3,000	1.5
Vitrification Technologies					
Dry Storage phase (earthquake-induced criticality)	Once in 2,000 years	13	0.22	12,000	6.2
Vitrification phase (earthquake-induced release with loss of ventilation)	Once in 200,000 years	0.10	0.0017	71	0.035
Electrometallurgical Treatment					
Dry Storage phase (earthquake-induced criticality)	Once in 2,000 years	13	0.22	12,000	6.2
Electrometallurgical phase (metal melter earthquake induced spill with loss of ventilation)	Once in 200,000 years	30	0.5	21,000	10

MEI = Maximally Exposed Individual.
RBOF = Receiving Basin for Offsite Fuels.

a. All alternatives would use RBOF and the L-Reactor Disassembly Basin; therefore, accidents in these facilities are possible for each technology.
b. Not available.

considered specifically to reduce the potential for accidents with adverse consequences. During that process, assumptions about the design and operation of the proposed technologies have changed. Changes in the assumptions have resulted in changes in the outcome of the accident analyses. Details concerning the analyses are found in Appendix D of this EIS.

TC

For all of the accidents, there is a potential for injury or death to involved workers in the vicinity of the accident. In some cases, the impacts to the involved worker would be greater than to the noninvolved worker. However, prediction of latent potential health effects becomes increasingly difficult to quantify as the distance between the accident location and the receptor decreases because the individual worker exposure cannot be precisely defined with respect to the presence of shielding and other protective features. The worker also may be acutely.injured or killed by physical effects of the accident itself. DOE identified potential accidents through a detailed hazard assessment and estimated impacts using the AXAIRQ computer model (Simpkins 1995a,b), as discussed in Appendix D.

Results of accident calculations listed in Table 4.2-1 have been updated since the Draft EIS to incorporate evolution of the technology alternatives and to incorporate information that was not available at the time the Draft EIS was prepared.

TC

4.3 Construction Impacts

This section describes environmental impacts that could result from construction activities associated with SNF management at SRS. These activities would include the construction of a Transfer and Storage Facility under theNew Packaging Technology or the construction of a Transfer, Storage, and Treatment Facility under the New Processing Technology or Conventional Processing. DOE does not expect such construction activities to have appreciable impacts on geologic resources, groundwater, traffic, transportation, or cultural resources, as explained below

4.3.1 GEOLOGY AND GROUNDWATER

DOE would confine the construction of new facilities to previously disturbed and developed areas and, therefore, expects little or no environmental impacts to the geologic resources of the area. Neither the construction nor the operation of the proposed Transfer and Storage Facility or Transfer, Storage, and Treatment Facility would affect groundwater in the area. The proposed DOE action to remove stored fuels from existing basins would eliminate a potential source of environmental releases (leaks from wet basins). The Transfer and Storage Facility or Transfer, Storage, and Treatment Facility could include the capability to perform wet receipt and unloading of SNF.

4.3.2 TRAFFIC AND TRANSPORTATION

DOE would transport construction materials, wastes, and excavated materials associated with building the proposed facilities both on and off SRS. These activities would result in increases in the operation of personal vehicles by construction workers, commercial truck traffic, and traffic associated with the daily operations of SRS. However, increases in worker and materials traffic would be small in comparison to existing traffic loads. Increased traffic congestion would be minimal.

4.3.3 CULTURAL RESOURCES

As discussed in Section 3.6, activities associated with the proposed action and alternatives for SNF management at SRS that could affect cultural resources would be the use of the three candidate sites for the Transfer and Storage Facility or Transfer, Storage, and Treatment Facility. These sites are in reactor areas (L, C, and P) within 100 to 400 yards (91 to 366 meters) of the reactor buildings. The Savannah River Archaeological Research Program has not examined these sites. The Site Use Program, which requires a permit for clearing land on the SRS, usually initiates archaeological investigations. DOE would direct an investigation of the selected site before starting facility design and construc-

tion. Although there were homesites at or near the proposed facility sites in C and L Areas, the likelihood of historic resources surviving the construction of the reactors in the early 1950s, before the enactment of regulations to protect such resources would be small (Sassaman 1997).

The potential for the presence of prehistoric sites in the candidate locations also is limited. The L-Area site is in archaeological site density Zone 3, which has the least potential for prehistoric sites of significance. The C-Area site is in Zones 2 and 3 and has more potential. Zone 2 includes areas of moderate archaeological site density. The P-Area site is in Zone 2. However, as with any historic sites, reactor construction activities probably destroyed or severely damaged prehistoric deposits. DOE would direct an examination of the selected location for prehistoric resources before starting the design and construction of the Transfer and Storage Facility or Transfer, Storage, and Treatment Facility (Sassaman 1997).

4.3.4 SURFACE WATER RESOURCES

Construction at SRS must comply with the requirements of South Carolina stormwater management and sediment reduction regulations, which became effective in 1992 as part of the Clean Water Act. These regulations and their associated permits require DOE to prepare erosion and sediment control plans for all projects, regardless of the land area. Runoff from the construction site would be part of a stormwater management and sedimentation control plan to minimize potential discharges of silts, solids, and other contaminants to surface-water streams. Effective January 2, 1997, the South Carolina Department of Health and Environmental Control (SCDHEC) approved General Permit coverage for stormwater management and sediment reduction at the SRS (SCDHEC 1996). Although the General Permit does not exempt any land-disturbing and construction activities from the requirements of State stormwater management and sediment control regulations, it does preclude the necessity of SCDHEC plan review and approval for land disturbing and construction activities at the SRS.

Before beginning construction, DOE would develop erosion and sediment control plans for the planned facilities. After construction and depending on the location of the construction site, the *SRS Stormwater Pollution Prevention Plan* (WSRC 1993), which is a requirement of the general NPDES stormwater permit covering industrial activities (Permit SCR000000), would include applicable erosion and sediment control measures; inclusion in the plan would not be necessary if the facility to be constructed was in the drainage area of a stormwater collection system permitted as part of NPDES Permit SC0000175.

4.3.5 AIR RESOURCES

The potential construction of facilities for the management of SNF would cause emissions of fugitive dust (particulate matter) from land-clearing activities and exhaust emissions from construction equipment (earth-moving vehicles, diesel generators). DOE has considered such impacts for activities at SRS that were similar in facility size and application and concluded that impacts to air quality would be minimal (DOE 1995a,b) and would have no effect on SRS compliance with state and Federal ambient air quality standards. Concentrations of pollutants emitted during construction activities would be at least an order of magnitude less than the South Carolina ambient air quality standards.

4.3.6 ECOLOGICAL RESOURCES

DOE is considering three brown field sites for the Transfer and Storage Facility or Transfer, Storage, and Treatment Facility, if they are not constructed in a renovated reactor: C Area, L Area, and P Area. As noted in Section 3.4, the sites would encompass approximately 60,700 square meters (15 acres), including the main building and land required for ancillary facilities. The Treatment Facility could also be constructed on a previously disturbed site inside the F-Area or H-Area fences.

All construction activity for the Transfer and Storage Facility or Transfer, Storage, and Treatment Facility would take place within the

boundary of one of the three reactor areas in an already-developed brownfield area. Undeveloped portions of the three proposed sites provide some low-quality wildlife habitat.

