CHAPTER 5. CUMULATIVE IMPACTS

The Council on Environmental Quality (CEQ) regulations that implement the procedural provisions of the National Environmental Policy Act (NEPA) define cumulative impacts as impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions (40 CFR 1508.7).

Based on an examination of the environmental impacts resulting from salt processing, coupled with those from U.S. Department of Energy (DOE) and other agency actions and some private actions, it was determined that cumulative impacts for the following areas need to be presented: (1) air resources; (2) water resources; (3) public and worker health; (4) waste generation; and (5) utilities and energy consumption. Discussion of cumulative impacts for the following subject areas is omitted because impacts to these topics from the proposed salt processing alternatives would be so small that their potential contribution to cumulative impacts would be minimal: geologic resources, ecological resources, aesthetic and scenic resources, cultural resources, traffic, and socioeconomics.

The baseline represents current conditions at Savannah River Site (SRS), as detailed in Chapter 3. In this chapter, DOE considers the baseline to represent the No Action alternative because the No Action alternative would continue current high-level waste (HLW) management activities through 2010. Any incremental impacts under the No Action alternative would occur after that. DOE provides a mostly qualitative assessment of the No Action alternative in Chapter 4.

<u>Impacts that vary among the salt processing alternatives</u>

The cumulative impacts analysis presented in this section is based on the actions associated with the SRS salt processing alternative with the greatest impact for each resource, other onsite activities, reasonably foreseeable future actions, and offsite activities with a potential for related environmental impacts. In certain cases, the magnitude of an impact to a particular resource varies among the salt processing alternatives. To be conservative, DOE based this analysis of cumulative impacts on the alternative with the highest impact for a particular resource category, but not on the same alternative for all resource areas (see data tables in this chapter).

As an overview, the resource categories that varied among the alternatives and the salt processing alternatives with the highest and lowest impacts are presented below:

<u>Carbon monoxide and sulfur dioxide ground-level concentrations</u>

- Highest – Direct Disposal in Grout
- Lowest – Small Tank Precipitation, Ion Exchange, and Solvent Extraction would be equal and have 83 percent of the Direct Disposal in Grout concentration for carbon monoxide, 75 percent of the highest 3-hour and annual sulfur dioxide concentrations, and 80 percent of the highest concentration for 24-hour sulfur dioxide.
- Conclusion – The addition to baseline concentrations is very small (less than 0.5 percent) for all action alternatives.

<u>Ozone ground-level concentrations</u>

- Highest – Small Tank Precipitation would not be expected to contribute more than 1 percent of observed background levels.
- Lowest – Concentration under Direct Disposal in Grout would be substantially lower than that for Small Tank Precipitation.

- Conclusion – The effect of any salt processing alternative is minimal on ozone concentration.

Project phase radiological dose and health effects

- Highest – Solvent Extraction would result in essentially no increased probability of latent cancer fatalities from exposure during the 13 years of operation ($1.6x10^{-7}$) for the maximally exposed offsite individual (MEI), and 0.009 and 0.12, respectively, for the offsite population and involved worker populations.

- Lowest – Ion Exchange would have 16 percent of Solvent Extraction's offsite population health impacts and 11 percent of the Solvent Extraction impacts to involved workers.

- Conclusion – Health effects from the salt processing alternatives are well below levels of concern.

Liquid High-Level Waste generation

- Highest – Solvent Extraction would be a major contributor (24 percent) to cumulative HLW generation.

- Lowest – Direct Disposal in Grout would contribute 16 percent of the Solvent Extraction contribution.

- Conclusion – If an HLW salt processing alternative is implemented, current and future liquid HLW generation would be managed effectively and safely.

Electric energy consumption

- Highest – Solvent Extraction would consume a minor portion (4 percent) of the cumulative energy consumption at SRS.

- Lowest – Direct Disposal in Grout would use 55 percent of the Solvent Extraction energy consumption rate.

- Conclusion – Existing electrical capacity is adequate to supply these very small increases in electrical energy consumption.

Water usage

- Highest – Small Tank Precipitation would consume a minute fraction of the production capacity of the aquifer.

- Lowest – Direct Disposal in Grout would use 67 percent of Small Tank Precipitation water requirements.

- Conclusion – The increment of water usage from salt processing is very small and would not be noticeable.

> DOE has examined impacts of the construction and operation of SRS over its 50-year history. It has analyzed trends in the environmental characteristics of the Site and nearby resources to establish a baseline for measurement of the incremental impact of salt processing activities.

SRS History

In 1950, the U.S. Government selected a large rural area in southwestern South Carolina for construction and operation of facilities required to produce nuclear fuels (primarily defense-grade plutonium and tritium) for the Nation's defense. Then called the Savannah River Plant, the facility had full production capability, including fuel and target fabrication, irradiation of the fuel in five production reactors, product recovery in two chemical separations plants, and waste management facilities, including the HLW Tank Farms (DOE 1980). In 1988, DOE placed the active SRS reactors in standby, and the end of the Cold War in the early 1990s prompted their permanent shutdown.

