4 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

This final environmental impact statement (FEIS) evaluates the potential impacts of the construction, operation, and decommissioning of the Mixed Oxide Fuel Fabrication Facility (the proposed MOX facility) proposed for construction at the Savannah River Site (SRS). Operation of the proposed MOX facility would also require the construction of two support facilities, the Pit Disassembly and Conversion Facility (PDCF) and the Waste Solidification Building (WSB).

Construction of the facilities would involve site preparation, including the clearing and grading of land, realignment of electrical utilities, and addition of access roads. After site preparation, the remaining construction activities would involve excavation for the foundation and erection of the buildings, connection of SRS utilities to the facilities, and final landscaping. Details of the construction and operational impacts are provided in Sections 4.3 and Appendix H. Operational impacts would include routine facility emissions, waste management, and potential accidents. The impacts of the transportation of the MOX feed materials, the fresh MOX fuel, and spent MOX fuel are discussed collectively with the transport of transuranic (TRU) waste generated by MOX fuel production in Section 4.4.1.[1]

Once the fresh MOX fuel was manufactured and transported, it would be irradiated in authorized nuclear reactors as part of the power generation process. Following irradiation, the spent fuel would be temporarily stored at the reactor sites until shipped to a final disposal repository. The potential indirect impacts for the use of MOX fuel in a nuclear reactor are discussed in Section 4.4.3.

An initial evaluation of projected decommissioning impacts is provided in Section 4.3.6. However, the exact nature and scope of these impacts are uncertain because only present-day technologies are considered, and decommissioning of the facilities would occur well into the future.

In addition to considering the proposed action, this FEIS, in Section 4.2, considers the no-action alternative should the U.S. Nuclear Regulatory Commission (NRC) either not authorize construction of the proposed MOX facility, or not license its operation. Under the no-action alternative, the surplus plutonium would continue to be stored at its current storage locations.

As stated in Section 1.4.2, this chapter presents significant or more important environmental impacts of the proposed action and no-action alternative. Impacts considered to be less significant are presented in Appendixes G and H. The technical areas discussed in this chapter include human health, air quality, surface water and groundwater, waste management, and decommissioning. Impacts from potential accidents at the proposed MOX facility, the PDCF,

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[1] Definitions of descriptive terms used to categorize the magnitudes of impacts are provided in Section 2.4.

and the WSB are discussed in Section 4.3.5. Environmental justice is discussed in detail in Section 4.3.7. In addition, transportation impacts are discussed in detail for the proposed action in Section 4.4.1.

Human health impacts include potential exposure to radiological and chemical materials via pathways associated with air, water, soil, and the food chain. Air quality impacts relate to compliance with National Ambient Air Quality Standards (NAAQS) from emissions of chemical pollutants. Surface and groundwater impacts relate to capacity effects from using these waters and to potential changes in quality of these waters. Waste management impacts relate to the types and quantities of both radiological, hazardous, and nonhazardous wastes generated and how those wastes would be handled. Generally technical terms used in this chapter are defined and discussed in Chapter 3. In those cases, the reader is referred back to specific areas of Chapter 3.

4.2 Impacts of the No-Action Alternative

4.2.1 Introduction

As described in Section 2.1, the no-action alternative would be a decision by the NRC not to approve the proposed MOX facility. If such a decision is made, the 34 MT (37.5 tons) of weapons-useable fissile nuclear materials would remain in storage at DOE sites. The impacts of the continued storage of surplus plutonium would be essentially the same as those discussed under the no-action alternative of the *Surplus Plutonium Disposition Final Environmental Impact Statement* (SPD EIS) (DOE 1999a, Section 4.2) and are summarized in the following sections. Some of the impacts for the no-action alternative presented in this EIS represent impacts for the entire DOE site at which the surplus plutonium is currently being stored.

It is possible that limited new construction would be required at one or more sites to upgrade surplus plutonium storage conditions. For example, previous analyses assumed that surplus pits[2] at the Pantex site in Texas would be moved from Zone 4 to Zone 12, but DOE decided to leave the surplus pits in Zone 4 for long-term storage (DOE 2002a). If new construction is required to accommodate continued storage, the impacts of that construction would be addressed under a separate environmental review required by the DOE regulations for implementation of the National Environmental Policy Act (NEPA) (*Code of Federal Regulations* Title 10, Part 1021 [10 CFR 1021]).

The SPD EIS discusses plans to build an Actinide Packaging and Storage Facility (APSF) at the SRS and to move SRS surplus plutonium to that facility for continued storage (DOE 1999a). After publication of the SPD EIS, the APSF project was canceled. Surplus plutonium at the SRS continues to be stored in existing facilities. It should also be noted that the potential impacts of construction and operation of the proposed MOX facility (as summarized in

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[2] A pit is the core element of a nuclear weapon's "primary" or fission component.

Section 4.3) would be avoided by implementation of the continued storage alternative. The impacts of continued storage are presented in the following sections.

The DOE is currently working to close the Rocky Flats Environmental Technology Site (RFETS) by the year 2006. Such a closure entails the shipment of all radioactive waste and special nuclear materials, including the surplus plutonium, to off-site locations. Storage of the RFETS surplus plutonium at other DOE sites currently storing surplus plutonium is expected to result in a long-term reduction of radiological exposure to workers and the public. For example, approximately 6 MT (6.6 tons) of plutonium dioxide is expected to be shipped from the RFETS to the SRS (Roberson 2002). Storage of the additional plutonium material during normal operations was estimated to result in small, if any, impacts to noninvolved workers and the public (DOE 2002c). The eventual removal and return of the shipping containers was estimated to result in a dose of no greater than 1 mrem/yr to a maximally exposed individual (MEI) of the public (DOE 2002c). Thus the cumulative risks from the no-action alternative presented in Table 4.1, which includes the RFETS, are expected to bound the risks that the surplus plutonium will contribute to other DOE storage sites following shipment from the RFETS.

4.2.2 Human Health Risk

4.2.2.1 Radiological Risk

The radiological doses and risks for members of the public are shown in Table 4.1 for all ongoing activities at each of the storage sites; radiological doses and risks from maintaining the surplus plutonium are portions of the totals. The doses are less than 2% of doses associated with natural background (see Section 3.10.3 and Table 3.7 for information on background radiation).

The average annual dose to facility workers maintaining the surplus plutonium inventories at the storage sites is also shown in Table 4.1. The maximum individual worker dose for the sites (3.2 mSv/yr [320 mrem/yr] at Pantex) is 16% of the administrative limit set by DOE (DOE 1999b) and 6% of the radiological limit of 50 mSv/yr (5,000 mrem/yr) as specified in 10 CFR 835, "Occupational Radiation Protection."

4.2.2.2 Chemical Exposure and Risk

Health risks from exposure to hazardous chemicals used in ongoing operations at the storage sites within the DOE complex were estimated in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a, Appendix M) (these risks are also summarized in the SPD EIS [DOE 1999a]). The estimated baseline cancer risks for the storage sites include inhalation exposures to all carcinogens measured from site point emission sources. Surplus plutonium storage would account for only a small portion of the total exposures from ongoing operations at the various DOE sites. For members of the public, the estimated increased lifetime cancer risks from continued operations

Table 4.1. Radiological impacts from continued plutonium storage in current locations[a,b]

Site	Annual population dose within 80 km in 2030 [person-Sv (person-rem)]	Expected number of fatal cancers in population from 50 years of storage[c]	Annual dose to the public MEI [mSv (mrem)]	Public MEI 50-year fatal cancer risk[c]	Average worker dose [mSv/yr (mrem/yr)]
Hanford	4.7×10^{-4} (4.7×10^{-2})	1×10^{-3}	4.1×10^{-6} (4.1×10^{-4})	1×10^{-8}	2.5 (250)
INEEL	7.6×10^{-7} (7.6×10^{-5})	2×10^{-6}	1.4×10^{-7} (1.4×10^{-5})	4×10^{-10}	0.26 (26)
Pantex	6.3×10^{-8} (6.3×10^{-6})	2×10^{-7}	1.8×10^{-10} (1.8×10^{-8})	5×10^{-13}	3.2 (320)[d]
SRS	2.9×10^{-6} (2.9×10^{-4})	9×10^{-6}	6.8×10^{-8} (6.8×10^{-6})	2×10^{-10}	2.5 (250)
LLNL	6.7×10^{-5} (6.7×10^{-3})	2×10^{-4}	3.1×10^{-6} (3.1×10^{-4})	9×10^{-9}	2.5 (250)
LANL	0.027 (2.7)	8×10^{-2}	6.5×10^{-2} (6.5)	2×10^{-4}	2.5 (250)
RFETS[e]	1.0×10^{-3} (0.10)	3×10^{-3}	4.8×10^{-3} (0.48)	1×10^{-5}	2.5 (250)

[a]The population doses and cancer risks are from all ongoing activities at each site. The worker doses are for workers involved in surplus plutonium continued storage activities.

[b]MEI = maximally exposed individual, INEEL = Idaho National Engineering and Environmental Laboratory, SRS = Savannah River Site, LLNL = Lawrence Livermore National Laboratory, LANL = Los Alamos National Laboratory, RFETS = Rocky Flats Environmental Technology Site.

[c]Latent cancer fatalities are calculated by multiplying dose by the Federal Guidance Report (FGR) 13 health risk conversion factor of 0.06 fatal cancer per person-Sv (6×10^{-4} fatal cancer per person-rem) (Eckerman et al. 1999).

[d]This is the dose for workers involved in gasket replacement activities projected to occur over a period of 10 years; the dose for other storage workers at Pantex would be 1.16 mSv/yr (116 mrem/yr).

[e]Closure of the RFETS is planned for 2006. As discussed in Section 4.2.2.1, the risks presented here are expected to bound the impacts on storage of the RFETS surplus plutonium at other DOE storage sites.

Source: DOE (1999a, Section 4.2.4, based on data in DOE 1996a).

at all the storage sites were estimated to be lower than or within the risk range of 1×10^{-6} to 1×10^{-4} (the target used by the U.S. Environmental Protection Agency (EPA) to determine whether mitigation actions are needed [EPA 1990; see Section 3.10.4]). Except for Lawrence Livermore National Laboratory (LLNL), the hazard index (HI) for members of the public was also less than 1 in every case (an HI of less than 1 indicates no or small noncancer health risk; see Section 3.10.4). The general public HI for LLNL was estimated as 1.1, narrowly exceeding the noncancer health risk screening criterion. For the site employee populations, the noncancer HI values for all sites except the SRS and LLNL were less than 1; the value for the SRS was 1.2, and the value for LLNL was 2.4. Estimated cancer risks from ongoing operations for employees at several sites (i.e., Idaho National Engineering and Environmental Laboratory [INEEL], SRS, LANL, RFETS) also exceeded EPA's tolerable risk range, although none was greater than 10^{-3}.

The emissions data used as the basis for the HI values and cancer risks from all ongoing operations at the storage sites are several years old. The methods used to estimate the HI values and cancer risks are generally conservative (assuming such things as the public receptor present at the site boundary for 24 hours per day), resulting in overestimates of actual exposure. Furthermore, only a small portion of the total exposures from site emissions would be from plutonium storage activities. Therefore, although it is possible on the basis of the cited data that members of the public (for LLNL) or on-site employees (for several sites) might experience adverse health impacts as a result of exposures from ongoing plutonium storage operations, it is more likely that actual exposures would be less than those that would result in adverse health impacts.

4.2.2.3 Physical Hazards

The number of full-time employees required to maintain continued storage of the excess plutonium at the various sites was not given in the SPD EIS (DOE 1999a). Therefore, it is not possible on the basis of available information to estimate the annual number of fatalities and injuries that would be associated with continued plutonium storage under the no-action alternative.

4.2.2.4 Facility Accidents

The potential for accidental release of plutonium from storage vaults is much lower than for release from MOX fuel fabrication, which involves numerous operations. In the SPD EIS (DOE 1999a), the health risks of beyond-design-basis earthquake events on plutonium storage facilities were reported for the off-site population. Of the DOE sites evaluated, a high value of 0.4 latent cancer fatality (LCF) was reported for the 80-km (50-mi) off-site population at INEEL (see Section 3.10.3 for LCF definition). For a MEI of the public, an explosive airplane crash at Pantex was estimated to result in an LCF probability of 0.04.

There is no known use of hazardous chemicals required for the continued storage of the surplus plutonium at the various storage sites. Therefore, accidental release of hazardous chemicals during continued storage would not be expected.

4.2.3 Air Quality

The SPD EIS (DOE 1999a) summarized ambient concentrations of criteria pollutants (carbon monoxide [CO], nitrogen dioxide [NO_2] , particulate matter with a diameter of 10 μm or less [PM_{10}], and sulfur dioxide [SO_2]) at each storage site from total site contributions, including plutonium storage operations. With one exception, the total site contributions were in compliance with applicable standards. At LLNL, however, the estimated maximum 1-hour ambient concentration of NO_2 was 2.5 times higher than the State of California standard. Because plutonium storage operations do not generate appreciable quantities of NO_2, continued storage of the plutonium would not change the impacts of ongoing operations on air quality at LLNL.

4.2.4 Hydrology

The annual water usage and wastewater discharges for all ongoing activities at each of the storage sites are shown in Table 4.2. Water use and wastewater generation for maintaining the surplus plutonium storage are small portions of the totals. No impacts to surface or groundwater resources from continued storage are anticipated beyond those of existing activities.

4.2.5 Waste Management

For all the storage locations, wastes generated by activities required to maintain continued storage of surplus plutonium would be a portion of the existing waste generation rates and are not anticipated to change appreciably. Continued storage should not have a major impact on waste management activities at any of the sites.

4.3 Impacts of the Proposed Action

This section presents the direct impacts of the proposed action. As discussed in Section 2.2, the proposed action is for NRC to authorize DCS to construct and later operate the proposed MOX facility at the SRS to convert 34 MT (37.5 tons) of surplus plutonium to MOX fuel. Section 4.3.1 presents the estimated impacts to human health. Sections 4.3.2 and 4.3.3 cover potential impacts to air and water, respectively. Waste management impacts (Section 4.3.4), potential accident impacts (Section 4.3.5), and environmental justice impacts (Section 4.3.7)

Table 4.2. Annual water usage and wastewater discharges for the sites of continued plutonium storage

Site	Water requirement (million L/yr)[a]	Wastewater discharge (million L/yr)
Hanford	13,511/195	246
INEEL	0/7,570	540
Pantex	0/249	141
SRS	127,000/13,247	700
LLNL	NA[b]	NA[b]
LANL	0/5,760	693
RFETS	439/0	130

[a]Surface water/groundwater.

[b]NA = not available.