Construction of the Transfer and Storage Facility or Transfer, Storage, and Treatment Facility would involve the movement of workers and construction equipment, and would be associated with relatively loud noises from earth-moving equipment, portable generators, pile-driving equipment, pneumatic tools, drills, hammers, and the like. Although noise levels in construction areas could be as high as 110 dBA, these high local noise levels would not extend far beyond the boundaries of the project site.

Table 4.3-1 gives the attenuation of construction noise over relatively short distances. At 120 meters (400 feet) from the construction site, construction noises would range from approximately 60 to 80 dBA. Golden et al. (1980) suggest that noise levels higher than 80 to 85 dBA are sufficient to startle or frighten birds and small mammals. Thus, there would be minimal Potential for disturbing birds and small mammals outside a 120-meter radius from the construction site.

Although noise levels would be relatively low outside the immediate area of construction, the combination of construction noise and human activity probably would displace small numbers of animals (e.g., songbirds and small mammals) that could forage, feed, nest, rest, or den in the area. Construction-related disturbances are likely to create impacts to wildlife that would be small, temporary (approximately 24 months), and localized. Some animals could be driven from the area permanently, while others could become accustomed to the increased noise and activity and return to the area. Species likely to be affected (e.g., gray squirrel, opossum, white-tailed deer) are common to ubiquitous in these areas. Construction would not disturb any threatened or endangered species, would not degrade any critical or sensitive habitat, and would not affect any jurisdictional wetlands.

Table 4.3-1. Peak and attenuated noise (in dBA) levels expected from operation of construction equipment.[a]

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

a. Source: Golden et al. (1980).
b. To convert feet to meters, multiply by 0.3048.

4.3.7 IMPACTS FROM RENOVATING AN EXISTING FACILITY

4.3.7.1 Waste Generation

As discussed in Section 2.3.2.3, DOE could locate the Transfer, Storage, and Treatment Facility in a renovated reactor area, such as the 105-L facility. This would require decontamination and removal of components and systems and subsequent construction activities inside the reactor building and would result in impacts that would not occur during the construction of a virgin facility. Impacts would include generation of radioactive waste during decontamination, removal and construction. DOE has estimated that decontamination and removal and construction activities would result in the generation of approximately 476 m^3 of low-level waste over the total duration of the activities (WSRC 1998). Eventual decontamination and decommissioning (D&D) of the Transfer, Storage, and Treatment Facility (either stand-alone or in a renovated reactor facility) also would result in generation of radioactive waste.

4.3.7.2 Worker Health

DOE could locate the Transfer, Storage, and Treatment Facility in a renovated reactor area, such as the 105-L facility. This would require decontamination and removal of components and systems and subsequent construction activities inside the reactor building and would result in impacts that would not occur during the construction of a virgin facility. Impacts would include radiation exposure of workers performing these activities. The decontamination and removal and construction activities would result in a total collective worker radiation dose of 32 person-rem, based on 54 total workers and a duration of 1 year to complete all activities (Nathen 1998). The collective worker dose is estimated to result in 1.3×10^{-3} latent cancer fatalities. Eventual decontamination and decommissioning (D&D) of the Transfer, Storage, and Treatment Facility (either stand-alone or in a renovated reactor facility) also would result in radiation exposure of D&D workers.

4.3.8 SOCIOECONOMIC IMPACTS

The implementation of the alternatives discussed in this EIS could result in the construction and operation of a Transfer and Storage Facility or a Transfer, Storage and Treatment Facility, which could in turn cause incremental socioeconomic impacts in the SRS area Section 2.3.2 discusses the construction and operation of the Transfer and Storage Facility. Its construction would cost an estimated $200 million. A 2-year construction period would result in a short-term increase of fewer than 500 jobs in the region, approximately 75 percent of which would be in construction. This would be an increase in consruction jobs of approximately 2 percent (from about 16,000) and an increase of considerably less than 1 percent in total employment for the region (REMI 1995). After the 2-year period, employment would return back to its previous equilibrium. The small temporary increases in employment would not present significant impacts to the regional economy, services, or infrastructure. | TC

DOE would construct the treatment phase of the Transfer, Storage, and Treatment Facility after the Transfer and Storage phase was constructed; the construction periods would not overlap. The treatment phase would require less effort to construct and would employ fewer construction employees.

None of these construction activities would significantly increase regional employment or population, and socioeconomic impacts would be negligible.

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CHAPTER 5. CUMULATIVE IMPACTS

The Council on Environmental Quality (CEQ) regulations implementing the procedural provisions of the National Environmental Policy Act (NEPA) define cumulative impacts as the impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions (40 CFR 1508.7). The cumulative impacts analysis presented in this section is based on the incremental actions associated with the maximum impact alternative for spent nuclear fuel (SNF) management at the Savannah River Site (SRS), other actions associated with onsite activities, and offsite activities with the potential for related environmental impacts. Although it is unlikely that the maximum impact alternative would be implemented to manage SNF at SRS, it was used to estimate cumulative impacts to ensure a conservative analysis. In accordance with a handbook recently prepared by CEQ (1997), the U.S. Department of Energy (DOE) identified the resource areas in which SNF management could add to the impacts of past, present, and reasonably foreseeable actions within the project impact zones as defined by CEQ (1997).

Based on an examination of the environmental impacts of direct and indirect SNF management actions coupled with DOE and other agency actions, it was determined that cumulative impacts for the following areas need to be presented: (1) air resources; (2) water resources; (3) public and worker health; (4) waste generation; (5) utilities and energy consumption; and (6) socioeconomics. Discussion of cumulative impacts for the following resources is omitted because impacts from the proposed SNF management activities would be so small that their potential contribution to cumulative impacts would be negligible: geologic resources, ecological resources, aesthetic and scenic resources, cultural resources, and traffic. EC

For determining the impact to air, water, human health, waste generation, utilities and energy, and socioeconomic resources from commercial and Federal nuclear facilities, the 50-mile (80-kilometer) radius surrounding SRS was selected as the project impact zone. For aqueous releases, the downstream population that uses the Savannah River as its source of drinking water was included in the project impact zone.

Nuclear facilities within a 50-mile radius of SRS include Georgia Power's Plant Vogtle Electric Generating Plant across the river from SRS; Chem-Nuclear Inc., a commercial low-level waste burial site just east of SRS; and Starmet CMI, Inc. (formerly Carolina Metals), located southeast of SRS, which processes uranium-contaminated metals. Radiological impacts from the operation of the Vogtle Electric Generating Plant, a two-unit commercial nuclear power plant are minimal, but DOE has factored them into the analysis. The South Carolina Department of Health and Environmental Control Annual Report (SCDHEC 1995) indicates that operation of the Chem-Nuclear Services facility and the Starmet CMI facility do not noticeably impact radiation levels in air or liquid pathways in the vicinity of SRS. Therefore, they are not included in this assessment.