Construction impacts included land clearing, excavation, air emissions from construction vehicles, relocation of about 6,000 persons, and the formation of mobile home communities to house workers and families during construction. Peak construction employment totaled 38,500 in 1952 (DOE 1980).

Early impacts to surrounding communities stabilized quickly. The largest community on the Site, Ellenton, was relocated immediately north of the Site boundary and was renamed New Ellenton.

The SRS has had a beneficial effect on employment in the region. The operations workforce has varied from 7,500 (DOE 1980) to almost 26,000 (HNUS 1992), and presently numbers approximately 14,000 (DOE 2000a).

Currently, the SRS is approximately 90 percent natural areas, with 10 percent devoted to industrial facilities and infrastructure. The Savannah River Site Natural Resource Management and Research Institute (SRI), formerly the Savannah River Forest Station, manages natural resources at SRS. The SRI supports forest research projects, erosion control projects, and native plants and animals (through maintenance and improvements to their habitats). SRI sells timber, manages control-burns, plants seedlings, and maintains secondary roads and exterior boundaries (Arnett and Mamatey 1998a).

Normal SRS operations produced nonradioactive and radioactive emissions of pollutants to the surrounding air and discharges of pollutants to onsite streams. Impacts of these releases to the environment were minimal. In addition, large withdrawals of cooling water from the Savannah River caused minimal entrainment and impingement of aquatic biota from the river and severe thermal impacts to onsite streams, due to the discharge of high volumes of heated cooling water. The discharges stripped the vegetation along stream channels and adjacent banks and destroyed cypress-tupelo forests in the Savannah River Swamp. In 1991, DOE committed to reforest the Pen Branch delta in the Savannah River Swamp, using appropriate wetland species, and to manage it until successful reforestation had been achieved (56 FR 5584-5587; February 11, 1991). Groundwater contamination occurred in areas of hazardous, radioactive, and mixed waste sites and seepage basins.

Because of the large buffer area between the center of operations and the Site boundary, offsite effects were minimal. Thermal effects from surface water discharges did not extend beyond the Site boundary. Groundwater contamination plumes did not move offsite, and onsite surface water contamination had minimal effects offsite because SRS streams discharge to the Savannah River and the large volume of river water, compared to the small volumes of onsite creek water, reduced the concentrations of pollutants to well below concentrations of concern.

Over the years of operation, mitigation measures have substantially reduced onsite environmental contamination. DOE installed a Liquid Effluent Treatment Facility that removes pollutants (except tritium) from wastewater to below regulatory limits before discharge through a National Pollutant Discharge Elimination System (NPDES) outfall to Upper Three Runs. Direct discharge of highly tritiated disassembly basin purge water to surface streams was replaced by discharge to seepage basins, allowing substantial decay of the tritium before the water from the seepage basins outcropped to onsite streams. In addition, DOE minimized the effects of thermal discharges with the construction of a cooling lake for L-Reactor and a cooling tower intended to support K-Reactor operation.

Savannah River water quality has improved over the years and the U.S. Army Corps of Engineers has regulated the flow. Five large reservoirs upriver of SRS were constructed from the 1950s through the early 1980s. These have reduced peak flows in the Savannah River, moderated flood cycles in the Savannah River Swamp and, with the exception of a severe drought from 1985 through 1988, maintained flows sufficient for water quality and managing fish and wildlife resources downstream (DOE 1990). In 1975, the City of Augusta installed a secondary sewage treatment plant to eliminate the discharge of untreated or inadequately treated domestic and industrial waste into the Savannah River and its tributaries. Similar treatment facilities for Aiken County began operation in 1979 (DOE 1987). Industrial dischargers to the River complied with NPDES permits issued by the U.S. Environmental Protection Agency or the State (South Carolina and Georgia), which improved water quality.

Effects of operations decreased rapidly after production ceased. For example, one indicator of potential impacts to human health is the radiation dose to the MEI. The MEI is not an actual person, but is defined as a single person receiving the highest possible offsite dose. From dose, it is possible to estimate the probability of a latent cancer fatality. The estimate of latent cancers is, at best, an order of magnitude approximation. This means that with an estimate of 10^{-5} latent cancer fatalities, the actual probability of a latent cancer fatality is between 10^{-6} and 10^{-4}. By 1997, the dose to the MEI (and the associated probability of a latent cancer fatality) had decreased to about 1/7th of its 1988 value (Arnett and Mamatey 1998a). Further detail on the MEI is discussed later in Section 5.3 (Public and Worker Health) and shown in Table 5-3.