Source: DOE (1996a, Section 4.2).

were also evaluated. The scope of the proposed action includes decommissioning of the proposed facilities (Section 4.3.6).

As discussed in Section 1.4.1, the technology option to substitute sand filters for the proposed high-efficiency particulate air (HEPA) filters was identified during the scoping process. Discussions of the differences in impacts between sand filters and HEPA filters are summarized in Section 4.3.8.

Construction of the proposed MOX facility is assumed to occur over a 5-year period. Construction of the WSB is assumed to occur during the same 5-year period; whereas construction of the PDCF is assumed to begin 2 years after the construction start for the other facilities (DCS 2002c).

If construction of the proposed MOX facility is authorized, DCS plans to submit an application for a 20-year license to possess and use special nuclear material to manufacture MOX fuel. The actual operation period may be 10 to 14 years, with the additional time needed for facility startup, testing, and decommissioning prior to license termination. For purposes of evaluating operational impacts, a 10-year period was assumed for processing the 34 MT (37.5 tons) of surplus plutonium. That period is based on the facility design for a maximum annual throughput of 3.5 MT (3.9 tons) of plutonium. If the actual period of operation is greater than 10 years because the actual throughput is less than the maximum facility design capacity, the annual impacts would be less, but they would occur over a longer time period.

The following sections present potential impacts on human health, air quality, hydrology, waste management, and environmental justice. A discussion of the impacts in other technical areas is presented in Appendix H.

4.3.1 Human Health Risk

4.3.1.1 Radiological Risk

4.3.1.1.1 Construction

The construction workers for the proposed MOX facility, the PDCF, and the WSB, like other workers at the SRS, would be subject to exposure to baseline radiation from other SRS activities. However, no additional radiological impacts to the construction workers, to existing SRS workers, or members of the public off-site are expected from the construction activities because no surface contamination is present.

Although radioactive contamination is present in the groundwater underlying the Old F-Area Seepage Basin and the proposed MOX facility, the primary movement of this contamination is expected to follow the direction of the groundwater flow. This direction is toward the north-northwest, where the groundwater discharges to Upper Three Runs Creek (WSRC 1995), away from the proposed facilities. Another possible source of exposure of the construction workers would be any radioactively contaminated soil in the area disturbed by construction activities. An exploration and sampling program across the project site, however, did not identify any radioactive contaminants (DCS 2000b; Fledderman 2002). As discussed in Section 5.2.8, soil would be further sampled for radioactive contamination before excavation begins at the site. If contamination was found, potential exposures and health impacts to the construction workers would be assessed.

4.3.1.1.2 Operations

Radiological impacts to human health from normal operations would result from releases to the environment and direct exposure of facility workers to sources of radiation (see description in Section 3.10). The impacts were evaluated for three receptor groups (facility workers, SRS employees, and members of the public).

All radiological impacts were assessed in terms of committed dose and associated health effects. The dose calculated was the total effective dose equivalent (TEDE) (10 CFR Part 20), which is the sum of the deep dose equivalent (DDE) from exposure to external radiation and the 50-year committed effective dose equivalent (CEDE) from exposures to internal radiation. Details of the dose calculations are provided in Appendix E. The DDE is the dose equivalent at a tissue depth of 1 cm and applies to external whole-body exposure. The CEDE is the dose equivalent to organs or tissues that is received over a 50-year period following the intake of radioactive material.

For each of the receptor groups, doses were estimated for the group as a whole (population or collective dose) and for an MEI. The MEI was defined as a hypothetical person who — because of proximity, activities, or living habits — could receive the highest possible dose. The MEI for SRS employees and members of the public usually was assumed to be at the location of the highest on-site or off-site air concentrations of contaminants, respectively — even if no individual actually worked or lived there. Under actual conditions, all radiation exposures and releases of radioactive material to the environment are required to be as low as reasonably achievable (ALARA), a practice that has as its objective the attainment of dose levels as far below applicable limits as is practical, taking into account social, technical, economic, and public policy considerations. Annual estimated radiological impacts from normal operations of the proposed MOX facility, the PDCF, and the WSB are provided in Table 4.3.

Facility Workers

MOX facility: Approximately 400 workers are expected to be employed at the MOX facility. Facility workers during normal operations were estimated to receive an annual collective dose of 0.15 person-Sv (15 person-rem). Approximately 0.12 person-Sv (12 person-rem) would be from external exposure and the remaining 0.03 person-Sv (3 person-rem) from internal exposure. The resulting health effects were calculated to be approximately 0.009 LCF/yr. On average, the facility workers' dominant exposure pathway would be external exposure.

Table 4.3. Annual estimated radiological impacts to facility workers, SRS employees, and the public from normal operations at the proposed facilities

Receptor	PDCF		MOX facility		WSB	
	Dose [person-Sv (person-rem)]	Latent cancer fatalities/yr[a]	Dose [person-Sv (person-rem)]	Latent cancer fatalities/yr[a]	Dose [person-Sv (person-rem)]	Latent cancer fatalities/yr[a]
Collective population						
Facility workers	1.97 (197)	0.1	0.15 (15)	0.009	0.50 (50)	0.03
SRS employees (13,295)[b]	0.00031 (0.031)	2×10^{-5}	0.00022 (0.022)	1×10^{-5}	–[c]	–
Public (1,042,000 persons off-site)	0.015(1.5)	0.0009	0.00073 (0.073)	4×10^{-5}	–	–
	PDCF		**MOX facility**		**WSB**	
	Dose [Sv (rem)]	**LCF risk[d]**	**Dose [Sv (rem)]**	**LCF risk[d]**	**Dose [Sv (rem)]**	**LCF risk[d]**
Maximally exposed individual						
Facility worker	0.020 (2.0)	0.001	0.017 (1.7)	0.001	0.020 (2.0)	0.001
SRS employee (225 m to the ENE)	5.6×10^{-7} (5.6×10^{-5})	3×10^{-8}	4.2×10^{-7} (4.2×10^{-5})	3×10^{-8}	–	–
Public (10,680 m to the N)	3.5×10^{-8} (3.5×10^{-6})	2×10^{-9}	5.1×10^{-9} (5.1×10^{-7})	3×10^{-10}	–	–

[a]Latent cancer fatalities are calculated by multiplying dose by the Federal Guidance Report (FGR) 13 health risk conversion factor of 0.06 fatal cancer per person-Sv (6×10^{-4} fatal cancer per person-rem) (Eckerman et al. 1999).

[b]*Source:* Birch (2001).

[c]Impacts from the WSB are included in the proposed MOX facility results.

[d]For annual individual exposure estimates, number represents the lifetime risk of fatality from a radiologically induced cancer.

However, the MEI dose of approximately 0.017 Sv/yr (1.7 rem/yr) with a fatal cancer risk of 1 chance in 1,000 (0.001) was estimated from inhalation exposure. The facility worker estimates were based on operational experience from a similar facility, as discussed in Appendix E.

PDCF: Average annual worker exposures are expected to remain below 0.005 Sv/yr (0.5 rem/yr), the SRS guideline. For 393 workers, an annual collective dose should not exceed 1.97 person-Sv (197 person-rem) with the potential for 0.1 LCFs/yr of operation. The maximum annual exposure to a single facility worker is expected to be maintained less than the DOE administrative limit of 0.02 Sv/yr (2 rem/yr) (DOE 1994). Such an exposure has an expected lifetime risk of developing a fatal cancer of approximately 0.001 (1 chance in 1,000).

WSB: Average annual worker exposures are expected to remain below 0.005 Sv/yr (0.5 rem/yr), the SRS guideline. For 100 workers, an annual collective dose should not exceed 0.50 person-Sv (50 person-rem) with the potential for 0.03 LCFs/yr of operation. The maximum annual exposure to a single facility worker is expected to be maintained at less than the DOE administrative limit of 0.02 Sv/yr (2 rem/yr). Such an exposure has an expected lifetime risk of developing a fatal cancer of approximately 0.001 (1 chance in 1,000).

SRS Employees

MOX facility and WSB: Normal operations were estimated to result in an annual collective SRS employee dose of 0.00022 person-Sv/yr (0.022 person-rem/yr), which corresponds to approximately 1×10^{-5} LCF/yr. The MEI dose was found to occur at a location 225 m (738 ft) east-northeast of the proposed MOX facility stack location. The MEI was estimated to receive a dose of 4.2×10^{-7} Sv/yr (4.2×10^{-5} rem/yr), which results in an annual fatal cancer risk of 3×10^{-8} (1 chance in 33 million).

PDCF: Normal operations were estimated to result in an annual collective dose of 0.00031 person-Sv (0.031 person-rem) to the SRS employee population, resulting in an estimated 2×10^{-5} LCFs/yr of operation. An MEI located 225 m (738 ft) east-northeast of the facility stack location was estimated to receive an annual dose of 5.6×10^{-7} person-Sv (5.6×10^{-5} person-rem). The resulting lifetime LCF is approximately 3×10^{-8} (1 chance in 33 million).

Members of the Public

Operation of the facilities is considered to have an insignificant impact on members of the public. Maximally exposed individuals of the public were estimated to receive exposures that are about 10,000 times less than that received from the baseline radiological exposures as discussed in Section 3.10.3.

MOX facility and WSB: For members of the public, operations were estimated to result in an annual collective population dose of 0.00073 person-Sv/yr (0.073 person-rem/yr), which is about 3.2% of the estimated dose received by the public from air emissions from the SRS for the year 2000 (0.023 person-Sv [2.3 person-rem]), as discussed in Section 3.10. The number of expected annual LCFs from operations was estimated to be 4×10^{-5}. The MEI location was determined to be at the SRS fenceline, 10,680 m (35,040 ft) north of the proposed MOX facility stack location. An MEI at this location would receive an estimated annual dose of 5.1×10^{-9} Sv/yr (5.1×10^{-7} rem/yr). This dose corresponds to an annual fatal cancer risk of 3×10^{-10} and is 1.3% of the estimated dose received by the public MEI from air emissions from the SRS for the year 2000 (4×10^{-7} Sv [4×10^{-5} rem]), as discussed in Section 3.10.

PDCF: Normal operations were estimated to result in an annual collective population dose of 0.015 person-Sv (1.5 person-rem) that corresponds to approximately 0.0009 LCFs/yr of operation. Thus, the average member of the public would receive a dose of approximately 1.4×10^{-8} Sv (1.4×10^{-6} rem), with an expected lifetime risk of developing a fatal cancer of 9×10^{-10} (1 chance in 1.1 billion). The pubic MEI was estimated to receive an individual dose of 3.5×10^{-8} Sv (3.5×10^{-6} rem) that has an expected lifetime fatal cancer risk of 2×10^{-9} (1 chance in 500 million).

4.3.1.2 Chemical Exposure and Risk

4.3.1.2.1 Construction

The potential airborne emissions of criteria pollutants (a group of air pollutants for which federal ambient standards exist) from construction of the proposed MOX facility and supporting facilities are summarized in Section 4.3.2.1. Emissions of toxic air pollutants during construction would be very low (less than 1 kg/yr (2 lb/yr) [DCS 2000a, 2002a]) and would not result in adverse health impacts. The potential ambient concentrations of criteria pollutants at or beyond the SRS boundary resulting from facility construction emissions were modeled. The estimated incremental criteria pollutant levels varied between 0.01% and 5% of the applicable ambient standard levels (see Table 4.6 in Section 4.3.2.1). Levels of criteria pollutants above the ambient standard levels would not be expected in the vicinity of SRS.

Wastewater generated during construction would be transported to the SRS Central Sanitary Wastewater Treatment Facility for treatment (DCS 2002a). No adverse impacts from human exposure to contaminants in wastewater effluents are expected from the construction of the facilities.

Hazardous wastes generated during construction would be shipped off-site to permitted commercial recycling, treatment, and disposal facilities. Exposure to hazardous materials used during construction (e.g., paints, solvents) would be kept to a minimum by following applicable OSHA regulations and precautions, such as ensuring good ventilation and cleaning up small chemical spills as soon as they occur.

If soil contamination from past site activities exists in the construction area for the proposed facilities, construction workers doing excavation work could be exposed, primarily through inhalation or incidental soil ingestion. The project site is located at the northern boundary of the main processing facility in the F-Area. Historically, the site proposed for facility construction has been used as a disposal area for excavated soil from F-Area construction projects (Wike 2000).

A recent limited investigation of possible contamination in the proposed construction area included 50 shallow soil samples (i.e., cores from 0 to 12 in.) (Fledderman 2002). Data were available for 10 metals (aluminum, beryllium, chromium, copper, gallium, iron, lead, manganese, nickel, and zinc). The concentrations in all samples were lower than the corresponding EPA Region IX health-based screening levels for industrial use properties. These results do not indicate an initial cause for concern regarding potential chemical exposures for excavation workers. However, the number of substances analyzed was low, and past operating history shows extensive contamination at SRS with such substances as trichloroethylene and arsenic, which were not analyzed in the soil samples. Also, if contamination was present at lower soil depths it would not have been detected. Therefore, if indications of possible chemical contamination (e.g., chemical odors, presence of old construction rubble) are observed during excavation activities, further soil testing to evaluate the potential for adverse health impacts to construction workers would be necessary.

4.3.1.2.2 Operations

During operations, the proposed MOX facility would use about 30 chemicals for processing, mostly for aqueous polishing to remove impurities from the plutonium (DCS 2004a; Table 3-2; DCS 2002b; 2004b); the chemicals would include dodecane, hydrazine, hydrogen peroxide, hydroxylamine nitrate, nitric acid, nitrogen, nitrogen tetroxide, and tributyl phosphate. The WSB would use three chemicals for waste processing: aluminum nitrate, nitric acid, and sodium hydroxide (DCS 2004a; Table G-2). Operation of the PDCF would require about 15 processing chemicals, including nitrogen, chlorine, sulfuric acid, phosphoric acid, and aluminum sulfate (DOE 1999a; Table E-7). At all three facilities, the chemicals would generally be stored in liquid or compressed gas form. Accidental releases of the process chemicals are discussed in Section 4.3.5.3 and Appendix E. After the chemicals were used in operations, resulting wastes would be recycled through the systems or disposed of at appropriate licensed facilities for hazardous or radioactive waste. The facilities would not discharge any process liquid directly to the environment.

Facility Workers. For normal operations, inhalation exposures and risks for facility workers (those working at the proposed MOX facility and related facilities) are difficult to estimate. This is due, in part, to the large amount of uncertainty associated with estimating airborne chemical concentrations in various rooms of the facilities. For this reason, quantitative estimates of risks to facility workers from inhalation of substances emitted during facility operations were not developed for this FEIS. However, the workplace environment would be monitored to ensure that airborne chemical concentrations were below applicable occupation exposure limits. In addition, health risks from occupational exposure through all pathways would be minimized by using enclosed operations (e.g., gloveboxes) to the extent possible.