The counties surrounding SRS have numerous existing (e.g., textile mills, paper product mills, and manufacturing facilities) and planned (e.g., Bridgestone Tire) industrial facilities with permitted air emissions and discharges to surface waters. Because of the distances between SRS and the private industrial facilities, there is little opportunity for interactions of plant emissions, and no major cumulative impact on air or water quality. Construction and operation of Bridgestone Tire and Hankook Polyester facilities could affect the regional socioeconomic cumulative impacts. TC

Additional offsite facilities with the potential to affect the nonradiological environment include South Carolina Electric and Gas Company's Urquhart Station. Urquhart Station is a three-unit, 250-megawatt, coal- and natural-gas-fired steam electric plant in Beech Island, South Carolina, located about 32 river kilometers (20 river miles) north of SRS. Because of the distance between SRS and the Urquhart Station and the regional wind direction frequencies, there is little opportunity for any interaction of plant emissions, and no significant cumulative impact on air quality.

EC | DOE also evaluated the impacts from its own proposed future actions by examining impacts to resources and the human environment as shown in NEPA documentation related to SRS (see Section 1.6). Additional NEPA documents related to SRS that are considered in the cumulative impacts section include the following:

Final Environmental Impact Statement - Interim Management of Nuclear Materials (DOE/EIS-0220) (DOE 1995a). DOE has begun implementation of the preferred alternatives for the nuclear materials discussed in the Interim Management of Nuclear Materials EIS. SRS baseline data in this chapter reflect projected impacts from implementation.

EC |

TC |

Final Environmental Impact Statement for the Accelerator Production of Tritium at Savannah River Site (DOE/EIS-0270) (DOE 1999a). DOE has proposed an accelerator design (using helium-3 target blanket material) and an alternate accelerator design (using lithium-6 target blanket material). If an accelerator is built, it would be located at SRS. However, since the Record of Decision states the preferred alternative as use of an existing commercial light-water reactor, data from this EIS are not used.

EC |

TC |

Environmental Assessment for the Tritium Facility Modernization and Consolidation Project at the Savannah River Site (DOE/EA-1222) (DOE 1997). This environmental assessment (EA) addresses the impacts of consolidating the tritium activities currently the new Building 233-H and Building 234-H. Tritium extraction functions would be transferred to Tritium Extraction Facility. The overall impact would be to reduce the tritium facility complex net tritium emissions by up to 50 percent. Another positive effect of this planned action would be to reduce the amount of low-level radioactive job-control waste. Effects on other resources would be negligible. Therefore, impacts from the environmental assessment have not been included in this cumulative impacts analysis.

EC |

Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement (DOE/EIS-0240) (DOE 1996). This cumulative impacts analysis incorporates the alternative of blending at SRS highly enriched uranium to 4 percent low-enriched uranium as uranyl nitrate hexahydrate as stated in the Record of Decision (61 FR 40619, August 5, 1996).

EC |

TC |

Final Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site (DOE/EIS-0277F) (DOE 1998). DOE proposes to process certain plutonium-bearing materials being stored at the Rocky Flats Environmental Technology Site. These materials are plutonium residues and scrub alloy remaining from nuclear weapons manufacturing operations formerly conducted by DOE at Rocky Flats. DOE has decided to remove the plutonium from certain residues that would be shipped from the Rocky Flats Environmental Technology Site to SRS for stabilization. The separated plutonium would be stored at SRS pending disposition decisions. Environmental impacts from using F Canyon to chemically separate the plutonium from the remaining materials at SRS are included in this section.

EC |

EC | ***Final Environmental Impact Statement for the Construction and Operation of a Tritium Extraction Facility at the Savannah River Site (DOE/EIS-0271)*** (DOE 1999b).
EC | As stated in the Record of Decision (64 FR 26369; 5/14/99), DOE will construct and operate a Tritium Extraction Facility on SRS to provide the capability to extract tritium from commercial light water reactor targets and targets of similar design. The purpose of the proposed action and alternatives evaluated in the EIS is to provide tritium extraction capability to support either accelerator or reactor production. Environmental impacts from the maximum processing option in this EIS are included in this section.

EC | ***Surplus Plutonium Disposition Final Environmental Impact Statement (DOE/EIS-0283)*** (DOE 1999c). This EIS analyzes the activities necessary to implement DOE's disposition strategy for surplus plutonium. In January 2000 DOE issued a Record of Decision selecting SRS as the site for all three
TC | disposition facilities: mixed-oxide fuel fabrication, plutonium immobilization, and plutonium pit disassembly and conversion. Impacts from these facilities are included in this section.

EC | ***Defense Waste Processing Facility Supplemental Environmental Impact Statement (DOE/EIS-0082-S)*** (DOE 1994). The selected alternative in the Record of Decision (ROD) was the completion and operation of the Defense Waste Processing Facility to immobilize high-level radioactive waste at the SRS. The facility is currently processing sludge from SRS high-level waste tanks. However, SRS baseline data is not representative of full DWPF operational impacts, including processing of salt and supernate from these tanks. Therefore, the DWPF data is listed separately.

L2-16
EC | ***Draft Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel (DOE/EIS-0306D) (DOE 1999d)***. DOE has published a draft environmental impact statement (64 FR 8553, 2/22/99) for treatment of sodium-bonded spent nuclear fuel. Two of the alternatives being evaluated in the Treatment and Management EIS are to process INEEL's sodium-bonded fuel inventory at SRS using the Plutonium-Uranium Extraction (PUREX) process and to use the Melt and Dilute facility being proposed in the EIS. Because processing at SRS is a reasonable alternative to processing at INEEL, it is being included in the Spent Nuclear Fuel Management EIS cumulative impact analysis. These methods could be used for the sodium-bonded spent nuclear fuel blanket assemblies currently in storage at INEEL. There are approximately 22.4 MTHM of Experimental Breeder Reactor-II (EBR-II) fuel blankets and 34.2 MTHM of Fermi-1 fuel blankets to be processed. This fuel would be declad before shipment to SRS. Because the decladding activities would occur at INEEL, the impacts of these decladding activities are not included in this chapter. L2-16 TC

This EIS includes cumulative impacts of sodium-bonded spent nuclear fuel processing at the SRS based on data from the Draft Electrometallurgical Treatment EIS. Data used in this EIS are based on Purex processing at SRS, which is more is conservative.

DOE is currently evaluating nuclear material disposition needs. Other material discussed for processing at SRS under the PNA include single-pass reactor SNF at Hanford, a small amount of damaged SNF at Idaho National Engineering and Environmental Laboratory (INEEL), classified fissile material metal parts at the Rocky Flats Environmental Technology Site (RFETS), and plutonium scrap at Hanford. Currently, DOE has no plan or proposal to transfer the single-pass reactor SNF at Hanford or the damaged SNF at INEEL to SRS so that material was not considered for the cumulative impacts under this EIS. In an amended Record of Decision for the *Final Environmental Impact Statement on Storage and Disposition of Surplus Fissile Material,*

DOE decided to transfer classified metal from RFETS to SRS for stabilization and storage. DOE is considering transferring the plutonium scrap from Hanford to SRS for stabilization and storage pending appropriate National Environmental Policy Act review. As a result, DOE has included processing that material as part of the cumulative impacts for this EIS.

L2-16 DOE is continuing to evaluate the inventory of nuclear material at facilities throughout the DOE complex. DOE's Nuclear Material Integration initiative is one such recent effort that has identified material which could be processed at SRS. Although there are no current plans to process these materials at SRS, DOE considers it appropriate to include a qualitative estimate of impacts as part of the cumulative impacts for this EIS because it is not unforeseen that processing at SRS could occur.