In general, the combination of mitigation measures and post-Cold War cleanup efforts are protecting and improving the quality of the SRS environment, and further minimizing any impacts to the offsite environment. Although groundwater modeling indicates that most contaminants in the groundwater have reached their peak concentrations, several slow-moving constituents will not reach maximum groundwater concentrations for thousands of years (DOE 1987). Long-term cumulative impacts are discussed further in Section 5.6.

CEQ Cumulative Effects Guidance

A handbook prepared by CEQ (1997) guided the preparation of this chapter. In accordance with the handbook, DOE identified the resource areas in which salt processing could add to the impacts of past, present, and reasonably foreseeable actions within the project impact zones, as defined by CEQ (1997).

Spatial and Temporal Boundaries

In accordance with the CEQ guidance, DOE defined the geographic (spatial) and time (temporal) boundaries to encompass cumulative impacts on the five identified areas of concern.

For determining the human health impact from airborne emissions of radionuclides, the population within the 50-mile radius surrounding SRS was selected as the project impact zone. Although the doses are almost undetectable at the 50-mile limit, this is the standard definition of the offsite public for air emissions.

For aqueous releases, the downstream population that uses the Savannah River as its source of drinking water was selected. This population is outside the 50-mile radius used for assessing air impacts. Analyses indicate that other potential incremental impacts from salt processing, including those to air quality (with the exception of ozone), waste management, and utilities and energy diminish within or very near the Site boundaries. Ozone is not emitted directly into the air, but is formed through complex chemical reactions between emissions of volatile organic compounds and nitrogen oxides in the presence of sunlight. Both volatile organic compounds and nitrogen oxides are emitted by industrial sources. Ozone formation occurs fairly rapidly in warm climates and any ozone formation from salt processing emissions would most likely occur within the project impact zone described below. The effective project impact zone for each of these incremental impacts is identified in the discussions that follow.

Nuclear facilities in the vicinity of SRS include: Georgia Power's Plant Vogtle Electric Generating Plant across the Savannah River from SRS; Chem-Nuclear, Inc., a commercial low-level waste burial site just east of SRS; and Starmet CMI, Inc. (formerly Carolina Metals), located southeast of SRS, which processes uranium-contaminated metals. Plant Vogtle, Chem-Nuclear, and Carolina Metals are approximately 11, 8, and 15 miles, respectively, from S and Z Areas. Other nuclear facilities are too far away (more than 50 miles) to contribute to any cumulative effect. Therefore, the project impact zone for cumulative impacts on air quality from radioactive emissions includes four nuclear facilities, SRS and the three smaller ones discussed above. Radiological impacts from the operation of the Vogtle Electric Generating Plant, a two-unit commercial nuclear power plant, are minimal; however, DOE has factored them into the analysis. The South Carolina Department of Health and Environmental Control (*SCDHEC) Annual Report* (SCDHEC 1995) indicates that operations of the Chem-Nuclear and Starmet CMI facilities 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., Bridgestone Tire, textile mills, paper product mills, and manufacturing facilities) and planned industrial facilities with permitted air emissions and discharges to surface waters. Because of the distances between SRS and these private industrial facilities, there is little opportunity for interactions of plant emissions and no major cumulative impact on air or water quality. As indicated in results from the SRS Environmental Surveillance program report, ambient levels in air and water have remained below regulatory levels in and around the SRS region (Arnett and Mamatey 1998a).

An additional offsite facility with the potential to affect the nonradiological environment is South Carolina Electric and Gas Company's Urquhart Station. Urquhart Station is a three-unit, 250-megawatt, coal- and natural-gas-fired steam electric plant in Beech Island, South Carolina, located about 20 river miles and about 18 aerial miles north of SRS. Because of the distance between SRS and the Urquhart Station and the regional wind direction frequencies, there is little opportunity for any interaction of plant emissions, and no detectable cumulative impact on air quality. The project impact zone for nonradiological atmospheric releases is less than 18 miles.

Finally, excess utility and energy capacity is available onsite and demand is too small to affect the offsite region. Similarly, onsite waste disposal capacity can easily satisfy the small quantities generated by salt processing. Thus, the extent of the project impact zone (from utilities, energy, and waste generation) is best described as the SRS.

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 salt processing are expected to begin in 2001. The period of interest for the cumulative impacts analysis for this EIS includes 2001 to 2023.

Reasonably Foreseeable DOE Actions

DOE also evaluated possible impacts from its own reasonably foreseeable future actions by examining impacts to resources and the human environment identified in NEPA documents related to SRS (see Section 1.4). Impacts to the environment that are considered in this cumulative impacts section were identified in the following NEPA documents:

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

- *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement (DOE/EIS-0240)* (DOE 1996). This cumulative impacts analysis incorporates an alternative at SRS that would blend 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).