SRS Employees and the Public. SRS employees and members of the public could be exposed to chemicals emitted to air, water, or soil from the proposed MOX facility, the PDCF, and the WSB.

In general, the chemicals involved in processing at the three facilities would be used in small amounts, have low volatilities[3], and/or have low toxicities. On the basis of information that emissions of hazardous chemicals from all three facilities to air and water would be very low (Sections 4.3.2 and 4.3.3), no hazard index or increased cancer risk estimates were made for SRS employees and the public. Adverse impacts to SRS employees and the public from exposure to air or water emissions from the facilities would not be expected. Two process chemicals from the proposed MOX facility requiring special consideration, hydrazine and uranium dioxide, are discussed below.

Hydrazine would be used in the aqueous polishing process to separate plutonium from the solvent. Hydrazine is highly reactive and corrosive; it is a carcinogen and a reproductive hazard. The maximum anticipated on-site inventory of hydrazine would be 480 L (126 gal); annual use would be 2,000 L (530 gal). In the Reagent Storage Building, hydrazine would be kept in sealed containers. Prior to use in the aqueous polishing process, the hydrazine would be blanketed with nitrogen (a process in which the nitrogen gas, which does not mix well with hydrazine, shields the liquid hydrazine from unwanted side reactions). As discussed in Section 3.10.4.2, current SRS sitewide hydrazine emissions do not result in exceedance of the ambient level specified in the South Carolina Department of Health and Environmental Control (SCDHEC) standard. During permitting of the proposed MOX facility, demonstration that operational hydrazine emissions would be limited to levels that would not cause exceedance of the SCDHEC standard would be conducted.

During the fuel fabrication process, purified plutonium dioxide powder would be mixed with depleted uranium dioxide powder. The health risk from plutonium exposure is dominated by the radiological risk, whereas the health risk from uranium exposure is dominated by the chemical risk (i.e., possible damage to the kidney). The radiological health risk from plutonium emissions during operations of the proposed MOX facility and related facilities is addressed above in Section 4.3.1.1.2.

In the proposed MOX facility, uranium powder would be processed in closed containers located in gloveboxes to confine contamination to inaccessible areas and keep occupational exposures within specified guideline and standard levels (DCS 2004a). Air exhaust from gloveboxes would be equipped with HEPA filters to collect particulate emissions. Operation of the facility would generate less than 1 g of uranium emissions annually (see Table E.1). These uranium emissions would result in small exposures and chemical health risks for SRS employees and the public.

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[3] A chemical with a "low volatility" does not readily change from a liquid to a gas at a relatively low temperature (e.g., near room temperature).

4.3.1.3 Physical Hazards

4.3.1.3.1 Construction

As with any construction project, there would be occupational hazards to construction workers at the proposed MOX facility and related facilities. Occupational hazards were estimated by using the same method as was discussed in Section 3.10.5 for baseline physical hazards. The annual fatality and injury rates for construction activities used were as follows: 13.6 fatalities per 100,000 full-time workers and 4.2 injuries per 100 full-time workers (NSC 2001). On the basis of this methodology, the annual number of fatalities was calculated to be less than 1 for all facilities, assuming peak year employment (see Table 4.4). The estimated annual number of injuries was about 40 per year for each facility. The injuries included in these numbers are those resulting in lost workdays, not including the day of injury.

4.3.1.3.2 Operations

Occupational hazards associated with normal operations at the proposed MOX facility and related facilities were estimated by the same method discussed in Section 3.10.5; impacts are summarized in Table 4.4. Annual fatality and injury rates used were as follows: 3.3 fatalities per 100,000 full-time workers and 4.6 injuries per 100 full-time workers (NSC 2001). Annual fatality and injury rates for the manufacturing sector were used because that sector was assumed to be the most representative for operational work at the proposed facilities. The annual number of fatalities was estimated to be less than 1 for all facilities. The estimated number of injuries was 36 per year collectively for operation of the proposed MOX facility and the PDCF, and 5 per year for the WSB (includes only injuries resulting in lost workdays, not including the day of injury).

4.3.2 Air Quality

This section presents the maximum potential air quality impacts associated with construction and operation of the proposed MOX facility, the PDCF, and the WSB. Air quality impacts associated with construction and operation of the facilities were assessed by determining the concentrations of pollutants in the air caused by emissions associated with the facilities and comparing those concentrations with generally accepted measures of air quality impact, typically standards set by regulatory agencies. Two types of standards exist. Incremental standards set maximum concentrations that cannot be exceeded by emissions from sources associated with a facility or facilities. Total standards set maximum concentrations that cannot be exceeded by total emissions from both sources associated with a facility or facilities and other nearby sources, such as existing SRS sources.

Determining the air quality concentrations involves three steps. First, the emissions of the sources associated with a facility or facilities are calculated. Next, the incremental concentrations caused by these emissions are determined with an air quality model that uses emissions and meteorological data to estimate concentrations at various locations. To

Table 4.4. Annual physical hazard impacts from normal operations[a]

Facility	Peak year construction FTEs[b]	Annual operations FTEs[b]	Projected annual fatalities – construction	Projected annual fatalities – operations	Projected annual injuries – construction	Projected annual injuries – operations
MOX facility	950	400	0.13	0.013	40	18
PDCF	1,024	400	0.14	0.013	40	18
WSB	1,000	100	0.14	0.003	42	5

[a]Fatality estimates of less than 0.5 should be interpreted as "no expected fatalities." Construction of each of the facilities is projected to require 3 to 5 years. The duration of operations is estimated as 10 or more years.

[b]Full-time equivalent employees; the numbers of FTEs were obtained from DCS (2004a) for the proposed MOX facility and the WSB, and from DOE (1999a) for the PDCF.

determine a total concentration, the impacts of other sources not associated with a facility or facilities must be added to the incremental concentrations. The impacts of these other sources are determined either by additional modeling or by selecting a measured background concentration representative of the impacts of the sources not modeled. Finally, the incremental concentrations due to a facility or facilities alone or the total concentrations due to a facility or facilities and other sources are compared against appropriate measures of impact.

In this analysis, incremental impacts of construction activities and operations were determined separately using the Industrial Source Complex Short Term (ISCST3) air quality model (EPA 1995). (Appendix F provides additional detail on the calculations of emissions and the assumptions and data used in the model.) The ISCST3 model is recommended by the EPA for modeling construction activities and operations. The meteorological data used in modeling came from Athens, or Atlanta, Georgia, and Columbia, South Carolina, nearby locations where meteorological data are recorded. The maximum modeled pollutant concentrations were selected to represent the impact of construction activities or operations.

The impacts of other sources were taken into account by adding two additional concentrations to the facility maximum: an SRS maximum concentration for other sources at the SRS (SRS maxima) and a background concentration representing the overall impact of non-SRS sources. The total concentrations were then compared with the applicable ambient standard levels given in Table 3.3. Facility maxima were compared with the incremental PSD standards to provide another measure of impact.

The background concentrations are those used by the State of South Carolina to evaluate air quality impacts. The SRS environmental staff modeled the maxima in support of its air permit process (SCDHEC 2001). These SRS maxima are based on the assumption that all permitted sources operate at their fully permitted limits; thus these values are conservative estimates of SRS impacts. In addition, for a given pollutant and averaging time, maximum values associated with the proposed action and other SRS facilities are unlikely to occur at the same locations. Adding them together for comparison with the corresponding standard level adds additional conservatism to the procedure.

A slightly different procedure was used to evaluate potential impacts of $PM_{2.5}$. Implementation of the $PM_{2.5}$ standard has been delayed, and states have not developed plans for attaining it. SRS maxima and background values were not available for $PM_{2.5}$. Background values were taken as the maximum concentrations measured at background monitors within 80 km (50 mi)[4] of the SRS and were added to the modeled facility maxima for comparison with applicable standard levels. Background concentrations also were not available for air toxics and are generally considered negligible. Therefore, for air toxics, the sum of the facility maximum concentration and the SRS maxima was taken to be the total concentration for comparison with ambient standard levels.

[4] $PM_{2.5}$ background values were the 2001 maximum annual average and the maximum 98th percentile concentrations measured at the two rural background monitors within 80 km (50 mi) of the MOX facility. Compliance with the 24-hour $PM_{2.5}$ standard is based on the 98th percentile values being below the standard level.

4.3.2.1 Construction

The earth-moving activities during the construction period for the proposed MOX facility and the WSB will not overlap the earth-moving activity period for the PDCF. The impacts presented below assume simultaneous construction of the proposed MOX facility and the WSB and were found to exceed the impacts from construction of the PDCF. The impacts presented are, therefore, considered to be bounding for construction activities.

During construction, emissions of criteria pollutants (see Section 3.4.2), total suspended particulates (TSP), and volatile organic compounds (VOCs) would include fugitive dust emissions from earthmoving activities, fugitive dust emissions from the concrete batch plant, and exhaust emissions from diesel-powered construction equipment and from worker and delivery vehicles. The emissions associated with constructing the proposed MOX facility and the WSB are listed in Table 4.5. The tabulation does not include emissions of lead, a criteria pollutant. The phaseout of lead in gasoline has led to a significant reduction in lead levels throughout the country. Appendix F summarizes the emission factors and assumptions used in estimating construction emissions.

Fugitive dust emissions would be the emissions of principal concern during construction of the facilities. Dust from construction activities and exhaust from diesel construction equipment would be emitted within the limited area of the construction site. Other vehicles used by construction workers and for deliveries would emit exhaust along various roadways around the site, and this dispersal would reduce the impacts of these emissions relative to emissions from the limited construction area. Therefore, only fugitive dust emissions from construction activities and operation of the concrete batch plant and exhaust emissions from construction equipment were analyzed for the construction phase.

The results of the impact analysis for construction of the proposed MOX facility and the WSB, including the total concentration and its individual components (i.e., the modeled facility maximum, the SRS maximum, and the background concentration) are presented in Table 4.6. As noted above, the totals are conservative in that they overestimate the likely concentrations. Comparison of the total concentrations with applicable ambient standard levels provides a measure of the impact of construction.

Annual maxima would occur 10.7 to 9.5 km (5.9 to 6.7 mi) west northwest of the proposed MOX facility site. Short-term maxima would occur 9.5 to 10.4 km (5.9 to 6.5 mi) west or west northwest of the site except for the 1-hour CO maximum, which would occur 20.6 km (12.8 mi) to the southeast.

The total TSP concentration would be close to, but still less than, the maximum value allowed by the applicable standard. Most of this TSP concentration would be due to existing sources; the TSP concentration from facility construction would be at most only 0.06% of the standard level. Expected PM_{10} ambient levels would not exceed standard levels, and the concentrations from construction of the facilities would be equivalent to, at most, 5.0 and 0.05% of the 24-hour and annual PM_{10} standard levels, respectively.

Table 4.5. MOX facility and WSB construction emissions[a,b,c]

Pollutant	Construction fugitive dust[d]		Concrete batch plant		Construction equipment exhaust	
	Annual (kg/yr)	Hourly (g/h)	Annual (kg/yr)	Hourly (g/h)	Annual (kg/yr)	Hourly (g/h)
TSP	121,000	59,200	5,670	2,730	5,580	2,680
PM_{10}	36,900	17,800	1,640	790	5,580	2,680
$PM_{2.5}$	18,500	8,880	850	409	5,580	2,680
CO	0	0	0	0	25,600	12,300
NO_2	0	0	0	0	67,600	32,500
SO_2	0	0	0	0	6,510	3,130
VOC	0	0	0	0	6,550	3,150

[a]See Appendix F for details on emission calculations.

[b]Hourly values are based on a construction schedule of 8 hours per day, 5 days per week, 52 weeks per year.

[c]The proposed MOX facility and the WSB are assumed to be constructed at the same time. The construction of the PDCF is expected to occur outside the time frame for construction of the other two facilities.

[d]Calculations assume that water is applied to control dust, resulting in a 50% reduction in emissions, and that emissions from earth-moving activities occur over a 9-month period.

Expected $PM_{2.5}$ ambient levels would not exceed standard levels. Construction of the facilities would not exceed 4.3 and 0.070% of the 24-hour annual $PM_{2.5}$ standard levels, respectively.

The CO, SO_2, and NO_2 construction emissions would be from construction equipment exhaust. Concentrations from these emissions would amount to at most 0.29% of any ambient standard level and would not contribute to concentrations in excess of a standard level.

4.3.2.2 Operations

DCS has proposed to treat exhausts from the proposed MOX facility with (at a minimum) a two-stage HEPA filter system to remove radioactive materials before the exhaust is discharged to the atmosphere.

The introduction to Section 4.3.2 provides a short discussion of the method used to assess air quality impacts. Sections 4.3.1 and 4.3.5 discusses the human health impacts of routine and accidental chemical and radiological releases to the air. In addition to the emissions discussed in this section, the facilities also would emit the radionuclides listed in Table E.5.

Table 4.6. Maximum air quality impacts during construction of the facility

		Pollutant concentration (μg/m³)					Percent of standard		Receptor location[a]	
Pollutant	Averaging time	Facility maximum[b]	SRS maximum[c,d]	Background[c]	Total[e]	Ambient standard[f]	Total concentration	Facility maximum	Distance [km (mi)]	Direction
TSP	Annual	0.045	46.6	28	74.6	75	99.5	0.061	10.7 (6.7)	WNW
PM_{10}	24 hours	7.5	97.0	41	145.5	150	97.0	5.0	10.4 (6.5)	WNW
	Annual	0.023	6.9	19	25.9	50	51.8	0.047	10.7 (6.7)	WNW
$PM_{2.5}$	24 hours	2.8	-[g]	27	29.8	65	45.8	4.3	10.4 (6.5)	WNW
	Annual	0.011	-[g]	13.6	13.6	15	90.7	0.070	10.7 (6.7)	WNW
CO	1 hour	40	262.7	10,100	10,400	40,000	26	0.10	20.6 (12.8)	SE
	8 hours	8	67.4	6,800	6,880	10,000	69	0.08	9.5 (5.9)	WNW
SO_2	3 hours	3.7	1,171.3	50	1,225	1,300	94	0.29	9.6 (6.0)	W
	24 hours	0.83	337.2	18	356	365	98	0.23	9.5 (5.9)	WNW
	Annual	0.006	27.1	4	31	80	39	0.008	9.5 (5.9)	WNW
NO_2	Annual	0.063	17.32	9	26	100	26	0.06	9.5 (5.9)	WNW

[a] Location of facility maximum from center of proposed MOX facility site.

[b] Maximum concentration due to facility construction, modeled with ISCST3 model.