EC In addition, the cumulative impacts analysis includes the impacts from actions proposed in this SNF EIS. Risks to members of the public and site workers from radiological and nonradiological releases are based on operational impacts from the maximum impact alternative described in Section 4.1.2.

In addition, the cumulative impacts analysis accounts for other SRS operations. Most of the
EC SRS baseline data are based on 1997 environmental report information (Arnett and Mamatey
EC 1998), which are the most recent published data available.

Temporal limits were defined by examining the period of influence from both the proposed action and other Federal and non-Federal actions that have the potential for cumulative impacts. Actions for SNF management are expected to begin
TC in 2000 in preparation for ultimate offsite disposal, possibly in a monitored geologic repository which probably will not be available until at least 2010. Final offsite shipments of SNF from SRS for disposal would be completed by 2035.

The period of interest for the cumulative impacts analysis for this SNF EIS includes the potential construction and operation of the Tritium Extraction Facility and while actions for management of nuclear materials, highly enriched uranium, surplus plutonium disposition, and sodium-bonded nuclear fuel would be ongoing. TC

5.1 Air Resources

Table 5-1 compares the cumulative concentrations of nonradiological air pollutants from the SRS to Federal and state regulatory standards. The listed values are the maximum modeled concentrations that could occur at ground level at the Site boundary. The data demonstrate that total estimated concentrations of nonradiological air pollutants from SRS would in all cases be below the regulatory standards at the Site boundary. The highest percentages of the regulatory standards are for sulfur dioxide concentrations for the shorter time interval (approximately 97 percent of standard for the 24-hour averaging time), for particulate matter of less than 10 microns (approximately 89 per- cent of standard for the 24-hour averaging time), and total suspended particulates (approximately 90 percent of standard on an annual basis). The remaining pollutant emissions would range from 1 to 69 percent of the applicable standards. TC TC

The majority of the impacts come from estimates of SRS baseline concentrations. It is unlikely that actual concentrations at ambient monitoring stations would be as high as that shown for the baseline values. The SRS baseline values are based on maximum potential emissions from the 1998 air emissions inventory and for all SRS sources, and observed concentrations from nearby ambient air monitoring stations. TC

Table 5-1. Estimated maximum cumulative ground-level concentrations of nonradiological pollutants (micrograms per cubic meter) at SRS boundary.[a,b]

Pollutant	Averaging time	SCDHEC ambient standard ($\mu g/m^3$)	SNF	SRS baseline ($\mu g/m^3$)	Other foreseeable planned SRS activities[c] ($\mu g/m^3$)	Cumulative concentration[d,e] ($\mu g/m^3$)	Percent of standard
Carbon monoxide	1 hour	40,000	9.760	10,000	36.63	10,046	25
	8 hours	10,000	1.31	6,900	5.15	6,906	69
Oxides of Nitrogen	Annual	100	3.36	26	4.38	33.7	34
Sulfur dioxide	3 hours	1,300	0.98	1,200	8.71	1,210	93
	24 hours	365	0.13	350	2.48	352.6	97
	Annual	80	0.02	34	0.17	34.2	43
Ozone[f]	1 hour	235	0.80	NA[g]	0.71	1.5	1
Lead	Max. quarter	1.5	NA	0.03	0.00	0.03	2
Particulate matter	24 hours	150	0.13	130	3.24	133.4	89
(≤10 microns aerodynamic diameter)[f]	Annual	50	0.02	25	0.13	25.2	50
Total suspended particulates ($\mu g/m^3$)	Annual	75	0.02	67	0.06	67.1	89

L4-17 TC

a. DOE (1994; 1996; 1998; 1999b,c,d) and Hunter (1999) for baseline values.
b. Hydrochloric acid, formaldehyde, hexane, and nickel are not listed in Table 5-1 because operation of SNF or other foreseeable, planned SRS activities would not result in any change to the SRS baseline concentrations of these toxic pollutants.
c. Includes Highly Enriched Uranium, Tritium Extraction Facility, Management of Certain Plutonium Residues and Scrub Alloy Concentrations, Defense Waste Processing Facility, and Disposition of Surplus Plutonium, Sodium-Bonded Spent Nuclear Fuel, and components from throughout the DOE complex.
d. SCDHEC (1976).
e. Includes SNF concentrations.
f. New NAAQS for ozone (1 hr replaced by 8 hr standard = 0.08 ppm) and particulate matter ≤ 2.5 microns (24 hr standard = 65 $\mu g/m^3$) and annual standard of 15 $\mu g/m^3$ will become enforceable during the stated temporal range of the cumulative impacts analyses.
g. Not available.

TC

DOE also evaluated the cumulative impacts of airborne radioactive releases in terms of dose to a maximally exposed individual at the SRS boundary. DOE included the impacts of Plant Vogtle (NRC 1996) in this cumulative total. The radiological emissions from the operation of the Chem-Nuclear low-level waste disposal facility just east of SRS are very low (SCDHEC 1992) and are not included.

Table 5-2 lists the results of this analysis, using 1997 emissions (1992 for Plant Vogtle) for the SRS baseline. The cumulative dose to the maximally exposed member of the public would be 1 x 10^{-4} rem (or 0.1 millirem) per year, well below the regulatory standard of 10 millirem per year (40 CFR Part 61). Summing the doses to maximally exposed individual for the nine actions and baseline SRS operations listed in Table 5-2 is an extremely conservative approach because in order to get the calculated dose, the maximally exposed individual would have to occupy different physical locations at the same time, which is impossible.

TC

TC

Table 5-2. Estimated average annual cumulative radiological doses and resulting health effects to the maximally exposed offsite individual and population in the 50-mile radius from airborne releases.

Activity	Offsite Population			
	Maximally exposed individual		50-mile population	
	Dose (rem)	Probability of fatal cancer risk	Collective dose (person-rem)	Excess latent cancer fatalities
SRS Baseline[a]	5.0×10^{-5}	2.5×10^{-8}	2.2	1.1×10^{-3}
Management of Spent Nuclear Fuel[b]	1.5×10^{-5}	7.5×10^{-9}	0.56	2.8×10^{-4}
Surplus HEU Disposition[c]	2.5×10^{-6}	1.3×10^{-9}	0.16	8.0×10^{-5}
Tritium Extraction Facility[d]	2.0×10^{-5}	1.0×10^{-8}	0.77	3.9×10^{-4}
Surplus Plutonium Disposition[e]	7.4×10^{-6}	3.7×10^{-9}	1.8	9.0×10^{-4}
Management of Plutonium Residues/ Scrub Alloy[f]	5.7×10^{-7}	2.9×10^{-10}	6.2×10^{-3}	3.1×10^{-6}
Defense Waste Processing Facility[g]	1.0×10^{-6}	5.0×10^{-10}	0.071	3.6×10^{-5}
DOE complex miscellaneous components[h]	4.4×10^{-6}	2.2×10^{-9}	7.0×10^{-3}	3.5×10^{-6}
Sodium-Bonded Spent Nuclear Fuel[i]	3.9×10^{-7}	2.0×10^{-10}	1.9×10^{-2}	9.5×10^{-6}
Plant Vogtle[j]	5.4×10^{-7}	2.7×10^{-10}	0.042	2.1×10^{-5}
Total	1.0×10^{-4}	5.1×10^{-8}	5.6	2.8×10^{-3}

a. Arnett and Mamatey (1998) for 1997 data for MEI and population.
b. Maximum-impact alternative.
c. DOE (1996); HEU = highly enriched uranium.
d. DOE (1999b).
e. DOE (1999c).
f. DOE (1998).
g. DOE (1994).
h. Derive from impacts from conventional processing of Group A fuel.
i. DOE (1999d).
j. NRC (1996).