- *Final Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy at the Rocky Flats Environmental Technology Site (DOE/EIS-0277)* (DOE 1998). As stated in the Records of Decision (64 FR 8068; February 18, 1999, and 66 FR 4803; January 18, 2001), DOE will process certain plutonium-bearing materials currently being stored at the Rocky Flats Environmental Technology Site. These materials are plutonium residues and scrub alloy remaining from nuclear weapons manufacturing operations formerly conducted by DOE at Rocky Flats. DOE has decided to ship certain residues from the Rocky Flats Environmental Technology Site to SRS for plutonium separation and stabilization. The separated plutonium will be stored at SRS, pending disposition decisions. Environmental impacts from using F-Canyon to chemically separate the plutonium from the remaining materials at SRS are included in this section.

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

- *Surplus Plutonium Disposition Final Environmental Impact Statement (DOE/EIS-0283)* (DOE 1999b). This EIS analyzed the activities necessary to implement DOE's disposition strategy for surplus plutonium. As announced in the Record of Decision (65 FR 1608; January 11, 2000), SRS was selected for three disposition facilities, pit (a nuclear weapon component) disassembly and conversion, plutonium conversion and immobilization, and mixed oxide fuel fabrication. The DOE decision allows the immobilization of approximately 17 metric tons of surplus plutonium and the use of up to 33 metric tons of surplus plutonium as mixed oxide fuel. Both methods in this hybrid approach ensure that surplus plutonium originally produced for nuclear weapons is never again used for nuclear weapons. Impacts from this EIS are included in this section.

- *Final Defense Waste Processing Facility Supplemental Environmental Impact Statement (DOE/EIS-0082-S)* (DOE 1994a). The selected alternative in the Record of Decision (60 FR 18589; April 12, 1995) was the completion and operation of the Defense Waste Processing Facility (DWPF) to immobilize HLW at SRS. The facility is currently processing sludge from SRS HLW tanks. However, SRS baseline data are not representative of full DWPF operational impacts, including the processing of salt solution from these tanks. Therefore, DWPF data are listed separately.

- *Savannah River Site Spent Nuclear Fuel Management Final Environmental Impact Statement (DOE/EIS-0279)* (DOE 2000a). The selected alternative in the Record of Decision (65 FR 48224; August 7, 2000) is to prepare for disposal about 97 percent by volume (about 60 percent by mass) of the aluminum-based fuel considered in the EIS (48 metric tons heavy metal), using a Melt and Dilute treatment process. The remaining 3 percent by volume (about 40 percent by mass) would be managed using conventional processing in existing SRS chemical separations facilities.

  As part of the preferred alternative, DOE will develop and demonstrate the Melt and Dilute technology. Following development and demonstration of the Melt and

Dilute technology, DOE will begin detailed design, construction, testing, and startup of a new treatment and storage facility to combine the Melt and Dilute function with a new dry storage facility. The spent nuclear fuel will remain in existing wet storage until treated and then be placed in dry storage.

- *Savannah River Site High-Level Waste Tank Closure Draft Environmental Impact Statement (DOE/EIS-0303D)* (DOE 2000b). DOE evaluated three alternatives for tank closure. All of these alternatives would start after bulk waste removal occurs. The alternatives being considered include: (1) clean tanks with water and fill with grout (preferred option), sand, or saltstone; (2) clean and remove the tanks; and (3) no action. The cumulative impact analysis includes impacts from the preferred option to clean and fill with grout.

- *Savannah River Site Waste Management Final Environmental Impact Statement (DOE/EIS-0217)* (DOE 1995b). DOE issued the SRS Waste Management EIS to provide a basis for the selection of a Site-wide approach to managing present and future (through 2024) wastes generated at SRS. These wastes would come from ongoing operations and potential actions, new missions, environmental restoration, and decontamination and decommissioning programs. The SRS Waste Management EIS included the treatment of wastewater discharges in the Effluent Treatment Facility, F-and H-Area Tank Farm operations and waste removal, and construction and operation of a replacement HLW evaporator in the H-Area Tank Farm. In addition, it evaluated the Consolidated Incineration Facility for the treatment of mixed waste, including incineration of benzene waste from the then-planned In-Tank Precipitation (ITP) process. The first Record of Decision (60 FR 55249) on October 30, 1995, stated that DOE will configure its waste management system according to the moderate treatment alternative described in the EIS. The second Record of Decision (62 FR 27241) was published on May 9, 1997. This ROD was deferred regarding treatment of mixed waste to ensure consistency with the *Approved Site Treatment Plan* (WSRC 2000). The Waste Management EIS is relevant to the assessment of cumulative impacts because it provides the baseline forecast of waste generation from operations, environmental restoration, and decontamination and decommissioning. This forecast was updated in 1999 (Halverson 1999).

- *Final F-Canyon Plutonium Solutions Environmental Impact Statement (DOE/EIS-0219)* (DOE 1994b). As stated in the Record of Decision (60 FR 9824; February 22, 1995), DOE will process plutonium solution to a metal form using F-Canyon and FB-Line facilities at SRS. SRS baseline data include wastes and emissions from this activity.