[c] Based on SCDHEC (2001) and EPA (2003).

[d] The SRS maxima are based on maximum permitted emissions from SRS sources and do not necessarily quantify actual air quality impacts.

[e] Sum of facility maximum, SRS maximum, and background.

[f] South Carolina and Georgia standards are the same as NAAQS except for TSP, which is a South Carolina standard.

[g] SRS maxima and background levels are not available for $PM_{2.5}$. Values for background are the 2001 maximum annual average and maximum 98 percentile 24-hour average values measured at the two rural background monitors within 80 km (50 mi) of the MOX facility.

For purposes of this analysis, it was assumed that the proposed MOX facility, PDCF, and WSB would operate at the same time. While this may not always be the case, the combined analysis bounds the air quality impacts from normal operations.

The emissions from operation of the facilities are summarized in Table 4.7. It is expected that all these facilities would use electric boilers; there would be no emissions associated with production of hot water or steam. Air pollutants associated with the MOX process would be emitted from the stack located toward the eastern end of the proposed MOX facility. Nonradiological emissions from this stack would be limited to NO_2 from the aqueous polishing process. There would be no process emissions from the PDCF (DOE 1999a, Table G-59). Particulates from the cementation process in the WSB would be controlled to meet the condition specified in the SCDHEC permit.

Emissions from emergency and standby diesel-powered generators and storage of diesel fuel have been considered. Emergency and standby generators and associated fuel storage facilities would be located at each of the three facilities and would emit criteria pollutants, TSP, VOCs, and air toxics (see Table 4.7). The tabulated process VOCs would result from the storage of diesel fuel and would be small because of the low volatility of diesel fuel.

Air Toxics

Air toxics, also known as hazardous air pollutants, are substances judged to have adverse impacts on human health when present in the ambient air. The EPA and some states have issued lists of substances regulated as air toxics. The specific substances listed and the types of regulations applied differ among jurisdictions.

Parking lots and access roads would be paved to minimize fugitive dust emissions. Vehicle combustion emissions would be released along various roadways around the site, and this dispersal would reduce emission impacts compared with the emissions from the emergency/standby generator diesels. Only the process emissions from the facilities and diesel generators were modeled to evaluate emissions for the operations phase.

The results of the impact analysis for normal operations, including the total concentration and its individual components — the modeled facilities maxima, the SRS maximum, and the background levels — are presented in Table 4.8. As noted above, the totals are conservative in that they overestimate the likely total concentration. Impacts during normal operations were estimated by assuming that all three facilities were operating simultaneously. For short-term concentrations of 24 hours or less, emergency generators were assumed to operate 24 hours per day to simulate an extended power loss. For annual averages, the generators and process sources were modeled with emissions appropriate to their expected schedules (see Appendix F). Comparison of the total modeled concentrations with applicable ambient standard levels provides a measure of the potential impact of normal facility operations on air quality.

The total concentrations are all less than the levels stipulated in the corresponding standards, and the three facilities would contribute concentrations equivalent at most to 1.9% (for 24-hour PM_{10}) of the corresponding standard level. Given the conservative overestimation in the SRS maxima, ambient levels above the standard levels would not be expected.

Table 4.7. MOX, PDCF, and WSB operations emissions[a]

Pollutant[b]	Process: Annual (kg/yr)	Process: Hourly (g/h)	Emergency generators: Annual (kg/yr)	Emergency generators: Hourly (g/h)
TSP	6.00	463	761	4,222
PM_{10}	3.00	234	692	3,740
$PM_{2.5}$	0.90	70.2	649	3,500
SO_2			1,640	11,800
CO			3,440	25,900
NO_2	13,700	31,100	29,300	217,100
VOCs[c]	1.48	0.169	1,160	8,720
Chlorine	15.0	1.71		
Acetone	2.9	9.75		
Benzene			7.48	48.6
Toluene			2.71	17.6
Xylenes			1.86	12.1
Propylene			26.9	175
Formaldehyde			0.760	4.94
Acetaldehyde			0.243	1.58
Acrolein			0.076	0.493
Naphthalene			1.25	8.14
Total PAHs[d]			2.04	13.3

[a]See Appendix F for details on emission calculations.

[b]Except for PAHs, directly emitted criteria pollutants, their precursors, and federally listed air toxics are included. Naphthalene is both an air toxic and a component of PAH.

[c]Process emissions are from storage of diesel fuel.

[d]PAHs = polycyclic aromatic hydrocarbons.

Sources: DCS (2002a,c,d; 2004a,c); DOE (1999a).

The concentrations of toxic air pollutants and total polycyclic aromatic hydrocarbons (PAHs) associated with emissions from emergency and standby generators are all calculated to be less than 0.03% of the South Carolina standard levels.

Comparing the incremental facility concentrations with Prevention of Significant Deterioration (PSD) increments (see Table 4.9) provides another perspective on operational impacts even when a PSD analysis is not required. As the table shows, maximum concentrations for 3-hour and 24-hour averaging times would all be less than 6.0% of the PSD Class II increments

Prevention of Significant Deterioration (PSD)

The NAAQS establish maximum pollutant levels that should not be exceeded. The PSD program limits the deterioration of existing air quality in areas with air cleaner than the NAAQS. The program establishes a baseline level of air quality and specifies increments that cap the increases in pollutant levels above that baseline. The program applies to sulfur oxides, PM_{10}, and nitrogen dioxide emitted by major new or modified sources. Smaller increments apply in special areas such as national parks (Class I areas) than in other areas (Class II areas).

Table 4.8. Maximum air quality impacts during operation of the proposed facilities

		Concentration ($\mu g/m^3$)					Percent of standard		Receptor location[a]	
Pollutant	Averaging time	Facility maximum[b]	SRS maximum[c,d]	Background[c]	Total[e]	Ambient standard[f]	Total concentration	Facility increment	Distance (km [mi])	Direction
TSP	Annual	0.0017	46.6	28	74.6	75	99.5	0.002	16.5 (10.2)	NE
PM_{10}	24 hours	1.31	97.0	41	139	150	93.0	0.87	9.6 (6.0)	W
	Annual	0.0015	6.9	19	25.9	50	52	0.003	16.5 (10.2)	NE
$PM_{2.5}$	24 hours	1.21	–[g]	27	28.2	65	43.4	1.9	9.5 (5.9)	WNW
	Annual	0.0014	–[g]	13.6	13.6	15	90.7	0.009	16.5 (10.2)	NE
NO_2	Annual	0.074	17.3	9	26.4	100	26	0.060	16.5 (10.3)	NE
SO_2	3 hours	22	1,171.3	50	1,243	1,300	96	1.7	9.6 (6.0)	W
	24 hours	4.9	337.2	18	360	365	99	1.3	9.5 (5.9)	WNW
	Annual	0.0035	27.1	4	31.1	80	39	0.004	16.8 (10.4)	NE
CO	1 hour	116	262.7	10,100	10,478	40,000	26	0.29	9.7 (6.0)	NW
	8 hours	26	67.4	6,800	6,890	10,000	69	0.26	9.7 (6.0)	NW
Benzene	24 hours	0.019	4.6	NA[h]	4.6	150	3.1	0.01	9.5 (5.9)	WNW
Toluene	24 hours	0.007	14.6	NA	14.6	2,000	0.7	0.0004	9.5 (5.9)	WNW
Xylene	24 hours	0.005	69	NA	69.0	4,350	1.6	0.0001	9.5 (5.9)	WNW
Propylene	24 hours	0.067	NA	NA	NA	NA	NA	NA	9.5 (5.9)	WNW
Formaldehyde	24 hours	0.002	0.15	NA	0.152	7.5	2.0	0.03	9.5 (5.9)	WNW
Acetaldehyde	24 hours	0.0006	<0.01	NA	0.011	1,800	<0.001	<0.0001	9.5 (5.9)	WNW
Acrolein	24 hours	0.0002	<0.01	NA	0.010	1.25	0.82	0.02	9.5 (5.9)	WNW
Naphthalene	24 hours	0.003	<0.01	NA	0.013	1,250	0.001	0.0002	9.5 (5.9)	WNW
Chlorine	24 hours	0.0003	0.04	NA	0.04	75	0.054	0.0004	10.8 (6.7)	N
Acetone	24 hours	0.002	NA	NA	NA	NA	NA	NA	9.8 (6.1)	W
Total PAHs	24 hours	0.005	<0.01	NA	0.015	160	<0.010	0.003	9.5 (5.9)	WNW

[a]Location of facility maximum from center of the proposed MOX facility site.

[b]Maximum concentration due to normal facility operations, modeled using ISCST3 model (EPA 1995).

[c]SCDHEC (2001) and EPA (2003) for criteria pollutants; Hunter (2001) for air toxics.

[d]The SRS maxima are based on maximum permitted emissions from SRS sources and do not necessarily quantify actual air quality impacts.

[e]Sum of facility maximum, SRS maximum, and background.

[f]South Carolina and Georgia standards are same as NAAQS for PM_{10}, $PM_{2.5}$, NO_2, SO_2, and CO. The TSP standard and the air toxic standards are South Carolina standards.

[g]SRS maxima and background levels are not available for $PM_{2.5}$ and acetone. Values for $PM_{2.5}$ background are the 2001 maximum annual average and maximum 98 percentile 24-hour average values measured at the two rural background sites within 80 km (50 mi) of the MOX facility.

[h]NA = not available.

Table 4.9. Comparison of maximum concentration increments and PSD increments[a]

Pollutant	Averaging time	Maximum increment ($\mu g/m^3$)	PSD increment ($\mu g/m^3$) Class I	PSD increment ($\mu g/m^3$) Class II	Percent PSD II increment
SO_2	3 hours	22	25	512	4.30
	24 hours	4.9	5	91	5.38
	Annual	0.0035	2	20	0.02
NO_2	Annual	0.074	2.5	25	0.30
PM_{10}	24 hours	1.31	8	30	5.33
	Annual	0.0014	4	17	<0.01

[a]Class I increments apply only in Class I areas. An appropriate comparison is made in the text.

for SO_2, NO_2 , and PM_{10}. These pollutants are emitted by the emergency generators, not the processes, and the concentration estimates assume all generators at all three facilities operate continuously. For annual averages, the maximum concentrations would all be less than 0.02% of the PSD Class II increments.

Class I PSD increments were compared with the concentrations expected to be experienced at the closest receptor location to the Cape Romain National Wildlife Refuge, the nearest PSD Class I area. This receptor location is 51 km (32 mi) from the site, near the maximum distance at which the ISCST3 model can reliably estimate concentrations. All concentration increments were less than 1% of the Class I increments. Concentration increments attributable to the three facilities would be even lower at Cape Romain, located about 160 km (100 mi) from the site.

Concentrations of lead and ozone were not modeled. Facility operations would not emit lead. Ozone is formed by photochemical reactions of precursors (including NO_2 and VOCs) in the atmosphere. Contributions of individual sources to ozone formation cannot be quantified accurately. As shown in Tables 3.1 and 4.7, ozone precursor emissions from facility operations would be a small percentage of the four-county totals, about 0.3% and 0.02% for NO_2 and VOCs, respectively. The impact of facility operations on ozone concentrations in the area would be negligible.

Under the Clean Air Act (CAA), federal actions in nonattainment and maintenance areas must demonstrate that they conform to the applicable state implementation plan (SIP). The SRS is located in an attainment area for all NAAQS and is not covered by a maintenance plan. Thus, the requirement to demonstrate conformity with the SIP would not apply to the proposed MOX facility, PDCF, and WSB. At some time in the future, EPA will issue conformity regulations for the new NAAQS for ozone and $PM_{2.5}$. Those regulations could impose requirements to demonstrate conformity with the SIP on the proposed MOX facility, PDCF, or WSB.

4.3.3 Hydrology

4.3.3.1 Surface Water

4.3.3.1.1 Construction

The estimated annual average water use for constructing the proposed MOX facility is 125 million L (33 million gal) (DCS 2002a). An additional 12 million L/yr (3.2 million gal/yr) of water would be needed for constructing the PDCF (DOE 1999a), and 2 million L/yr (0.5 million gal/yr) of water would be needed for constructing the WSB. Because surface water would not be used for supplying this water, there would be no impacts to surface water levels or flows. No direct releases of contaminated effluent are planned for construction operations. Sanitary waste would be collected with a combination of portable toilets and semipermanent facilities connected to the SRS Central Sanitary Waste Treatment Facility. All wastewater would be treated in the sitewide treatment system, which has sufficient hydraulic and organic capacity to treat the flows expected from construction activities (DCS 2002a).

During construction, surface water quality could, however, be impacted by contaminated runoff from sources such as accidental oil or diesel fuel spills and sediment from disturbed areas and from construction materials stockpiled in areas that are exposed to precipitation. Two areas of concern identified in the Scoping Comments (see Appendix I) are Upper Three Runs Creek, which would receive runoff water from the affected area via nearby unnamed tributaries, and the Savannah River, which receives water from Upper Three Runs Creek. To comply with South Carolina standards for storm-water management and sediment reduction, detention ponds would be built at strategic locations as part of the SRS construction program. These detention ponds would be designed to control the release of storm-water runoff at a rate equal to or slightly less than that of the predevelopment stage. Good engineering practices, as required by the SCDHEC (see Chapter 6), such as the use of siltation fences or straw bales to control sediment and runoff, would be followed during construction, and a sediment control plan would be developed for areas exceeding 2 ha (5 acres) that are disturbed by construction (DCS 2002a). Therefore, impacts to surface water quality from construction activities are expected to be small. Similarly, impacts from accidental releases of contaminants such as gasoline, oil, diesel fuel, or paint during construction are expected to produce small impacts on surface water quality because cleanup activities would be prompt and thorough, as required in the facility's Spill Prevention Control and Countermeasures Plan. This plan would be developed by DCS to meet EPA regulations (40 CFR Part 112).

4.3.3.1.2 Operations

Normal operations of the proposed MOX facility would utilize 9.1 million L (2.4 million gal) of water per year (DCS 2002a). An additional 48 million L/yr (12.7 million gal/yr) of water would be needed for operating the PDCF, and 19 million L/yr (5 million gal/yr) of water would be needed for operating the WSB, but none of this water would be from surface water resources.

Therefore, there would be no impacts to surface water levels or flows. The nonhazardous wastewater produced by the proposed facilities would be discharged to an existing National Pollutant Discharge Elimination System (NPDES) outfall (H16) in the F-Area under an existing South Carolina Discharge permit, SC0000175. This water flows into Upper Three Runs Creek and ultimately the Savannah River. Because the concentrations of nonhazardous wastes in the discharge would be under the guidelines of the NPDES permit, impacts to water quality in Upper Three Runs Creek and the Savannah River would be small. The uncontaminated heating, ventilation, and air conditioning (HVAC) condensate would be discharged to the stormwater system in accordance with SCDHEC standard stormwater permit conditions. Sanitary wastewater would be sent to the WSRC Central Sanitary Waste Treatment Facility.