Adding the population doses from current and projected activities at SRS, Plant Vogtle, and management of SNF could yield a total annual cumulative dose of 5.6 person-rem from airborne sources. The total annual cumulative dose translates into 2.8×10^{-3} latent cancer fatality for each year of exposure for the population living within a 50-mile (80-kilometer) radius of the SRS. For comparison, 143,863 deaths from cancer due to all causes would be likely in the same population over their lifetimes.

5.2 Water Resources

At present, a number of SRS facilities discharge treated wastewater to Upper Three Runs and its tributaries and Fourmile Branch via National Pollutant Discharge Elimination System (NPDES)–permitted outfalls. These include the F and H Area Effluent Treatment Facility (ETF) and the M-Area Liquid Effluent Treatment Facility. As stated in Section 4.1.1.1, SNF operations are not expected to result in any discharges to groundwater. The only technology that would result in discharges of radioactive and nonradioactive effluents to surface water would be Conventional Processing. The major sources of liquid effluents from facilities associated with Conventional Processing would be process cooling water and steam condensate systems that could contain small quantities of radionuclides and chemicals. This process wastewater would be treated at ETF and then discharged to Upper Three Runs. Studies of water quality and biota

downstream of the ETF outfall suggest that discharges from it have not degraded the water quality of Upper Three Runs. Other potential sources of contaminants into Upper Three Runs during the SNF management period include the accelerator production of tritium, the tritium extraction facility, environmental restoration, and decontamination and decommissioning activities, as well as modifications to existing SRS facilities. Discharges associated with the accelerator production of tritium and tritium extraction facility activities would not add significant amounts of nonradiological contaminants to Upper three Runs. The amount of discharge associated with environmental restoration and decontamination and decommissioning activities would vary based on the level of activity. All the potential activities that could result in wastewater discharges would be required to comply with the NPDES permit limits that ensure protection of water quality. Studies of water quality and biota in Upper Three Runs suggest that discharges from facilities outfalls have not degraded the stream (Halverson et al. 1997).

Table 5-3 summarizes the estimated cumulative radiological doses from waterborne sources to human receptors downstream from SRS. Liquid effluents would be released to SRS streams that are tributaries of the Savannah River could contain small quantities of radionuclides. The exposure pathways considered in this analysis included drinking water, fish ingestion, shoreline exposure, swimming, and boating. The estimated cumulative dose to the maximally exposed member of the public from liquid releases would be 2.4×10^{-4} rem (or 0.24 millirem) per year, well below the regulatory standard of 4 millirem per year (40 CFR Part 141). Adding the population doses associated with current and projected SRS activities would yield a cumulative annual dose of 2.6 person-rem from liquid sources. This translates into 0.0013 latent cancer fatality for each year of exposure of the population living within a 50-mile (80-kilometer) radius of the SRS. For comparison, 15,300 deaths from cancer due to all causes would be likely in the population of 70,000 downstream residents over their lifetimes.

5.3 Public and Worker Health

Table 5-4 summarizes the cumulative radiological health effects of routine SRS operations, proposed DOE actions, and non-Federal nuclear facility operations (Plant Vogtle Electric Generating Facility). Impacts resulting from proposed DOE actions are described in the EISs listed previously in this chapter. In addition to estimated radiological doses to the hypothetical maximally exposed offsite individual, the offsite population, and involved workers, Table 5-4 also lists the potential number of latent cancer fatalities for the public and workers due to exposure to radiation. The radiation dose to the maximally exposed offsite individual from air and liquid pathways would be 3.4×10^{-4} rem (0.34 mrem) per year, which is well below the applicable DOE regulatory limits (10 mrem per year from the air pathway, 4 mrem per year from the liquid pathway, and 100 mrem per year for all pathways). The total annual population dose for current and projected activities of 8.2 person-rem translates into 0.004 latent cancer fatality for each year of exposure for the population living within a 50-mile (80-kilometer) radius of the SRS. As stated in Section 5.1, for comparison, 143,863 deaths from cancer due to all causes would be likely in the same population over their lifetimes.

The annual radiation dose to the involved worker population would be 859 person-rem. In addition, doses to individual workers would be kept below the regulatory limit of 5,000 mrem per year (10 CFR 835). Furthermore, as low as reasonably achievable principles would be exercised to maintain individual worker doses below the DOE Administrative Control Level of 2,000 mrem per year.

Table 5-3. Estimated average annual cumulative radiological doses and resulting health effects to offsite population in the 50-mile radius from aqueous releases.

	Offsite Population			
	Maximally exposed individual		50-mile population	
Activity	Dose (rem)	Probability of fatal cancer risk	Collective dose (person-rem)	Excess latent cancer fatalities
SRS Baseline[a]	1.3×10^{-4}	6.5×10^{-8}	2.4	1.1×10^{-3}
Management of Spent Nuclear Fuel[b]	5.7×10^{-5}	2.9×10^{-8}	0.19	9.5×10^{-5}
Surplus HEU Disposition[c]	(d)	(d)	(d)	(d)
Tritium Extraction Facility[e]	(d)	(d)	(d)	(d)
Defense Waste Processing Facility[f]	(d)	(d)	(d)	(d)
Surplus Plutonium Disposition[g]	(d)	(d)	(d)	(d)
Management Plutonium Residues/Scrub Alloy[h]	(d)	(d)	(d)	(d)
DOE complex miscellaneous components[i]	4.2×10^{-8}	2.1×10^{-11}	2.4×10^{-4}	1.2×10^{-7}
Sodium-Bonded Spent Nuclear Fuel[j]	1.2×10^{-7}	6.0×10^{-11}	6.8×10^{-4}	3.4×10^{-7}
Plant Vogtle[k]	5.4×10^{-5}	2.7×10^{-8}	2.5×10^{-3}	1.3×10^{-6}
Total	2.4×10^{-4}	1.2×10^{-7}	2.6	1.3×10^{-3}

a. Arnett and Mamatey (1998) for 1997 data for MEI and population. Worker dose is based on 1997 data (WSRC 1998).
b. Maximum-impact alternative.
c. DOE (1996); HEU = highly enriched uranium.
d. Less than minimum reportable levels.
e. DOE (1999b).
f. DOE (1994).
g. DOE (1999c).
h. DOE (1998).
i. Derived from impacts from conventional processing.
j. DOE (1999d).
k. NRC (1996).

5.4 Waste Generation

As stated in Section 4.1.1.4, high-level waste, transuranic waste, and low-level waste would be generated from SNF management activities. Smaller amounts of mixed and hazardous waste would also be generated from SNF processing activities. The largest volume of high-level and transuranic waste would be generated with the Conventional Processing alternative. However, as stated in Section 4.1.1.4, the projected high-level waste and transuranic waste generation rates would not require additional treatment and storage capacities beyond the current and planned SRS capacities. In general, the waste generation rate varies with each phase of SNF handling and the type of fuel group. The total radioactive/hazardous waste volume associated with SNF activities could range from 20,700 cubic meters (27,076 cubic yards) for the minimum impact option to 154,967 cubic meters (202,681 cubic yards) for the maximum impact (conventional processing) option.