Other materials under consideration for processing at SRS chemical separation facilities include various components currently at other DOE sites, including Oak Ridge, Rocky Flats, Los Alamos, and Hanford. These materials, which were identified during a Processing Needs Assessment, consist of various plutonium and uranium components. If DOE were to propose processing these materials in the SRS chemical separations facilities, additional NEPA reviews would need to be performed. In this chapter, estimates of the impacts of processing these materials have been included in the cumulative analysis. These estimates are qualitative, because DOE has not yet determined the impacts from processing these materials. When considering cumulative impacts, the reader should be aware of the very speculative nature of some of the estimated impacts.

In addition, the cumulative impacts analysis includes impacts from actions proposed in this SEIS. Risks to members of the public and Site workers from radiological and nonradiological releases are based on operational impacts from the salt processing alternatives described in

Chapter 4. Because these impacts vary among the alternatives, DOE has selected the alternative that produces the maximum impact for each characteristic (e.g., concentration of a specific pollutant). This ensures that the incremental impacts of the proposed action are not underestimated.

The cumulative impacts analysis also accounts for other SRS operations. Most of the SRS baseline data are based on 1997 environmental report information (Arnett and Mamatey 1998a).

5.1 Air Resources

Table 5-1 compares the cumulative concentrations of nonradiological air pollutant emissions from 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 regulatory standards at the Site boundary. The highest percentages of the regulatory standards are for sulfur dioxide concentrations for the shorter time intervals (approximately 96 percent of the 3-hour averaging standard and 96 percent of the 24-hour averaging standard), for ozone (approximately 94 percent of the 1-hour averaging standard), for particulate matter less than 10 micrometers in diameter (approximately 91 percent of the 24-hour averaging standard), and total suspended particulates (approximately 90 percent of the standard). The remaining cumulative pollutant concentrations would range from 2 to 69 percent of the applicable standards.

The majority of the impact comes from estimated SRS baseline concentrations and not from salt processing and other foreseeable actions. It is unlikely that actual concentrations at any ambient monitoring stations at the SRS boundary would be as high as those listed in Table 5-1. The SRS baseline values are based on the maximum potential emissions from the 1997 air emissions inventory for all SRS sources, as well as on observed concentrations from nearby ambient air monitoring stations. The maximum cumulative concentration is an artificial calculation, which assumes that the maximum concentration from each source would occur at the same point on the SRS boundary and at the same time, without considering facility locations, operation schedules, variable wind directions, and other factors. Therefore, it is impossible to actually achieve the maximum cumulative concentration. Thus, the SRS baseline in Table 5-1 is overestimated and this affects the percent of standard values. For example, nearly all of the cumulative concentration for sulfur dioxide comes from the SRS baseline and, therefore, assuming it is 96 percent of the standard is very conservative.

DOE also evaluated the cumulative impacts of airborne radioactive releases in terms of dose to an MEI 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, Inc., low-level waste disposal facility and Starmet CMI, Inc., are very low (SCDHEC 1995) and are not included.

Table 5-2 lists the results of this analysis, using SRS baseline 1997 emissions (1992 for Plant Vogtle). The cumulative dose from airborne emissions to the MEI would be 4.1×10^{-4} rem (or 0.41 millirem [mrem]) per year, well below the regulatory standard of 10 mrem per year (40 CFR Part 61). Summing the doses to the MEI for the actions and baseline SRS operations listed in Table 5-2 is an extremely conservative approach because, in order to get the calculated dose from each facility, the MEI would have to occupy different physical locations at the same time, which is impossible.

Adding the population doses from current and projected activities at SRS, Plant Vogtle, and salt processing activities could yield a total annual cumulative dose of 24 person-rem from airborne sources. That total annual cumulative dose translates into 0.012 latent cancer fatality for each year of exposure for the population living within a 50-mile radius of SRS. A majority of this cumulative impact to the public is

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

Pollutant	Averaging time	Regulatory standard	Salt processing alternative	Other foreseeable[a]	SRS baseline[b]	Cumulative concentrations	Percent of standard
Carbon monoxide	1 hour	40,000	18.0[c]	40.7	10,354	10,413	26
	8 hours	10,000	2.3[c]	6.0	6,866	6,874	69
Nitrogen oxides	Annual	100	0.03[d]	4.7	26.2	31	31
Sulfur dioxide	3 hours	1,300	0.4[c]	9.4	1,244	1,254	96
	24 hours	365	0.05[c]	2.6	349	352	96
	Annual	80	5.0×10^{-4}[c]	0.19	33.6	34	42
Ozone	1 hr	235	2[e]	3.5	216	221	94
Lead	Max Qtr	1.5	4.0×10^{-7}[d]	5.1×10^{-6}	0.03	0.03	2
Particulate matter less than 10 microns	24 hr	150	0.07[d]	3.3	132.7	136	91
	Annual	50	1.0×10^{-3}[d]	0.17	25.3	25	51
Total suspended particulates	Annual	75	1.0×10^{-3}[d]	0.089	67.1	67	90