Storm-water runoff from the proposed MOX facility, the PDCF, and the WSB would be controlled under existing NPDES storm-water permits. These permits would limit potential contaminants to safe concentrations, and compliance with the permit conditions would ensure that any surface water impacts were small.

4.3.3.2 Groundwater

4.3.3.2.1 Construction

During construction, the groundwater system beneath the SRS would be directly affected by additional pumping from existing wells because groundwater would be the only source of water used for construction activities. Groundwater for constructing the MOX facilities would be obtained from the A-Area loop, which obtains groundwater from wells in the F- and A-Areas. The capacity of the A-Area loop wells in 2000 was about 11,360 L/min (3,000 gal/min) (DCS 2003a). Water use from the loop, including F-Area use, averaged about 2,850 L/min (754 gal/min) in 2000. Construction of the MOX facility, PDCF, and WSB would require about 264 L/min (70 gal/min). This additional groundwater demand would represent an increase of about 10% for the A-Area loop and about 3% of the excess loop capacity. This withdrawal would have a small impact on the groundwater system at SRS.

In addition to impacts from groundwater use, impacts during construction (e.g., grading and excavating) could also occur because groundwater beneath the proposed MOX facility site is contaminated (Section 3.3.2). Impacts from this contamination would not be measurable because the deepest construction activities would occur at least 9.1 m (30 ft) above the zone of groundwater contamination (DCS 2002a). Because direct releases of contaminated effluent to groundwater during construction are not planned, there would be no direct impacts to groundwater quality. Groundwater quality, however, could still be indirectly affected by accidental releases of contaminated effluents and infiltration of contaminated runoff. However, these impacts are expected to be small because appropriate good engineering practices would be implemented during construction, detention basins would be used to control runoff, and any spills would be promptly and thoroughly cleaned up as required under the facility Stormwater Pollution Prevention Plan.

4.3.3.2.2 Operations

During normal operations, groundwater would be the only source of water used for the facilities, and the groundwater system beneath the SRS would be directly impacted by additional pumping that would deplete the resource. Operation of the proposed MOX facility would require 9.1 million L/yr (2.4 million gal/yr), the PDCF would require 48 million L/yr (12.7 million gal/yr), and the WSB would require 19 million L/yr (5 million gal/yr) (DCS 2002a). This water would be obtained from the A-Area loop groundwater wells. Impacts on the SRS groundwater system would be small because the total water use, approximately 145 L/min (38 gal/min), would represent an increase of about 5% of the water demand for the A-Area loop in 2000 and about 2% of the excess A-Area loop capacity.

Groundwater quality would not be affected because there would be no discharges (either shallow or deep) to underlying aquifers. During the scoping process, several commenters expressed concerns about potential contamination of groundwater resources by plutonium. Because no direct releases of contaminated effluent to the groundwater are planned during normal operations of the proposed facilities and because the facilities would not use settling or holding basins as part of the wastewater treatment system, there would be no direct impacts to groundwater quality (DCS 2002a).

Indirect impacts to groundwater could also occur during normal operations. These impacts would result from discharges to the NPDES outfall and surface spills. The impacts of such spills are expected to be small because appropriate good engineering practices would be implemented during the operational period, discharges would comply with NPDES guidelines, and any spills would be promptly and thoroughly cleaned up as required under the facility Spill Prevention Control and Countermeasures Plan.

4.3.4 Waste Management

This section presents the waste management impacts associated with the construction and operation of the proposed MOX facility, the PDCF, and the WSB. Waste management impacts relate to the types and quantities of radioactive, hazardous, and nonhazardous wastes generated and how these wastes are handled. Wastes generated by the three facilities would be managed similarly to wastes generated by other SRS facilities. The NRC conducted an evaluation to determine if existing and proposed facilities and capacities at SRS and within the DOE complex (e.g., the Waste Isolation Pilot Plant [WIPP]) would be adequate for handling and disposing of the generated waste. Because the types of wastes generated by the proposed MOX facility, the PDCF, and the WSB would be similar to the types of wastes already generated by existing SRS facilities and the volumes would be relatively small compared to the overall existing or projected volumes, the human health impacts discussed in Section 3.10 for current activities at SRS are expected to bound the human health impacts, if any, resulting from the waste generated by the proposed action. Also, the human health impacts discussed in Section 3.10 are not anticipated to change significantly as a result of the waste generated from the proposed action.

The WSB would process waste from both the proposed MOX facility and the PDCF. The waste volumes presented in the tables in this section are based on where the particular waste type is generated (e.g., solid TRU waste generated at the WSB as a result of processing the liquid high-alpha-activity waste transferred from the proposed MOX facility is presented as TRU waste volume for the WSB). The waste types that would be generated include TRU waste, liquid and solid LLW, hazardous/mixed waste, and liquid and solid nonhazardous waste.

4.3.4.1 Construction

The construction of the proposed MOX facility and the WSB is expected to take 5 years; the construction of the PDCF is expected to take 3 years. Waste generated from construction activities would be similar to that from construction of any industrial building and would include liquid and solid waste (nonhazardous) and hazardous wastes. Such solid wastes would be managed consistently with SRS waste management practices (see Section 3.9). No high-level (radioactive) (HLW) waste, TRU waste, low-level (radioactive) (LLW) waste, or mixed LLW would be expected to be generated during construction. No hazardous or radiologically contaminated soil is expected to be generated (DCS 2002a).

Hazardous wastes that would be generated would be similar to those expected during the construction of any industrial facility. Examples of these wastes include liquids (such as motor oil), batteries, and other machinery-related products, cleaning products, and other chemicals (such as insecticides and pesticides). These wastes would be managed in accordance with the hazardous waste management practices in place at the SRS. The current practice includes accumulating the waste at the generating facility (which in this case would be in the F-Area) for a maximum of 90 days as necessary, and packaging such wastes in U.S. Department of Transportation (DOT)-approved containers to ship off-site to permitted commercial recycling, treatment, or disposal facilities.

As shown in Table 4.10, the following waste types and estimated volumes would be generated during construction of the three facilities:

- For the proposed MOX facility: 77 m^3/yr (100 yd^3/yr) of hazardous wastes; 36 million L/yr (9.5 million gal/yr) of nonhazardous liquid waste and 8,410 m^3/yr (11,000 yd^3/yr) of nonhazardous solid waste;

- For the PDCF: 50 m^3/yr (65 yd^3/yr) of hazardous waste, 5.3 million L/yr (1.4 million gal/yr) of nonhazardous liquid waste and 120 m^3/yr (157 yd^3/yr) of nonhazardous solid waste; and

- For the WSB: 35 m^3/yr (46 yd^3/yr) of hazardous waste, 21 million L/yr (6.3 million gal/yr) of nonhazardous liquid waste and 2,200 m^3/yr (2,880 yd^3/yr) of nonhazardous solid waste.

Table 4.10. Annual waste volumes from the construction of the facilities compared with waste management capacities at the SRS

				SRS capacity[a]		
Waste type	Estimated MOX facility construction waste[b]	Estimated PDCF construction waste[c]	Estimated WSB construction waste[b]	Characterization or treatment (annual capacity)	Storage (total capacity in m^3)	Disposal (total capacity in m^3 unless specified)
TRU (m^3/yr)	–[d]	–[d]	–[d]	1,720	34,400	168,500[e]
LLW						
Liquid (L/yr)	–[d]	–[d]	–[d]	17,830,000	NA[f]	594,000,000 L
Solid (m^3/yr)	–[d]	–[d]	–[d]	17,830	NA	30,500
Hazardous[g] (m^3/yr)	77	50	35	17,830	5,170	NA
Nonhazardous						
Liquid[h] (L/yr)	36,000,000	5,300,000	21,000,000	1,033,000,000	NA	NA
Solid (m^3/yr)	8,410	120	2,200	NA	NA	24,900,000[i]

[a]Storage and disposal capacity estimates presented represent total capacity at the SRS. Sources of estimates: DOE (1999a).

[b]The construction period for the proposed MOX facility is assumed to be 5 years; the construction period of the PDCF is assumed to be 3 years. The construction period of the WSB is assumed to be 5 years. Source of estimates: DCS (2003a).

[c]Source of estimates: DOE (1999a).

[d]No radioactive waste would be generated by facility construction.

[e]Value represents limit for TRU waste at the WIPP.

[f]NA = not applicable.

Footnotes continued on next page.

Table 4.10. Continued

[g]Hazardous waste that would be generated is less than 4% of the treatment and about 3% of the storage capacity at the SRS. For estimating impact on the storage capacity, the annual generation rates for the three facilities were summed and the total divided by the storage capacity at the SRS. Hazardous wastes are generally not stored on-site for more than 90 days, consistent with permit requirements. Hazardous wastes are sent off-site for disposal.

[h]Nonhazardous liquid waste generated during construction of the facilities is equivalent to about 6% of the treatment capacity at SRS.

[i]The disposal capacity presented for nonhazardous solid waste is for a privatized landfill (Three Rivers Landfill) that is located on site. The combined volume of nonhazardous solid waste that would be generated from the construction of the three facilities constitutes less than 1% of the disposal capacity at the landfill.

The impact of the facilities construction waste on SRS waste management capacities would be small. The hazardous waste that would be generated would be shipped off-site to permitted facilities. The impacts at these permitted facilities from the proposed MOX facility, PDCF, and WSB wastes are expected to be within the bounds of the evaluations performed for the waste facilities. The nonhazardous liquid waste generated by the facilities would constitute a small percentage of the SRS's capacity for treatment (about 6%). Nonhazardous solid wastes are packaged in conformance with standard industrial practice and shipped to commercial or municipal facilities for recycling or disposal. Estimates for waste volumes that would be generated during construction of the facilities are presented in Table 4.10.

4.3.4.2 Operations

This section describes the waste management impacts of operating the proposed MOX facility, the PDCF, and the WSB. A discussion of radioactive effluents and wastes for each facility is provided in Sections 2.2.2.3, 2.2.3.3, and 2.2.4.3. The WSB would process some waste streams from the proposed MOX facility and PDCF. Other wastes would be managed by existing SRS waste management facilities. This section is divided into two parts. The first part describes where the waste is generated at each facility. A more detailed description of the processes that generate waste is provided in Chapter 2. The second part describes how those wastes would be handled and describes the potential waste management impacts. Consistent with waste management practices at the SRS, all wastes generated from operations of the facilities would be transferred to the WSB or to the appropriate facilities or areas elsewhere within the SRS or outside of the SRS for subsequent treatment, storage, shipment off site, or disposal. The period of operation for the proposed MOX facility is expected to be about 10 years.

Wastes that would be generated and the impacts from such wastes were identified as concerns during scoping. The waste types that would be generated from the three facilities include the following: solid TRU waste, liquid and solid LLW, hazardous/mixed waste, and nonhazardous liquid and solid waste. The estimated waste generation rates from the operation of each of the facilities are discussed in Sections 4.3.4.2.1 and 4.3.4.2.2 and are summarized in Table 4.11. Overall, the operation of the facilities would have a small impact on the SRS waste management system. The DOE has concluded (DOE 2003) that impacts are bounded by its SPD EIS (DOE 1999a).

4.3.4.2.1 Operating Facility Description

MOX Facility. The proposed fabrication of MOX fuel consists primarily of two steps: the aqueous polishing process and the fuel fabrication process. These two processes generate several types of waste that are discussed below. The aqueous polishing step removes impurities from the plutonium. The fuel fabrication process involves the blending of the purified plutonium with the depleted uranium dioxide to form pellets. The pellets would be incorporated

Table 4.11. Waste volumes from the 10-year operational period of the facilities compared with waste management capacities at the SRS

Waste type	Estimated MOX facility operational waste[b]	Estimated PDCF operational waste[b]	Estimated WSB operational waste[b]	SRS capacity[a]: Characterization or treatment (annual capacity)	SRS capacity[a]: Storage (total capacity)	SRS capacity[a]: Disposal (total capacity)
TRU (m^3)[c]	2,340	180	1,911	1,720	34,400	168,500[d]
LLW[e]						
Liquid (L)	10,800,000	416,000	11,570,000	17,830,000	NA[f]	594,000,000
Solid (m^3)	1,760	184	4,108	17,830	NA	30,500
Hazardous[g] (m^3)	110	10	0	17,830	5,170	NA
Nonhazardous[h]						
Liquid (L)	333,000,000	250,000,000	19,000,000	1,033,000,000	NA	NA
Solid (m^3)	13,400	18,000	10,000	NA	NA	NA

[a]Storage and disposal capacity estimates presented represent total capacity at the SRS. Sources of estimates: DOE (1999a).

[b]The facilities are assumed to be in operation for a 10-year period. Sources for estimates: MOX facility (DCS 2004a); PDCF (DOE 1999a and DCS 2004a); WSB (DCS 2004a and DOE 1999a). The volumes presented for WSB TRU and solid LLW represent that generated from processing the high-alpha liquid and stripped uranium waste streams from the MOX facility. Liquid LLW volume was obtained from DCS 2004a (presented on page 5-23 of DCS 2004a as 890 m^3 annually and multiplied by 13 years of approximate operation for the WSB). Hazardous and nonhazardous waste volumes obtained by subtracting PDCF volumes presented in this table from values presented in DCS 2004a Table 5-15c.

[c]The combined values of TRU waste that would be generated from the three facilities is estimated to be approximately 26% and 13% of the treatment and storage capacity, respectively, at the SRS. The generated TRU waste is approximately 2.6% of the disposal capacity at WIPP.

[d]Value represents limit for TRU waste at the WIPP.

Footnotes continued on next page.

Table 4.11. Continued

[e]The volume reported for PDCF (in DOE 1999a) is 60 m^3/yr (or 600 m^3/10 yrs), but the liquid versus solid amounts were not specified. The volume of 41,600 L/yr or 416,000 L (416 m^3) over 10 years, as reported in DCS 2004a, was subtracted from the volume reported in DOE 1999a to obtain the volume for solid LLW (i.e., 600 m^3 – 416 m^3 = 184 m^3). The liquid LLW generated by the three facilities constitutes 4% of the discharge capacity at SRS. The solid LLW generated constitutes about 21% of the disposal capacity at SRS (if disposed of entirely at the SRS). Disposal of solid LLW will either be at the SRS or at another approved facility.

[f]NA = Not applicable.

[g]Hazardous waste that would be generated is less than 1% of the treatment and less than 2% of the storage capacity at the SRS.