Table 5-4. Estimated average annual cumulative radiological doses and resulting health effects to offsite population and facility workers.

	Maximally exposed individual				Offsite population[a]				Workers	
Activity	Dose from airborne releases (rem)	Dose from liquid releases (rem)	Total Dose (rem)	Probability of fatal cancer risk	Collective dose from airborne releases (person-rem)	Collective dose from liquid releases (person-rem)	Total collective dose (person-rem)	Excess latent cancer fatalities	Collective dose	Excess latent cancer fatalities
SRS Baseline[b]	5.0×10^{-5}	1.3×10^{-4}	1.8×10^{-4}	9.5×10^{-8}	2.2	2.4	4.6	2.3×10^{-3}	160	0.066
Management of Spent Nuclear Fuel[c]	1.5×10^{-5}	5.7×10^{-5}	7.2×10^{-5}	3.6×10^{-8}	0.56	0.19	0.75	3.8×10^{-4}	55	0.022
Surplus HEU Disposition[d]	2.5×10^{-6}	(e)	2.5×10^{-6}	1.3×10^{-8}	0.16	(e)	0.16	8.0×10^{-5}	11	4.4×10^{-3}
Tritium Extraction Facility[f]	2.0×10^{-5}	(e)	2.0×10^{-5}	1.0×10^{-8}	0.77	(e)	0.77	3.9×10^{-4}	4	1.6×10^{-3}
Defense Waste Processing Facility[g]	1.0×10^{-6}	(e)	1.0×10^{-6}	5.0×10^{-10}	0.071	(e)	0.071	3.6×10^{-5}	120	0.048
Surplus Plutonium Disposition[h]	4.0×10^{-6}	(e)	4.0×10^{-6}	2.0×10^{-9}	1.6	(e)	1.6	8.0×10^{-4}	541	0.22
Management Plutonium Residues/ Scrub Alloy[i]	2.4×10^{-7}	(e)	2.4×10^{-7}	1.2×10^{-10}	0.026	(e)	0.026	1.3×10^{-5}	25	0.01
DOE complex miscellaneous components[j]	4.4×10^{-6}	4.2×10^{-8}	4.4×10^{-6}	2.2×10^{-9}	7.0×10^{-3}	2.4×10^{-4}	7.2×10^{-3}	3.6×10^{-6}	2	0.001
Sodium-Bonded Spent Nuclear Fuel[k]	3.9×10^{-7}	1.2×10^{-7}	5.1×10^{-7}	2.6×10^{-10}	1.9×10^{-2}	6.8×10^{-4}	2×10^{-2}	9.8×10^{-6}	38	0.015
Plant Vogtle[l]	5.4×10^{-7}	5.4×10^{-5}	5.5×10^{-5}	2.7×10^{-8}	0.042	2.5×10^{-3}	0.045	2.2×10^{-5}	NA	NA
Total	9.8×10^{-5}	2.4×10^{-4}	3.4×10^{-4}	1.7×10^{-7}	5.4	2.6	8.1	4.0×10^{-3}	1,030	0.41

N/A = not available

a. A collective dose to the 50-mile (80-kilometer) population for atmospheric releases and to the downstream users of the Savannah River for aqueous releases.
b. Arnett and Mamatey (1998) for 1997 data for MEI and population. Worker dose is based on 1997 data (WSRC 1998).
c. Maximum-impacts alternative.
d. DOE (1996a); HEU = highly enriched uranium.
e. Less than minimum reportable levels.
f. DOE (1998b, 1999b).
g. DOE (1994).
h. DOE (1998c).
i. DOE (1998a).
j. Derived from impacts from conventional processing of Group A fuel.
k. DOE (1999).
l. NRC (1996).

Table 5-5 lists cumulative volumes of high-level, low-level, transuranic, and hazardous and mixed wastes that SRS would generate. The table includes data from the SRS 30-year expected waste forecast (WSRC 1994). The 30-year expected waste forecast is based on operations, environmental restoration, and decontamination and decommissioning waste forecasts from existing generators and the following assumptions: secondary waste from the Defense Waste Processing Facility, In-Tank Precipitation, and Extended Sludge Processing operations are addressed in the DWPF EIS; high-level waste volumes are based on the selected option for the F-Canyon Plutonium Solutions EIS; some investigation-derived wastes are handled as hazardous waste per Resource Conservation and Recovery Act (RCRA) regulations; purge water from well samplings is handled as hazardous waste; and the continued receipt of small amounts of low-level waste from other DOE facilities and nuclear naval operations. The estimated quantity of radioactive/hazardous waste from operations in this forecast during the next 30 years would be 142,666 cubic meters. In addition, radioactive/hazardous waste associated with environmental restoration and decontamination and decommissioning activities would have a 30-year expected forecast of 67,808 cubic meters (Halverson 1999). Waste generated from the conventional processing option would add a total of 154,970 cubic meters. During this same time period, other reasonably foreseeable activities that were not included in the 30-year forecast would add an additional 192,915 cubic. The major contributor to the other waste volumes would be from weapons components from various DOE sites that could be processed in SRS canyons. Therefore, the potential cumulative amount of waste generated from SRS activities during the period of interest would be 558,359 cubic meters. It is important to note that the quantities of waste generated are not equivalent to the amounts that will require disposal. As discussed in Section 4.1.1.4 for example, high-level waste is evaporated and concentrated to a smaller volume for final disposal. Combustible low-level waste is volume reduced on site in the Consolidated Incineration Facility.

TC | TC | TC | L4-17 EC TC | TC

The Three Rivers Solid Waste Authority Regional Waste Management Center at the Savannah River Site accepts non-hazardous and non-radioactive solid wastes from SRS and eight surrounding South Carolina counties. This municipal solid waste landfill provides state of the art Subtitle D (non-hazardous) facilities for landfilling solid wastes while reducing the environmental consequences associated with construction and operation of multiple county-level facilities (DOE 1995b). It was designed to accommodate combined SRS and county solid waste disposal needs for at least 20 years, with a projected maximum operational life of 45 to 60 years (DOE 1995b). The landfill is designed to handle an average of 1,000 tons per day and a maximum of 2,000 tons per day of municipal solid wastes. The SRS and eight cooperating counties had a combined generation rate of 900 tons per day in 1995. The Three Rivers Solid Waste Authority Regional Waste Management Center opened in mid-1998.

EC | EC

The SNF management activities and other planned SRS activities would not generate larger volumes of radioactive, hazardous, or solid wastes beyond current and projected capacities of SRS waste storage and/or management facilities.

5.5 Utilities and Energy

Table 5-6 lists the cumulative consumption of electricity from activities at SRS. The values are based on annual consumption estimates. Among the SNF management technologies, Conventional Processing would place the largest annual demand on electricity and water re sources. The SNF management values are based on the maximum impact analysis (Section 4.1.1.5).

The overall SRS activities occurring concurrently with SNF management activities would not place an unreasonable demand on electricity resources.