Sources: DOE (1994a; 1996; 1998; 1999a,b; 2000a,b).

a. All SRS sources including spent nuclear fuel management, disposition of highly enriched uranium, tritium extraction facility, management of certain plutonium and scrub alloy from the Rocky Flats site, HLW tank closure activities, plutonium disposition, and management of weapons components from the DOE complex.

b. Source: Arnett and Mamatey (1998b).

c. Based on data for the Direct Disposal in Grout alternative.

d. Estimated emissions from each of the four action alternatives are the same for this parameter.

e. Although a specific value has not been determined, ozone formation based on volatile organic compounds and nitrogen oxide emissions from the Small Tank Precipitation alternative would not be expected to exceed 2 micrograms per cubic meter.

Table 5-2. Estimated average annual cumulative radiological doses and resulting health effects to offsite population from airborne emissions.

Activity	Offsite population			
	Maximally exposed individual		50-mile population	
	Dose (rem)	Fatal cancer risk[a]	Collective dose (person-rem)	Latent cancer fatalities
SRS baseline[b]	5.0×10^{-5}	2.5×10^{-8}	2.2	1.1×10^{-3}
Salt processing[c]	3.1×10^{-4}	1.6×10^{-7}	18.1	9.1×10^{-3}
Other SRS activities[d]	5.1×10^{-5}	2.5×10^{-8}	3.4	1.7×10^{-3}
Plant Vogtle[e]	5.4×10^{-7}	2.7×10^{-10}	0.045	2.3×10^{-5}
Total	4.1×10^{-4}	2.1×10^{-7}	24	0.012

a. Probability of fatal cancer.
b. Arnett and Mamatey (1998b).
c. Based on data for the Solvent Extraction alternative.
d. Consists of dose impacts associated with reasonably foreseeable future actions such as DWPF, HLW tank closure, spent nuclear fuel management, tritium extraction facility, plutonium residues, surplus plutonium disposition, highly enriched uranium, and weapons components that could be processed at SRS canyons. Sources: DOE (1994a; 1996; 1998; 1999a,b; 2000a,b).
e. NRC (1996).

directly attributable to salt processing activities from the Solvent Extraction alternative. Doses are elevated due to the larger airborne cesium-137 emissions associated with this alternative. Small Tank Precipitation, Ion Exchange, and Direct Disposal in Grout alternatives range from 16 to 66 percent of the Solvent Extraction alternative values. Doses from the No Action alternative are considerably less. For comparison, as shown in Section 3.8.1, approximately 144,000 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 via NPDES-permitted outfalls. These include the F/H-Area Effluent Treatment Facility and the M-Area Liquid Effluent Treatment Facility. The cumulative impact of liquid releases is measured in terms of human health effects and is presented in Section 5.3. As stated in Section 4.1.2, salt processing activities are not expected to result in any radiological or nonradiological discharges to groundwater.

Discharges to surface water would be treated to remove contaminants prior to release into Upper Three Runs. Other potential sources of contaminants into Upper Three Runs during the time of salt processing activities include DWPF, the tritium extraction facility, environmental restoration, decontamination and decommissioning activities, and modifications to existing SRS facilities. Discharges associated with the 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 according to the activity. All 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).

5.3 Public and Worker Health

Table 5-3 summarizes the cumulative radiological health effects of routine SRS operations, proposed DOE actions, and non-Federal nuclear

Table 5-3. Estimated average annual cumulative radiological doses and resulting health effects to offsite population and facility workers.

	Maximally exposed individual				Offsite population[a]				Workers	
Activity	Dose from airborne releases (rem)	Dose from 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 (person-rem)	Excess latent cancer fatalities
SRS Baseline[b]	5.0×10^{-5}	1.3×10^{-4}	1.8×10^{-4}	9.0×10^{-8}	2.2	2.4	4.6	2.3×10^{-3}	160	0.066
Salt Processing[c]	3.1×10^{-4}	(d)	3.1×10^{-4}	1.6×10^{-7}	18.1	(d)	18.1	9.1×10^{-3}	29	0.12
Other foreseeable SRS activities[e]	5.1×10^{-5}	5.7×10^{-5}	1.1×10^{-4}	5.4×10^{-8}	3.4	0.19	3.6	1.8×10^{-3}	730	0.29
Plant Vogtle[f]	5.4×10^{-7}	5.4×10^{-5}	5.5×10^{-5}	2.7×10^{-8}	0.045	2.5×10^{-3}	0.048	2.4×10^{-5}	NA	NA
Total	4.1×10^{-4}	2.4×10^{-4}	6.5×10^{-4}	3.3×10^{-7}	24	2.6	26	0.013	920	0.37

N/A = not available

a. A collective dose to the 50-mile population for atmospheric releases and to the downstream users of the Savannah River for aqueous releases.

b. Arnett and Mamatey (1998b) for 1997 data for MEI and population. Worker dose is based on 1997 data (WSRC 1998).

c. Based on data from the Solvent Extraction alternative.

d. Radioactive liquid waste would be returned to the HLW tank farms and treated in the waste evaporators. No radioactive liquids would be released to the environment. L6-62

e. Includes spent nuclear fuel, highly enriched uranium, tritium extraction facility, management of certain plutonium residues and scrub alloy concentrations, DWPF, and disposition of surplus plutonium and components from throughout the DOE complex.

f. NRC (1996).