[h]The nonhazardous liquid waste generated constitutes about 6% of the treatment capacity at SRS.

into the fuel rods, which would then be placed in fuel assemblies. Figure 4.1 depicts the waste streams and volumes generated and the final disposition for each.

The aqueous polishing process would generate approximately 33,300 L/yr (8,800 gal/yr) of liquid high-alpha waste, 174,000 L/yr (46,000 gal/yr) of stripped uranium waste, 1,078,000 L/yr (285,000 gal/yr) of chloride removal waste, and 10,600 L/yr (2,800 gal/yr) of excess solvent waste. The liquid high-alpha waste consists of three waste streams (liquid americium waste stream, excess acid waste stream, alkaline wash waste stream). The liquid high-alpha waste and the stripped uranium waste stream would be sent to the WSB via separate pipelines for further treatment. Because the liquid high alpha waste and stripped uranium waste would be processed at the WSB, the final waste volumes following processing are included in the discussion of the WSB. The chloride removal waste would be collected in tanks and transferred to the WSB. The excess solvent waste would be sent to SRS facilities or to a commercial facility for treatment and disposal as a contaminated solvent waste.

The fuel fabrication process and maintenance activities would generate approximately 1,340 m^3/yr (1,750 yd^3/yr) of solid nonhazardous waste, 176 m^3/yr (230 yd^3/yr) of solid LLW, and 234 m^3/yr (306 yd^3/yr) of solid TRU waste. The solid non-hazardous waste consists of sanitary waste (e.g., garbage, machine shop waste, and other industrial waste) and non-sanitary waste (e.g, paper, metal cans, plastic and glass bottles).

The MOX facility would also generate approximately 33.3 million L/yr (8.8 million gal/yr) of nonhazardous liquid waste. This waste includes uncontaminated HVAC condensate, rinse water, and sanitary waste from sinks, showers, urinals, and water closets from the inactive area. The uncontaminated HVAC condensate (94,600 L/yr [25,000 gal/yr]) would be discharged to the stormwater system. The remaining nonhazardous liquid waste would be sent to SRS for processing at the CSWTF.

PDCF. The PDCF would be used to recover the plutonium metal from the pits of disassembled weapons and would convert the weapons-grade plutonium to plutonium dioxide powder. The PDCF would accommodate the following surplus plutonium-processing activities: pit receipt, storage, and preparation; pit disassembly; plutonium conversion; oxide blending and sampling; nondestructive assay; product canning; product storage; product inspection and sampling for international inspection; product shipping; declassification of parts not made from special nuclear material (SNM); highly enriched uranium (HEU) decontamination, packaging, storage, and shipping; tritium capture, packaging, and storage; and waste packaging, sampling and certification.

Aside from the 41,600 L/yr (11,000 gal/yr) of laboratory radioactive liquid waste that would be transferred to the WSB for further processing, the operations at the PDCF would also generate about 18 m^3/yr (24 yd^3/yr) of solid TRU waste. TRU waste generated during operations would include spent filters, contaminated beryllium pieces and cuttings, used containers and equipment, paper and cloth wipes, analytical and quality control samples, and solidified inorganic solutions. Liquid TRU wastes would be evaporated or solidified before being packaged for storage. About 60 m^3/yr (78 yd^3/yr) of LLW (assumed to be all solid) would also be generated. LLW generated during operations would originate from activities in the

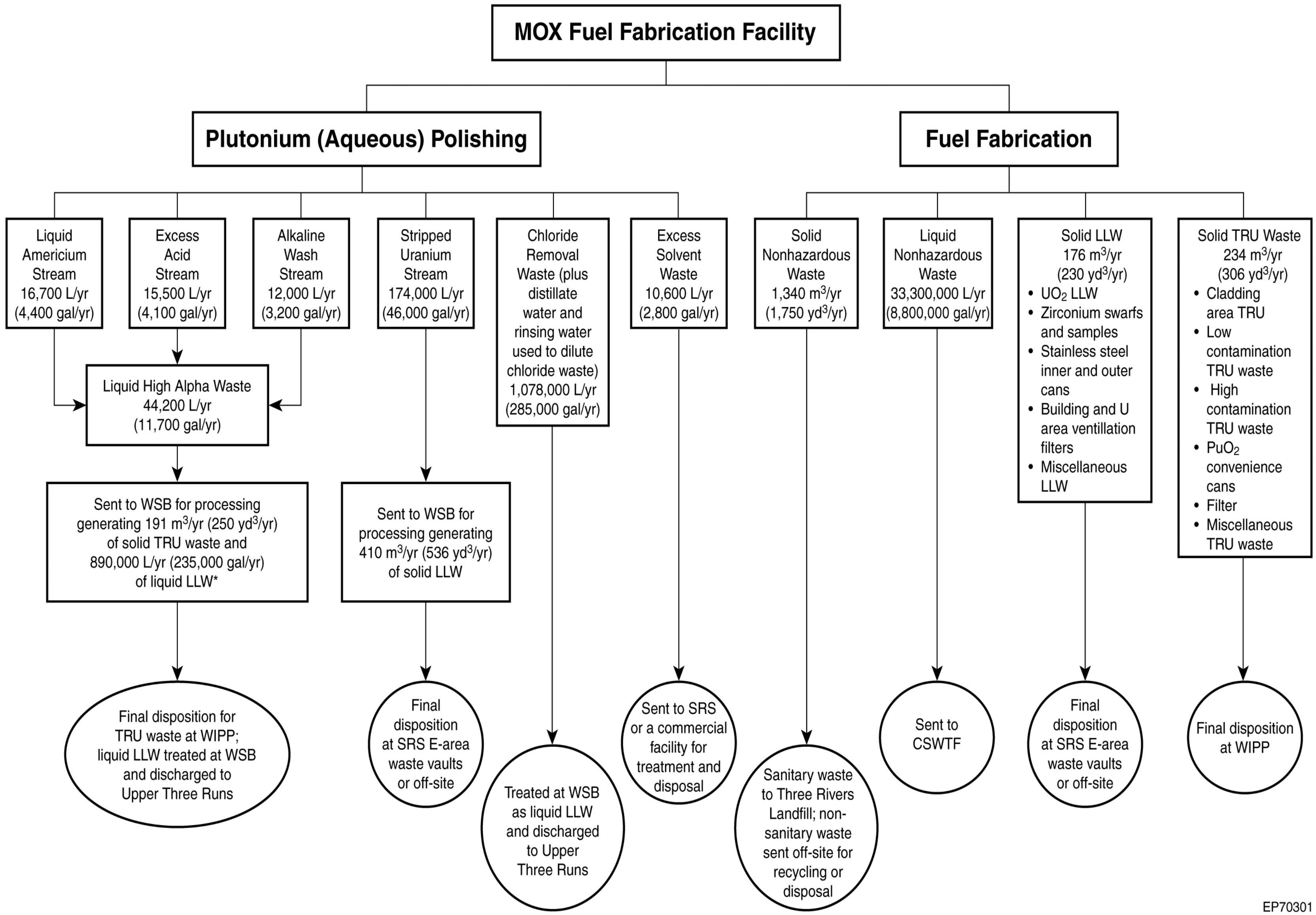

Figure 4.1. Waste streams generated by the proposed MOX facility (*Source*: Modified from DCS 2003a; 2004a).

processing areas. LLW would include equipment, wipes, protective clothing, solidified inorganic solutions, and tritium. Liquid LLW would be evaporated or solidified before being packaged for accumulation. About 1 m^3/yr (1.3 yd^3/yr) of hazardous/mixed waste generated during operations would include spent cleaning solutions, vacuum pump oils, film processing fluids, hydraulic fluids, antifreeze solutions, paints, chemicals, lead packaging, and contaminated rags or wipes. Hazardous waste would be packaged for treatment and disposal at off-site permitted commercial facilities.

Two types of nonhazardous waste would be generated; 25 million L/yr (6.6 million gal/yr) liquid waste and 1,800 m^3/yr (2,350 yd^3/yr) of solid waste. Nonhazardous solid waste would include office garbage, machine shop waste, and other industrial wastes from utility and maintenance operations. Recyclable solid waste would be sent off the site for recycling. Nonhazardous liquid waste would include sanitary waste from sinks, showers, urinals, and water closets and process wastewater from lab sinks and drains, mop water, and cooling tower blowdown.

Waste Solidification Building. The WSB would process three waste streams from the proposed MOX facility (i.e., liquid high-alpha waste, stripped uranium waste, and liquid LLW) and two waste streams from the PDCF (i.e., PDCF laboratory liquid stream and liquid LLW). The WSB would be expected to generate about 191 m^3/yr (250 yd^3/yr) of solid TRU waste from the processing of the liquid high-alpha-activity waste resulting from the aqueous polishing step conducted at the proposed MOX facility. About 890,000 L/yr (235,000 gal/yr) of liquid LLW would also be generated from the processing of the liquid high-alpha-activity waste and the stripped uranium waste from the aqueous polishing step, and the laboratory liquid waste from the PDCF. The waste streams would be batch-transferred as a separate waste to the WSB through separate double-walled stainless steel pipelines. The wastes would be collected in the waste receipt area of the WSB. This area would be equipped with separate collection tanks for each waste type, with capacities to hold waste volumes generated for a period of 6-8 weeks at a time.

Following receipt at the WSB, the high-alpha-activity waste would be reduced in volume by evaporation, and the still bottoms would be neutralized with sodium hydroxide. The distillate would be subjected to further treatment at the WSB and discharged to a permitted outfall. The neutralized bottoms would be blended with cement to produce a solid TRU waste matrix suitable for disposal at WIPP. The high-activity waste overheads (materials that evaporate and are collected) would be transferred to the low-activity waste head tank for a second evaporator process.

The stripped uranium waste and the PDCF laboratory liquids would also be evaporated at the WSB to reduce the volume. As noted above, the high-activity waste overheads would be further evaporated in the low-activity waste evaporator. The process is similar to what would be used for the liquid high-alpha waste. About 410 m^3/yr (536 yd^3/yr) of solid LLW is expected to be generated at the WSB from processing the stripped uranium waste transferred from the proposed MOX facility (DCS 2004c).

4.3.4.2.2 Waste Management Impacts from Operation

This section describes how the TRU, liquid and solid LLW, mixed LLW, hazardous, and nonhazardous wastes would be managed. It also describes the potential waste management impacts for a 10-year period. As discussed above, approximately, 4,431 m^3 (5,796 yd^3) of TRU waste would be generated each 10-year period during the operation of the three facilities. The DOE has a national program for the management and disposal of defense-related TRU waste. Subsequently, waste acceptance criteria (WAC) for receipt of TRU waste at WIPP have been established for contact-handled TRU (CH-TRU) waste. The TRU wastes generated from the proposed MOX facility, the PDCF, and the WSB are expected to be in this category. The WAC that must be met for CH-TRU waste to be transported to, managed at, and disposed of at WIPP address container properties, radiological properties, physical properties, chemical properties, and data package contents. The generator facilities are required to transmit characterization, certification, and shipping data to WIPP before shipping waste.

The liquid LLW generated (22,786,000 L [6.0 million gal]/10 yr) from the three facilities would be transferred to the WSB for treatment and then discharged to the Upper Three Runs Creek consistent with permit discharge limitations. The liquid LLW from the three facilities would be about 4% of the discharge capacities at SRS. Solid LLW generated (6,052 m^3 [7,916 yd^3]/10 yr) would be packaged, certified, and accumulated at the F-Area before transfer to the appropriate facilities for treatment and disposal (at the SRS E-Area waste vaults or at an approved off-site facility). The solid LLW from the three facilities would constitute about 21% of the disposal capacity at SRS (if disposed of entirely at SRS).

Hazardous wastes (120 m^3 [157 yd^3]/10 yr) generated from the three facilities would either be transferred to the SRS for treatment and storage at either on-site or off-site facilities and disposal at off-site, permitted facilities or shipped off site for treatment and disposition at permitted facilities. If the treatment and disposal are assumed to be on-site, the expected wastes volumes from the facilities would represent less than 2% of the capacities at the SRS. Therefore, the facilities' waste should not affect the SRS hazardous waste management system.

Nonhazardous solid waste (41,400 m^3 [54,149 yd^3]/10 yr) generated from the three facilities would be packaged and transported in accordance with standard industrial practices. Recyclable waste would be sent off-site, with the remaining waste (primarily solid sanitary waste) sent to the Three Rivers Landfill for disposal. The nonsanitary waste would be sent off-site for recycling or disposal.

Nonhazardous liquid wastes (602,000,000 L [159 million gal]/10 yr) from the three facilities would be treated before being discharged to the F-Area sanitary sewer system, which connects to the SRS Central Sanitary Wastewater Treatment Facility. The wastes of this type expected to be generated by operations of the facilities are estimated to be about 4% of the capacity of the Central Sanitary Wastewater Treatment Facility. These additional wastes would constitute a small contribution and should not affect the nonhazardous liquid waste management system at the SRS.

Although the current plans call for treating all liquid LLW generated at the proposed MOX facility, the PDCF, and the WSB at the WSB and discharging the treated effluents to a permitted outfall on the SRS site following the NPDES permit guidelines, it is possible that at some future date liquid LLW streams generated at these facilities may be sent to the Effluent Treatment Facility (ETF) on the SRS. If that should happen, the waste management impacts discussed in this EIS would still be comparable to or would bound the impacts that would occur during the management of wastes resulting from the operation of the three facilities, namely the proposed MOX facility, the PDCF, and the WSB.

4.3.5 Accident Impacts

This section discusses hypothetical accidents that could occur at the proposed facilities (the MOX facility, the PDCF, and the WSB), and the estimated maximum impacts that such accidents could produce. Table 4.12 lists the various accidents considered, and Tables 4.13, 4.14, and 4.15 list the estimated radiological impacts on SRS employees, the collective off-site public, and the maximally exposed member of the public, respectively. The potential impacts of accidental chemical releases from the proposed facilities are discussed in Section 4.3.5.3. This section describes the potential accident impacts in more detail and includes a discussion of impacts on local groundwater quality that could result from accidental releases.

4.3.5.1 Accidents Considered

4.3.5.1.1 Proposed MOX Facility

To obtain a possession and use license, DCS is required under 10 CFR Part 70, Subpart H, to perform an integrated safety analysis (ISA) to identify the hazards of the proposed MOX facility in a systematic and comprehensive manner. As an initial part of that process, DCS has completed a safety assessment that identified the following types of events that could lead to releases to the environment — natural phenomena, loss of confinement, internal fire, explosion, load handling events, external man-made events, criticality, direct radiation exposure, and chemical releases (DCS 2002a).