TC

Table 5-5. Estimated cumulative waste generation from SRS concurrent activities (cubic meters).[a,b,c]

Waste Type	SNF Management[a]	SRS Operations[b,c]	ER/D&D[b,c,d]	Other Waste Volume[e]	Total
High-level	11,000	14,129	0	69,552	94,681
Low-level	140,000	118,669	61,630	110,102	430,401
Hazardous/mixed	270	3,856	6,178	4,441	14,745
Transuranic	3,700	6,012	0	8,820	18,532
Total	154,970	142,666	67,808	192,915	558,359

L4-17 TC

a. Maximum-impact alternative.
b. Halverson (1999).
c. Based on a total 30-year expected waste generation forecast, which includes previously generated waste.
d. ER/D&D = environmental restoration/decontamination & decommissioning.
e. Life-cycle waste associated with reasonably foreseeable future activities such as TEF, plutonium residues, surplus plutonium disposition, highly-enriched uranium, commercial light water reactor waste, sodium-bonded spent nuclear fuel, and weapons components that could be processed in SRS canyons. Impacts for the last group is based on conventional processing impacts for SNF Fuel Group A.

TC EC

Table 5-6. Estimated average annual cumulative utility consumption.

Activity	Electricity (megawatt-hours)	Water usage (liters)
SRS baseline[a]	4.11×10^{5}	1.70×10^{10}
SNF management[b]	1.58×10^{4}	2.11×10^{8}
Other SRS foreseeable activities	1.51×10^{5}	6.73×10^{8}
Total	5.77×10^{5}	1.79×10^{10}

TC

a. Halverson (1999) for electricity usage and Arnett and Mamatey (1996) for water usage.
b. Based on the maximum impact alternative.
c. Includes utility consumption associated with reasonable foreseeable future actions such as tritium extraction, facility, plutonium residues, surplus plutonium disposition, highly-enriched uranium, sodium-bonded spent nuclear fuel, and weapons components that could be processes at SRS canyons. Impacts for last group are based on conventional processing impacts of spent nuclear fuel "Group A." See EISs referenced at end of chapter. Sodium-bonded spent nuclear fuel electricity usage based on "Group A" conventional processing; water usage from EIS.

DOE has also evaluated the SRS water needs during the SNF management activities period. At present, the SRS rate of groundwater with-drawl is estimated to be up to 17 billion liters annually. The estimated amount of groundwater needed for SNF management activities from 1998 to 2035 is 211 million liters per year, depending on the management option chosen. Operation of other foreseeable activities would require approximately 673 million liters of groundwater per year. Thus, sitewide groundwater withdrawals would increase minimally over the projected SNF management period.

TC

Surface water usage during the SNF management period is not projected to approach capacity levels.

TC

5.6 Socioeconomic Impacts

Cumulative regional economic and population changes from construction and operation of the Transfer and Storage Facility or the Transfer, Storage and Treatment Facility consider the impacts of other coincident economic development projects such as DOE's Accelerator for the Pro-

duction of Tritium, Bridgestone-Firestone, and Hankook Synthetics.

Bridgestone-Firestone is building a $435 million tire manufacturing plant in Aiken County that will employ 800 workers. The Bridgestone-Firestone project is expected to complete construction and be in operation by the year 2000. Thus, this project should not impact the construction workforce for the Transfer and Storage Facility or Transfer, Storage and Treatment Facility which are not scheduled to be constructed until after the year 2000. Competition for construction workers should not overlap. TC

Construction of the Transfer and Storage Facility or the transfer and storage phase of the Transfer, Storage and Treatment Facility would begin sometime after the year 2000, employ 500 workers (375 construction and 125 professional), and require 2 years to complete. The treatment phase would begin construction at the completion of the transfer and storage phases and also could employ as many as 500 workers and take as long as 2 years to complete. No additional workers would be required during operations since existing SRS employees would assume those positions. TC

There would be no significant cumulative socioeconomic impacts from construction or operation of the Transfer and Storage Facility or the Transfer, Storage and Treatment Facility.

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CHAPTER 6. RESOURCE COMMITMENTS

6.1 Introduction

Chapter 6.0 describes the unavoidable adverse impacts, short-term uses of environmental resources versus long-term productivity, and irreversible or irretrievable commitments of resources associated with safely managing spent nuclear fuel (SNF) at the Savannah River Site (SRS) for the period 1998 to 2035. This chapter also includes discussions about U.S. Department of Energy (DOE) waste minimization, pollution prevention, and energy conservation programs as they would relate to implementation of the proposed action.

6.2 Unavoidable Adverse Impacts

Implementing any of the alternatives considered in this environmental impact statement (EIS) for the management of SNF at SRS would result in minimal unavoidable adverse impacts to the human environment. Construction and operation of a Transfer and Storage Facility to implement the New Packaging Technology or the construction and operation of a Transfer, Storage, and Treatment Facility to implement the New Processing Technology would result in negligible adverse impacts to geologic resources, groundwater, traffic, and cultural resources as described in Chapter 4. All construction activities would occur within the boundary of a reactor or a chemical separations area in an already-developed industrial complex and would require approximately 15 acres.

Potential adverse impacts from construction could occur to surface water resources. However, as part of the required sediment and erosion control plan, storm water management and sediment control measures would minimize runoff from the construction site and potential discharges of silts, solids, and other contaminants to surface-water streams. There would be minimal adverse impacts to air resources from construction activities. Concentrations of pollutants emitted during construction activities would be at least an order of magnitude less than the South Carolina ambient air quality standards concentrations. Likewise, there would be minimal adverse impacts to the ecological resources of the area, primarily due to construction-related noises. Although noise levels would be relatively low outside the immediate area of construction, the combination of construction noise and human activity probably would displace small numbers of animals. These adverse impacts would be small, temporary (24 months or less), and localized. Construction would not disturb any threatened or endangered species, would not degrade any critical or sensitive habitat, and would not affect any jurisdictional wetlands.

Renovating an existing facility for the Transfer, Storage, and Treatment Facility could result in additional low-level waste generation, which could be considered a potential adverse impact. Renovation would require decontamination and removal of components and systems and subsequent construction inside a building, such a reactor building. Adverse impacts would include the generation of approximately 480 m^3 of low-level radioactive waste. This waste volume would have minimal impact on the Site's overall waste management capacity. Eventual decontamination and decommissioning (D&D) of any facility (either new and dedicated to SNF management or renovated to accommodate SNF management) used for the management of SNF would result in the generation of radioactive waste. Impacts of these D&D activities would be evaluated in subsequent National Environmental Policy Act (NEPA) actions.

Unavoidable construction worker radiation exposures would result from renovating an existing reactor facility to become the Transfer, Storage, and Treatment Facility. These occupational exposures (32 person-rem in a population of 54 construction workers) would be well below regulatory limits.

6.3 Relationship between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

The proposed locations for any new facility are all within developed industrial landscapes. Each of the proposed sites would encompass approximately 15 acres. The existing infrastructure (roads; power-, steam-, and waterlines; wastewater treatment facilities, etc.) within each of the areas is sufficient to support the proposed facilities.

Regardless of location, after the operational life of the project, DOE could decontaminate and decommission (D&D) the facility in accordance with applicable regulatory requirements and restore the area to a brown-field site that would be available for other industrial use. Appropriate NEPA reviews would be conducted prior to the initiation of any D&D action. In all likelihood, none of the sites would be restored to a natural terrestrial habitat.