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 MEI, the offsite population, and involved workers, Table 5-3 also lists the potential number of latent cancer fatalities for the public and workers due to exposure to radiation. The radiation dose to the MEI from air and liquid pathways would be 6.5×10^{-4} rem (0.65 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 from current and projected activities of 26 person-rem translates into 0.013 latent cancer fatality for each year of exposure for the population living within a 50-mile radius of the SRS, or essentially no cumulative latent cancer fatalities. Most (75%) of this cumulative impact to the public is directly attributable to airborne releases from salt processing activities from the Solvent Extraction alternative (Table 5-2).

The annual radiation dose to the involved worker population in Solvent Extraction would be 920 person-rem, which could result in 0.37 latent cancer fatality. 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 SRS Administrative Control Level of 500 mrem per year. Salt processing activities would minimally increase the workers' and general public's health impacts due to radiation.

5.4 Waste Generation and Disposal Capacity

As stated in Section 4.1.11, low-level waste, hazardous/mixed waste, and sanitary/industrial waste would be generated from salt processing activities.

Table 5-4 lists cumulative volumes of high-level, low-level, transuranic, hazardous, and mixed wastes that SRS would generate. The table includes data from the SRS 30-year expected waste forecast generated by Halverson (1999), which incorporates changes in SRS activities that have occurred since the publication of the *Final SRS Waste Management Environmental Impact Statement* (DOE 1995b). The 30-year expected waste forecast is based on operations, environmental remediation, and decontamination and decommissioning waste forecasts from existing generators and the following assumptions:

- secondary waste from DWPF operations are addressed in the *Defense Waste Processing Facility EIS* (DOE 1994a); HLW volumes are based on the selected options for the *F-Canyon Plutonium Solutions EIS* (DOE 1994b) and the *Interim Management of Nuclear Materials at SRS EIS* (DOE 1995a); some investigation-derived wastes are handled as hazardous wastes per Resource Conservation and Recovery Act regulations; purge water from well samplings is handled as hazardous waste; and the continued receipt of small amounts of low-level waste from other DOE facilities and nuclear naval operations would occur.

In this forecast, the estimated quantity of radioactive/hazardous waste from operations during the next 30 years would be about 140,000 cubic meters. In addition, radioactive/hazardous waste associated with environmental restoration and decontamination and decommissioning activities would have a 30-year expected forecast of 68,000 cubic meters. Based on maximum values, waste generated from the Solvent Extraction alternative would produce 46,000 cubic meters. During this same time period, other reasonably foreseeable activities that were not included in the 30-year forecast would produce almost an additional 400,000 cubic meters. The major contributor to the other waste volumes would be weapons components from various DOE sites that could be processed in SRS canyons

Table 5-4. Estimated cumulative waste generation from SRS concurrent activities (cubic meters)[a].

Waste type	Salt processing[b]	SRS operations[c]	ER/D&D activities[c]	Other waste volumes[d]	Total
HLW	45,000[f]	14,000	0	130,000	190,000
(gallons)[e]	(12,000,000)	(3,700,000)	(0)	(34,000,000)	(50,000,000)
Low-level waste	920	120,000	62,000	250,000	430,000
Hazardous/mixed waste	56	3,900	6,200	5,000	15,000
Transuranic waste	0	6,000	0	12,000	18,000
Total	46,000	140,000	68,000	400,000	653,000

a. Values are rounded to two digits. The totals may not equal the sum of the four components, due to rounding.
b. Based on maximum value (Solvent Extraction alternative).
c. Halverson (1999).
d. Includes life-cycle waste associated with reasonably foreseeable future actions such as DWPF operations, HLW tank closure, spent nuclear fuel management, tritium extraction facility, plutonium residues, surplus plutonium disposition, highly enriched uranium, commercial light-water reactor waste, sodium-bonded spent nuclear fuel, and weapons components that could be processed at SRS canyons. Sources: DOE (1994a,b; 1996; 1998; 1999a,b; 2000a,b).
e. To convert from cubic meters to gallons, multiply by 264.2.
f. HLW value for salt processing is from DWPF recycle; it is not produced directly by salt processing activities.
ER/D&D = Environmental remediation/decontamination and decommissioning.

and spent nuclear fuel management activities. Therefore, the potential cumulative amount of waste generated from SRS activities during the period of interest would be 653,000 cubic meters. It is important to note that the quantities of waste generated are not equivalent to the amounts that would require disposal. For example, HLW is evaporated and concentrated to a smaller volume for final disposal.