With respect to natural phenomena, DCS has shown that flooding does not pose a credible threat to the proposed MOX facility. For the remainder of the credible natural phenomena events, which include extreme winds, earthquakes, tornadoes, external fires, rain, snow, ice, and lightning, the applicant has committed to design criteria and standards that would prevent accidents associated with these hazards. For this reason, the effects of accidents caused by these phenomena are not described in this EIS.

External man-made events were also considered in DCS's hazard evaluation. These events include hazards from nearby facilities or vehicles. These hazards may include industrial facilities, military facilities, chemical facilities, nearby SRS facilities, pipelines, automobiles, and aircraft. A screening evaluation by DCS determined that credible external man-made events

Table 4.12. Accidents evaluated for the proposed facilities

Facility/ accident	Description
Proposed MOX facility	
Internal fire	A fire was postulated to occur in a storage location for polished plutonium dioxide powder (the PuO_2 Final Dosing Unit). The frequency of this event is considered to be unlikely or lower because multiple failures are required for this event to occur.
Explosion	A hypothetical explosion event was postulated to occur in an aqueous polishing process cell and involved the maximum material at risk in any process cell. Simultaneous failure of the design features and administrative controls resulting in an explosion and the subsequent release of radioactive materials is highly unlikely.
Load handling	The load-handling event postulated to produce the largest radiological consequences was a drop event involving the glovebox in the Jar Storage and Handling Unit. This glovebox would contain jars of plutonium powder. The frequency associated with this event is estimated to be unlikely or lower since multiple failures would be required for this event to occur.
Criticality	A criticality hazard arises whenever fissionable materials (e.g., uranium-235 or plutonium-239) are present in sufficient quantities to attain a self-sustaining fission chain reaction under optimal conditions. Thus, a generic hypothetical criticality event was evaluated.
Chemical releases	Chemical releases were modeled by assuming that the largest container for each chemical in storage at the facility was punctured. Chemical-specific characteristics were used to determine the amount of material released.
PDCF	
Fire	The bounding fire accident was assumed to occur in a plutonium glovebox. Against procedure, a flammable cleaning liquid was assumed to be taken into the glovebox used for blending plutonium powder. The liquid is inadvertently spilled and ignited, involving all of the gloves.
Explosion	Multiple equipment failures and operator errors were postulated to result in the ignition of a hydrogen and oxygen gas mixture in an inert-atmosphere glovebox. The resulting explosive pressure was assumed to damage the glovebox windows but would be insufficient to compromise the building HEPA filtration system.
Leak/spill	A forklift or other heavy vehicle running over a package of plutonium dioxide was postulated as the most catastrophic leak or spill. A portion of the released oxide becomes airborne and is filtered by the HEPA filtration system before entering the environment.

Table 4.12. Continued

Facility/ accident	Description
Criticality	A criticality involving plutonium dioxide powder was postulated because the PDCF handles amounts in excess of that required for such an accident. However, facility design and procedures are intended to preclude such an occurrence. No specific scenario was identified other than multiple failures due to human error.
Earthquake	During an earthquake event, the PDCF was expected to maintain its structural integrity, and the major safety systems, including building confinement and HEPA filtration, were assumed to continue to function. It was conservatively assumed that loose plutonium powder in gloveboxes would be resuspended and result in some minor spills.
Tritium release	Tritium contamination of parts in a glovebox was assumed to be released during a major glovebox fire. The formation of tritiated water vapor is postulated to occur, and the resulting vapor is released through the building ventilation system.
Chemical releases	Chemical releases were modeled by assuming that the largest container for each chemical in storage at the facility was punctured. Chemical-specific characteristics were used to determine the amount of material released.
WSB	
Loss of confinement	A facility-wide spill of all material in the low-activity process area was considered due to natural phenomena or an external event. The high-activity waste in this area is in hardened structures that are designed to withstand such an event (DCS 2003b).
Fire	The bounding fire accident was postulated to be an area fire in the low-activity processing section of the WSB. As a result of structural damage to the facility, thousands of gallons of unprocessed low-activity waste, low-activity bottoms, low-activity overheads, effluent bottoms, and effluent overheads are released.
Earthquake	An earthquake event was assumed to cause a spill of all material in the low-activity process area. A fire was then assumed to occur throughout the entire facility except for within the hardened structure that contains the high-activity cells. The potential impacts are taken to be the sum of the loss of confinement and fire events evaluated for the WSB.
Chemical releases	Chemical releases were modeled by assuming that the largest container for each chemical in storage at the facility was punctured. Chemical-specific characteristics were used to determine the amount of material released.

Table 4.13. Estimated human health radiological impacts to SRS employees from hypothetical facility accidents

	SRS employee MEI			SRS employee population		
Facility/accident	**Dose [Sv (rem)]**	**Likelihood of LCF[a]**	**Major exposure pathway**	**Dose [person-Sv (person-rem)]**	**Fatalities (LCFs)[a]**	**Major exposure pathway**
Pit Disassembly and Conversion Facility						
Criticality	0.00070 (0.070)	4×10^{-5}	External	0.062 (6.2)	0.004	External
Earthquake	4.0×10^{-5} (0.0040)	2×10^{-6}	Inhalation	0.023 (2.3)	0.001	Inhalation
Explosion	0.00033 (0.033)	2×10^{-5}	Inhalation	0.19 (19)	0.01	Inhalation
Fire	1.2×10^{-6} (0.00012)	7×10^{-8}	Inhalation	0.00071 (0.071)	4×10^{-5}	Inhalation
Leak/spill	4.0×10^{-7} (4.0×10^{-5})	2×10^{-8}	Inhalation	0.00023 (0.023)	1×10^{-5}	Inhalation
Tritium release	0.026 (2.6)	0.002	Inhalation	18 (1,800)	1	Inhalation
Proposed MOX Facility						
Criticality	0.023 (2.3)	0.001	External	3.0 (300)	0.2	External
Explosion	0.0068 (0.68)	0.0004	Inhalation	3.9 (390)	0.2	Inhalation
Internal fire	0.00025 (0.025)	2×10^{-5}	Inhalation	0.15 (15)	0.009	Inhalation
Load handling	0.0010 (0.10)	6×10^{-5}	Inhalation	0.60 (60)	0.04	Inhalation
Waste Solidification Building						
Loss of confinement	0.00030 (0.030)	2×10^{-5}	Inhalation	0.16 (16)	0.01	Inhalation
Fire	0.0058 (0.58)	0.0003	Inhalation	3.2 (320)	0.2	Inhalation
Earthquake	0.0061 (0.61)	0.0004	Inhalation	3.4 (340)	0.2	Inhalation

[a]Latent cancer fatalities are calculated by multiplying dose by the FGR 13 health risk conversion factor of 0.06 fatal cancer per person-Sv (6×10^{-4} fatal cancer per person-rem) (Eckerman et al. 1999). Values are rounded to one significant figure.

Table 4.14. Estimated human health radiological impacts to the collective off-site public from hypothetical facility accidents

Facility/accident	Dose [person-Sv (person-rem)]	Fatalities (LCFs)[a]	Major exposure pathway
Short-Term Exposure			
Pit Disassembly and Conversion Facility			
Criticality	0.048 (4.8)	0.003	External
Earthquake	0.054 (5.4)	0.003	Inhalation
Explosion	0.44 (44)	0.03	Inhalation
Fire	0.0017 (0.17)	0.0001	Inhalation
Leak/spill	0.00053 (0.053)	3×10^{-5}	Inhalation
Tritium release	42 (4,200)	3	Inhalation
Proposed MOX Facility			
Criticality	1.3 (130)	0.08	Inhalation
Explosion	9.1 (910)	0.5	Inhalation
Internal fire	0.35 (35)	0.02	Inhalation
Load handling	1.4 (140)	0.08	Inhalation
Waste Solidification Building			
Loss of confinement	0.38 (38)	0.02	Inhalation
Fire	7.3 (730)	0.4	Inhalation
Earthquake	7.7 (770)	0.5	Inhalation
1-Year Exposure without Ingestion			
Pit Disassembly and Conversion Facility			
Criticality	0.052 (5.2)	0.003	External
Earthquake	0.054 (5.4)	0.003	Inhalation
Explosion	0.44 (44)	0.03	Inhalation
Fire	0.0017 (0.17)	0.0001	Inhalation
Leak/spill	0.00053 (0.053)	3×10^{-5}	Inhalation
Tritium release	42 (4,200)	3	Inhalation
Proposed MOX Facility			
Criticality	1.5 (150)	0.09	Inhalation
Explosion	9.1 (910)	0.5	Inhalation
Internal fire	0.35 (35)	0.02	Inhalation
Load handling	1.4 (140)	0.08	Inhalation
Waste Solidification Building			
Loss of confinement	0.38 (38)	0.02	Inhalation
Fire	7.3 (730)	0.4	Inhalation
Earthquake	7.7 (770)	0.5	Inhalation

Table 4.14. Continued

Facility/accident	Dose [person-Sv (person-rem)]	Fatalities (LCFs)[a]	Major exposure pathway
1-Year Exposure with Ingestion			
Pit Disassembly and Conversion Facility			
Criticality	0.13 (13)	0.008	Ingestion
Earthquake	0.16 (16)	0.01	Ingestion
Explosion	1.3 (130)	0.08	Ingestion
Fire	0.0049 (0.49)	0.0003	Ingestion
Leak/spill	0.0016 (0.16)	0.0001	Ingestion
Tritium release	1,800 (180,000)	100	Ingestion
Proposed MOX Facility			
Criticality	9.6 (960)	0.6	Ingestion
Explosion	27 (2,700)	2	Ingestion
Internal fire	1.1 (110)	0.07	Ingestion
Load handling	4.1 (410)	0.2	Ingestion
Waste Solidification Building			
Loss of confinement	0.65 (65)	0.04	Ingestion
Fire	13 (1,300)	0.8	Ingestion
Earthquake	14 (1,400)	0.8	Ingestion

[a]Latent cancer fatalities are calculated by multiplying dose by the FGR 13 health risk conversion factor of 0.06 fatal cancer per person-Sv (6×10^{-4} fatal cancer per person-rem) (Eckerman et al. 1999). Values are rounded to one significant figure.

will not significantly impact facility operations (DCS 2002a). For this reason, the effects of accidents caused by such events are not described in this FEIS.

Direct radiation hazards generally arise from radioactive material or other sources that emit penetrating gamma or neutron radiation. The radioactive material that would be used in the proposed MOX facility produces mostly alpha radiation, which is not as penetrating and is a less significant direct radiation hazard, but could cause adverse health effects when inhaled. As a result, there would be no accidents at the proposed MOX facility that would produce a direct radiation hazard to the public. In addition, other than a criticality event, there would be no accidents that would produce a direct radiation exposure hazard for an SRS employee.

The events for which accident consequences were evaluated in this FEIS are internal fire, explosion, load handling event, criticality, and chemical releases. The methods employed to analyze accident consequences were based on conservative assumptions and were intended to provide a comprehensive, bounding analysis for all potential events up to and including design basis accidents.

Table 4.15. Estimated human health radiological impacts to the maximally exposed member of the public from hypothetical facility accidents

Facility/accident	Dose Dose [mSv (mrem)]	Likelihood of LCF[a]	Major exposure pathway
Short-Term Exposure			
Pit Disassembly and Conversion Facility			
Criticality	0.0038 (0.38)	2×10^{-7}	External
Earthquake	0.0011 (0.11)	7×10^{-8}	Inhalation
Explosion	0.0094 (0.94)	6×10^{-7}	Inhalation
Fire	3.5×10^{-5} (0.0035)	2×10^{-9}	Inhalation
Leak/spill	1.2×10^{-5} (0.0012)	7×10^{-10}	Inhalation
Tritium release	0.90 (90)	5×10^{-5}	Inhalation
Proposed MOX Facility			
Criticality	0.098 (9.8)	6×10^{-6}	External
Explosion	0.2 (20)	1×10^{-5}	Inhalation
Internal fire	0.0077 (0.77)	5×10^{-7}	Inhalation
Load handling	0.030 (3.0)	2×10^{-6}	Inhalation
Waste Solidification Building			
Loss of confinement	0.0081 (0.81)	5×10^{-7}	Inhalation
Fire	0.16 (16)	1×10^{-5}	Inhalation
Earthquake	0.17 (17)	1×10^{-5}	Inhalation
1-Year Exposure without Ingestion			
Pit Disassembly and Conversion Facility			
Criticality	0.0042 (0.42)	3×10^{-7}	External
Earthquake	0.0011 (0.11)	7×10^{-8}	Inhalation
Explosion	0.0094 (0.94)	6×10^{-7}	Inhalation
Fire	3.5×10^{-5} (0.0035)	2×10^{-9}	Inhalation
Leak/spill	1.2×10^{-5} (0.0012)	7×10^{-10}	Inhalation
Tritium release	0.90 (90)	5×10^{-5}	Inhalation
Proposed MOX Facility			
Criticality	0.11 (11)	7×10^{-6}	External
Explosion	0.2 (20)	1×10^{-5}	Inhalation
Internal fire	0.0077 (0.77)	5×10^{-7}	Inhalation
Load handling	0.030 (3.0)	2×10^{-6}	Inhalation
Waste Solidification Building			
Loss of confinement	0.0081 (0.81)	5×10^{-7}	Inhalation
Fire	0.16 (16)	1×10^{-5}	Inhalation
Earthquake	0.17 (17)	1×10^{-5}	Inhalation

Table 4.15. Continued

Facility/accident	Dose Dose [mSv (mrem)]	Likelihood of LCF[a]	Major exposure pathway
1-Year Exposure with Ingestion			
Pit Disassembly and Conversion Facility			
Criticality	0.012 (1.2)	7×10^{-7}	Ingestion
Earthquake	0.0016 (0.16)	1×10^{-7}	Inhalation
Explosion	0.013 (1.3)	8×10^{-7}	Inhalation
Fire	4.9×10^{-5} (0.0049)	3×10^{-9}	Inhalation
Leak/spill	1.3×10^{-5} (0.0013)	8×10^{-10}	Inhalation
Tritium release	39 (3,900)	0.002	Ingestion
Proposed MOX Facility			
Criticality	0.6 (60)	4×10^{-5}	Ingestion
Explosion	0.23 (23)	1×10^{-5}	Inhalation
Internal fire	0.012 (1.2)	7×10^{-7}	Inhalation
Load handling	0.045 (4.5)	3×10^{-6}	Inhalation
Waste Solidification Building			
Loss of confinement	0.010 (1.0)	6×10^{-7}	Inhalation
Fire	0.20 (20)	1×10^{-5}	Inhalation
Earthquake	0.21 (21)	1×10^{-5}	Inhalation

[a]Latent cancer fatalities are calculated by multiplying dose by the FGR 13 health risk conversion factor of 0.06 fatal cancer per person-Sv (6×10^{-4} fatal cancer per person-rem) (Eckerman et al. 1999). Values are rounded to one significant figure.