The project-related uses of environmental resources for the duration of any of the proposed alternatives are characterized below.

- Over the life of the SNF management alternatives, groundwater would be used to meet sanitary and process water needs. After use and treatment, this water would be discharged into surface water streams. Depending on the site chosen and the technology implemented, over the short-term, the resulting increases in pollutant loadings would take advantage of the natural assimilative capacity of the receiving stream(s). However, these incremental pollutant loadings should not adversely affect either short- or long-term productivity of the aquatic ecosystem. These impacts would be assessed during the regulatory permitting process once an alternative has been selected.

- Regardless of location, air emissions associated with implementation of any of the technologies would add small amounts of radiological and nonradiological constituents to the air of the region. During the project's life, these emissions would result in an additional loading and exposure but would not impact SRS compliance with air quality or radiation exposure standards. There would be no significant residual environmental affects to long-term environmental productivity.

- The management and disposal of sanitary solid waste and non-recyclable radiological waste over the project's life would require energy and space at SRS treatment, storage, or disposal facilities (e.g., Three Rivers Sanitary Landfill, E-Area Vaults, Consolidated Incineration Facility). The land required to meet the solid waste needs would require a long-term commitment of terrestrial resources. Upon the facilities' closures, DOE could D&D them and restore them to brown field sites which could be available for future commercial or industrial development.

- Regardless of location, increased employment, expenditures, and tax revenues generated during the implementation of any of the alternatives would directly benefit the local, regional, and state economies over the short-term. Long-term economic productivity could be facilitated by local governments investing project-generated tax revenues into infrastructure and other required services.

6.4 Irreversible and Irretrievable Resource Commitments

Resources that would be irreversibly and irretrievably committed during the implementation of SNF management alternatives include those that cannot be recovered or recycled and those that are consumed or reduced to unrecoverable

forms. The commitment of capital, energy, labor, and material during the implementation of SNF management alternatives would generally be irreversible.

Energy expended would be in the form of fuel for equipment and vehicles, electricity for facility operations, and human labor. Construction would generate nonrecyclable materials such as sanitary solid waste and construction debris. Operation of any proposed facility would generate nonrecyclable waste streams such as radiological and nonradiological solid wastes and some process wastewaters. However, certain materials (e.g., copper, stainless steel) used during construction and operation of the proposed facility could be recycled when the facility was D&Ded. Some construction materials, particularly from existing facilities (e.g., Receiving Basin for Offsite Fuel, L-Reactor Disassembly Area, F- and H-Separation Facilities) would not be salvageable due to radioactive contamination. Table 6-1 lists estimated requirements for concrete and steel for any new facility.

Table 6-2 lists the major materials that would be consumed as a result of process operations, primarily chemicals and other commercial products. Table 2-4 lists the corresponding management technologies that would use the facilities.

EC | The implementation of the SNF management alternatives considered in this EIS, including the No-Action Alternative, would require water, electricity, steam, and diesel fuel. Tables 4.1-15 through 4.1-18 list estimated amounts of these resources that would be consumed during the period of analysis; Section 4.1.1.5 describes the uses. Water would be obtained from onsite groundwater sources and steam from existing onsite sources. Electricity and diesel fuel would be purchased from commercial sources. These commodities are readily available and the amounts required would not have an appreciable impact on available supplies or capacities. From a materials and energy resource commitment perspective, Conventional Processing and the Electrometallurgical Treatment Technology option would recover low enriched uranium, which is useable as commercial reactor fuel. None of the other alternatives would recover this resource. | EC

6.5 Waste Minimization, Pollution Prevention, and Energy Conservation

6.5.1 WASTE MINIMIZATION AND POLLUTION PREVENTION

DOE has implemented an aggressive waste minimization and pollution prevention program at SRS at the sitewide level and for individual organizations and projects. As a result, significant reductions have been achieved in the amounts of wastes discharged into the environment and sent to landfills, resulting in significant cost savings.

To implement a waste minimization and pollution prevention program at the SNF management facilities, DOE would characterize waste streams and identify opportunities for reducing or eliminating them. Emphasis would be placed on minimizing the largest waste stream, low-level waste, through source reduction and recycling. Selected waste minimization practices could include:

- Process design changes to eliminate the potential for spills and to minimize contamination areas | L1-5
- Decontamination of equipment to facilitate reuse
- Recycling metals and other usable materials, especially during the construction phase of the project
- Preventive maintenance to extend process equipment life
- Modular equipment designs to isolate potential failure elements to avoid changing out entire units.

Table 6-1. Estimated requirements for concrete and steel for stand-alone facilities.

Facility	Concrete (cubic yards)[a]	Steel (tons)[b]
Transfer and Storage Facility (including dry storage vaults)	11,000	600
Transfer, Storage, and Treatment Facility (construction of new facility)	20,000	1,800

a. To convert cubic yards to cubic meters, multiply by 0.764.
b. To convert tons to metric tons, multiply by 0.907.

Table 6-2. Major chemicals and other materials required for spent nuclear fuel management facilities.

Facility	Major material requirements (operation)
Receiving Basin for Offsite Fuel	Water treatment filters, deionizer resins
L-Reactor Disassembly Basin	Water treatment filters, deionizer resins
F or H Canyon	Nitric acid, gelatin, tributyl phosphate, n-paraffin, depleted uranium
Transfer and Storage Facility	Nuclear poison, helium, neutron absorbers, stainless steel (canisters), water treatment filters and deionizer resins (if receipt basin is used)
Melt and Dilute Treatment Facility	Depleted uranium, neutron poison, helium, stainless steel (canisters), glass formers (glass or ceramic frit, silicon dioxide)
Mechanical Dilution Treatment Facility	Depleted uranium, nuclear poison (e.g., borated steel), helium, stainless steel (canisters)
Vitrification Facility	Depleted uranium, glass or ceramic formers (e.g., silicon oxide), stainless steel (canisters), offgas treatment materials (filters, chemicals)
• Dissolve and Vitrify	• Nitric acid, boric acid
• Glass Material Oxidation and Dissolution System	• Boron oxide, lead dioxide (mostly reused in the process), carbon
• Plasma Arc	• Offgas treatment materials (filters, chemicals)
Electrometallurgical Treatment Facility	Depleted uranium; glass; silicon; lithium fluoride, potassium fluoride, and uranium fluoride electrolytes; aluminosilicate filters; waste separation materials (ion exchange media or chemical reduction/oxide precipitation chemicals)

L1-5 • Use of non-toxic or less toxic materials to prevent pollution and minimize hazardous and mixed waste streams

During construction, DOE would implement actions to control surface water runoff and construction debris and to prevent infiltration of contaminants into groundwater. The construction contractor would be selected, in part, based on prior pollution prevention practices.

6.5.2 ENERGY CONSERVATION

SRS has an active energy conservation and management program. Since the mid-1990s more than 40 onsite administrative buildings

have undergone energy efficiency upgrades. Representative actions include the installation of energy-efficient light fixtures, the use of occupancy sensors in rooms, use of diode light sticks in exit signs, and the installation of insulating blankets around hot water heaters. Regardless of location, the incorporation of these types of energy-efficient technologies into facility de-sign, along with the implementation of process efficiencies and waste minimization concepts, would facilitate energy conservation by any of the SNF management alternatives.

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