The Three Rivers Solid Waste Authority Regional Waste Management Center at SRS accepts non-hazardous and non-radioactive solid wastes from SRS and eight surrounding South Carolina counties. This municipal solid waste landfill provides state-of-the-art Subtitle D (non-hazardous) facilities for landfilling solid wastes, while reducing the environmental consequences associated with construction and operation of multiple county-level facilities (DOE 1995c). It was designed to accommodate SRS and county solid waste disposal needs for at least 20 years, with a projected maximum operational life of 45 to 60 years (DOE 1995c). 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.

Radioactive, hazardous, or solid wastes generated from salt processing activities and other planned SRS activities would not exceed current and projected capacities of SRS waste storage and/or management facilities.

5.5 Utilities and Energy

Table 5-5 lists the cumulative total of electricity used and water consumed by activities at SRS. The values are based on average annual consumption estimates.

Overall SRS electricity consumption would not increase greatly with the addition of salt processing activities. Electricity usage for salt processing would be less than 5 percent of the current SRS baseline level. Cumulative impacts of SRS baseline electricity consumption, coupled with salt processing and other foreseeable future usage (approximately 580,000 megawatt-hours per year), would be less than previous SRS annual consumption rates (1993 usage was over

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

Activity	Electricity (megawatt-hours)	Water usage (liters)
SRS baseline	4.1×10^{5}[a]	1.7×10^{10}[b]
Salt processing	2.4×10^{4}[c]	1.2×10^{7}[d]
Other SRS foreseeable activities[e]	1.5×10^{5}	8.3×10^{8}
Total	5.8×10^{5}	1.8×10^{10}

a. Halverson (1999).
b. Arnett and Mamatey (1996).
c. Based on maximum values from the Solvent Extraction alternative.
d. Based on maximum values from the Small Tank Precipitation alternative.
e. Consists of utility consumption associated with reasonably foreseeable future actions, such as DWPF operations, HLW tank closure, spent nuclear fuel management, tritium extraction facility, plutonium residues, surplus plutonium disposition, highly enriched uranium, and weapons components that could be processed at SRS canyons. Sources: DOE (1994a,b; 1996; 1998; 1999a,b; 2000a,b).

600,000 megawatt-hours per year) (DOE 1995a).

DOE has also evaluated the SRS water needs during salt processing. At present, the SRS rate of groundwater withdrawal is estimated to be a maximum of 1.7×10^{10} liters per year. The maximum estimated amount of water needed annually for salt processing and other reasonably foreseeable future actions is listed in Table 5-5. The annual cumulative level of water withdrawal of 1.8×10^{10} liters is not expected to exceed the production capacity of the aquifer of more than 3.6×10^{11} liters.

5.6 Long-Term Cumulative Impacts

Computer models predict that radiological and nonradiological contaminants leaching from the saltstone produced by any of the salt processing alternatives would always be below their respective regulatory limits in the groundwater 100 meters downgradient of the vaults and at the seeplines of McQueen Branch or Upper Three Runs.

SRS has prepared a report, referred to as the Composite Analysis (WSRC 1997), that calculated for 1,000 years into the future the potential cumulative impact to a hypothetical member of the public from releases to the environment from all sources of residual radioactive material expected to remain in the SRS General Separations Area. The General Separations Area contains all SRS waste disposal facilities, chemical separations facilities, HLW tank farms, and numerous other sources of radioactive material. The Composite Analysis considered 114 potential sources of radioactive material containing 115 radionuclides.

The Composite Analysis calculated maximum radiation doses to hypothetical members of the public at the mouth of Fourmile Branch, at the mouth of Upper Three Runs, and on the Savannah River at the Highway 301 bridge. The estimated peak all-pathway dose from all radionuclides was 14 mrem/year (mouth of Fourmile Branch), 1.8 mrem/year (mouth of Upper Three Runs), and 0.1 mrem/year (Savannah River).

The major contributors to dose were tritium, carbon-14, neptunium-237, and isotopes of uranium (WSRC 1997).

The analysis also calculated radiation doses from drinking water in Fourmile Branch and Upper Three Runs. The estimated peak drinking water doses from all radionuclides for these creeks were 23 mrem/year for Fourmile Branch and 3 mrem/year for Upper Three Runs (WSRC 1997).

As discussed in Section 4.2.2, DOE does not expect salt processing activities to add noticeable levels of radiological contaminants to the accessible environment. The dose effects of saltstone at Upper Three Runs are several orders of magnitude less than those calculated in the

Composite Analysis for the entire General Separations Area. Therefore, the peak all-pathway dose and the peak drinking water dose presented in the Composite Analysis will not be affected by salt processing activities and the conclusions of the Composite Analysis will remain the same.

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