Radiological release accidents were classified into likelihood categories on the basis of qualitative estimates (DCS 2001, 2002a). The likelihood categories were defined as follows:

- Not Unlikely – Event may occur during the facility’s lifetime.
- Unlikely – Event is not expected to occur during the facility’s lifetime, but may be considered credible.
- Highly Unlikely – Event originally classified as “not unlikely” or “unlikely” to which sufficient controls have been applied to further reduce its likelihood to an acceptable level.

DCS did not classify the likelihood of chemical release accidents. An assessment was conducted that assumed the largest container for each chemical in storage was punctured, although safety precautions are exercised to avoid such occurrences.

A short description of each event evaluated for the accident risk assessment is given in Table 4.12. Additional details of the assessment methodology are provided in Appendix E.

4.3.5.1.2 Pit Disassembly and Conversion Facility

A wide range of accident scenarios was considered previously for the PDCF (DOE 1999a). Potential accidents from both man-made and natural phenomena were considered. The potential accidents evaluated for this FEIS were taken from DOE (1999a) and are listed in Table 4.12.

4.3.5.1.3 Waste Solidification Building

A procedure similar to those used for the proposed MOX facility and the PDCF was used to identify potential accidents at the WSB. Those accidents considered to be credible were evaluated (DCS 2003b). A description of the accidents is presented in Table 4.12.

4.3.5.2 Radiological Human Health Risk

For exposures to depleted uranium, the health impacts would be expected to be dominated by the chemical toxicity of the compounds rather than by their radiological effects (see Section 4.3.5.3). A lethal exposure from the chemical toxicity of uranium (resulting from kidney failure), would occur with an internal radiation dose of about 0.01 Sv (1 rem) (over a lifetime), a dose that is not considered to have any significant radiation health effects.

Receptors: Radiation doses and health risk effects were calculated for SRS employees and the public. General definitions of these receptor groups are given in Section 3.10.2.

For radiological hazards, the dose consequences to facility workers and SRS employees following an accident would generally be dominated by the 50-year committed effective dose equivalent from radioactive material inhaled immediately following the event. For the purposes of analyses in this FEIS, this period of inhalation is assumed to last 8 hours. This exposure pathway would dominate the dose (except in the case of criticality accidents) because it is assumed that direct exposure to contaminated areas following an accident can be effectively limited. In addition, no food is grown on the SRS, so the consumption of contaminated food is not included in the dose for facility workers or SRS employees. Criticality accidents involve radionuclides, other than uranium or plutonium, that pose a higher direct radiation hazard than do inhalation or ingestion.

Unlike SRS employees, members of the public could reasonably be expected to be exposed to both contaminated soil and food for some time beyond the early phase of an accident if no protective action is taken. Initial food contamination occurs through the direct deposition of airborne radioactive material onto crops. A lower level of contamination occurs through crop root uptake of radioactive material from contaminated soil. Thus, the largest ingestion exposure would occur if crops were ready for harvest immediately following an accidental release. Many stakeholders want to know what could happen if no interdiction of crops occurred. Whether an individual would be exposed to contaminated soil and food would depend on the specific protective actions that the applicant and government agencies might take following an accident. The NRC recognizes that some interdiction would likely occur following a significant accident, even if contamination levels were below the protective action guides. Therefore, three separate sets of impacts to members of the public were assessed for accidents. The first set of impacts is for the early phase (short-term period) of an accident similar to the exposure pathways evaluated for the SRS employees. The second and third sets of impacts are for the intermediate/long-term period (1 year) following an accident. The second set presents the impacts without the ingestion pathway (if interdiction occurred). The third set presents the ingestion pathway included in the impacts (if interdiction did not occur) with crops assumed to be ready for harvest immediately following an accidental release (a bounding analysis). Thus, a range of impacts to the public are presented to provide perspective on the potential exposures associated with the consumption of contaminated crops for the 1-year exposure period.

Population doses were calculated for up to a distance of 80 km (50 mi) from the release point for 10 downwind distances and 16 wind directions. Radiation doses were calculated for the following receptors for accident conditions:

- *SRS employee MEI:* For the purposes of the accident consequence assessment, an employee on the SRS at the point of maximum air concentration located close to, but outside, the facility's protected area fence (at least 100 m [330 ft] or more from the accident location). Exposure pathways assessed were inhalation exposure and direct radiation from the passing cloud of airborne radioactive material (cloudshine) released by the accident. A period of 8 hours of direct radiation exposure from deposited radioactive material on the ground (groundshine) following the accident was also considered.

- *SRS employee population:* All employees on the site located more than 100 m (330 ft) from the accident location outside the facility. The same exposure pathways as evaluated for the SRS employee MEI were evaluated for the collective SRS employee population.

- *Off-site MEI:* A hypothetical individual member of the public living off-site and receiving the maximum exposure from accidental releases. For the purposes of the accident consequence assessment, this individual was assumed to be located at the SRS boundary. A short-term exposure period, involving the same exposure pathways assessed for the SRS employees, and a 1-year exposure period were evaluated. The 1-year exposure evaluation included the short-term exposures, but it also included a 1-year exposure, not 8 hours, to groundshine and a 1-year ingestion exposure to contaminated food grown locally. Contaminated crops were not assumed to be condemned; all locally grown food was assumed to have been consumed.

- *General population:* All members of the public within an 80-km (50-mi) radius of the site where the accident might occur. Short-term and 1-year impacts to the general population were assessed on the basis of the same exposure pathways as for the public, or off-site, MEI.

During an accident, facility workers might be subject to severe physical and thermal (fire) forces and could be exposed to releases of chemicals and radiation. The risk to the facility workers would be very sensitive to the specific circumstances of each accident and would depend on how rapidly the accident developed, the exact location and response of the workers, the direction and amount of the release, the physical and thermal forces causing or caused by the accident, meteorological conditions, and characteristics of the room or building if the accident occurred indoors. Quantitative facility worker accident impacts are not provided in this FEIS. For most events, the applicant has conservatively assumed that consequences to the facility worker MEI would exceed the applicable performance requirements in 10 CFR 70.61 and has identified preventive or mitigative features in the facility's design basis in order to meet the performance requirements. However, it is recognized that worker injuries and fatalities would be possible from chemical, radiological, thermal, and physical forces if an accident did occur.

Impacts: Estimated radiological impacts from the four hypothetical accident scenarios considered are presented in Tables 4.13, 4.14, and 4.15 and are discussed below. While the consequences of many of these accidents are significant, the likelihood of significant accidents will be very low (highly unlikely) through the use of safety systems discussed in DCS's Construction Authorization Request. Thus, the overall risk of significant accidents is considered to be low.

SRS employee population: SRS employees were assumed to be unshielded from the passing plume of airborne radioactivity released during an accident. The impacts for the collective SRS employee population given in Table 4.13 were estimated for inhalation and external radiation exposure. External radiation exposure consisted of cloudshine and groundshine. Groundshine exposure was evaluated for 8 hours following an accident and was negligible, less than approximately 0.02% of the total dose, in all cases. The impacts presented in Table 4.13 are the highest potential impacts to the SRS employee population and were found to occur in the direction of the major F-Area facilities, toward the south-southwest. The dominant exposure pathway was inhalation for all accidents except for the hypothetical criticality events. For those hypothetical criticality events, exposure to cloudshine was estimated to account for approximately 70% of the collective dose; the remaining dose was estimated to result from inhalation.

The SRS employee MEI was estimated to receive a maximum dose, 0.026 Sv (2.6 rem), from the tritium release at the PDCF. This dose was from the inhalation pathway. For this dose, the likelihood of developing a latent fatal cancer was estimated to be 0.002 (about 1 chance in 500). SRS employee MEI impacts for all accidents considered are presented in Table 4.13.

Members of the public: As discussed above, impacts to the public were assessed for a short-term period immediately following the accident and for a 1-year exposure period following the accident that includes the short-term exposures. With the exception of nuclear criticality accident events, inhalation was the dominant exposure pathway for the public in the short term and 1-year exposure without ingestion. Maximum inhalation doses would occur to the west-northwest of the SRS and would be more than 100 million times any external exposure. For the 1-year exposure to the public with ingestion, the ingestion pathway was the dominant exposure pathway. The highest potential 1-year ingestion dose would be to the southwest of the SRS.

Inhalation would account for the remainder of the dose except in the case of the criticality accidents where external exposure and inhalation make up the balance of the dose. Further details of the accident risk analysis are given in Appendix E.

The tritium release accident at the proposed PDCF was estimated to result in the largest short-term exposure. An estimated collective dose of 42 person-Sv (4,200 person-rem) was projected to be received by a population of approximately 309,900 persons extending out to 80 km (50 mi) to the west-northwest of the proposed MOX facility. The average individual dose was projected to be approximately 0.14 mSv (14 mrem), about 4% of the value an individual would receive on an annual basis from existing natural and man-made sources in the SRS vicinity. However, persons living closer to the accident location would receive a higher dose on average as discussed below for the hypothetical public MEI. The collective population dose received from this accident is estimated to have a risk of an additional 3 LCFs in the affected population.

The tritium release accident at the PDCF also produced the largest 1-year collective population doses. For the case without ingestion, the results were the same as discussed above for the short-term impacts because inhalation of the passing airborne emissions was the dominant exposure pathway. For the case with ingestion, the largest impact was calculated for winds blowing toward the southwest, where 18,010 people reside. The estimated collective population dose was 1,800 person-Sv (180,000 person-rem). This dose corresponds to a human health effect of up to 100 LCFs. However, for the purposes of this EIS, all contaminated food that would be grown in an affected area is assumed to be eaten. Because the amount of contaminated food exceeds the amount that would be consumed by persons living within the affected area, it is further assumed that some of the affected food would be shipped out of the region and consumed by persons living outside the region. Excluding ingestion, the dose received by the people residing in the southwest sector was 1.7 person-Sv (170 person-rem). The remainder of the dose was attributed to the ingestion of all contaminated crops in the southwest sector. Therefore, the collective dose of 1,800 person-Sv includes doses to persons both within the affected area and outside the region. As shown in Table 4.15, the public MEI was estimated to receive a dose of 0.039 Sv (3.9 rem) for this hypothetical accident, on the basis of individual consumption rates in Appendix E. Assuming that all 18,010 persons received the MEI dose, which would be an overestimate of the dose, the corresponding collective population dose would be about 40% of the total collective dose estimated above for the case including ingestion. Therefore, the people living within the affected area would receive less than 40% of the collective dose estimated.

The potential 100 LCFs among members of the public estimated from the PDCF tritium release accident is intended to be an upper bound for such an accident when the ingestion of contaminated food is considered. The GENII code used for the accident analysis provides impacts for the four seasons of the year (winter, spring, summer, and autumn), which correspond to various phases of crop growth. Ingestion impacts increase from winter (from radionuclide deposition on soil only) through autumn (from radionuclide deposition on plants immediately prior to harvest). As discussed earlier in this section, when impacts were estimated, crops were assumed to be ready for harvest (autumn) at the time of an accidental release. This assumption was made to place an upper bound on any expected impacts resulting from the ingestion of contaminated food. In addition, ingestion pathway impacts estimated with GENII typically display a steady increase upon progressing from winter through spring, summer, and autumn, resulting from an increase in direct deposition on crops due to increased crop growth. However, in the case of tritium contamination, an ingestion dose of 0 person-Sv was estimated for winter, spring, or summer, and an ingestion dose of 1,800 person-Sv (180,000 person-rem) was estimated for autumn.

GENII incorporates a tritium-specific model that recognizes that tritium, in the form of water vapor, is an integral part of the environment and human metabolism and exchanges readily with other water in the environment. As modeled, the deposited tritium has a chance to dissipate in the environment prior to crop harvest (i.e., winter, spring, and summer impacts), but if deposited immediately prior to harvest (autumn impacts), the tritium is assumed to remain in the crops. Thus, the 100 LCFs calculated from the collective population dose of 1,800 person-Sv (180,000 person-rem) from the PDCF tritium release accident is a high upper-bound estimate because further dissipation of the tritium after crop harvest would be likely to occur before ingestion.

Impacts were assessed for an MEI living at the SRS boundary for short-term, 1-year without ingestion, and 1-year with ingestion exposures. In all three cases, maximum impacts were found to occur to a hypothetical individual located 9,070 m (5.6 mi) northwest of the facilities as a result of the PDCF tritium release accident. As shown in Table 4.15 , the highest estimated dose to the public MEI was 0.90 mSv (90 mrem) in the short term from inhalation exposure. The potential maximum 1-year exposure without ingestion accident impact was estimated to be the same as the short-term exposure impact because both are dominated by inhalation exposure to the passing airborne contaminant plume immediately following an accidental release. If ingestion of contaminated crops is considered, a total exposure of 39 mSv (3,900 mrem) was estimated for the MEI. The resulting health effects were estimated to be a chance of contracting a latent fatal cancer over their lifetime of 5×10^{-5} (1 chance in 20,000) and 0.002 (about 1 chance in 500) as a result of the short-term or 1-year without ingestion exposures and the 1-year with ingestion exposure, respectively.

No mitigative actions were considered in the above analysis for the 1-year MEI exposure with ingestion. However, current Food and Drug Administration (FDA) recommendations (FDA 1998) include a protective action guide (PAG) of 5 mSv (500 mrem) CEDE and 50 mSv (5,000 mrem) committed dose equivalent to an individual tissue or organ, whichever is more limiting. These intervention levels of dose are radiation doses at which protective actions should be considered. The maximum public MEI ingestion dose of 39 mSv (3,900 mrem) would exceed the FDA PAG of 5 mSv (500 mrem) CEDE.

The impacts presented here are intended to provide a comprehensive bounding analysis for all potential events up to and including design basis accidents as discussed in Section 4.3.5.1. While non-credible “worst-case” accidents were not evaluated, a number of conservative assumptions were used to ensure that potential future impacts are bounded. Should an accident occur, potential nearby receptors would be the most vulnerable immediately after the event because they might not be aware of the accident and might not receive notification in time to take protective actions. However, those individuals farther from an accident would be more likely to receive notification in time and would be in a position to reduce doses by taking protective actions. The consequences reported here provide a range of impacts including the assumption that no protective actions are taken. Protective actions include sheltering or evacuation in the short-term and the banning of locally grown food in the long-term. Further, the 1-year results with ingestion presented here are based on the assumption that an accident occurs immediately before harvest. This is a bounding assumption because the direct deposition of radioactivity on crops would cause the highest ingestion exposures. However, long-term exposure without ingestion was also included for perspective. In addition, this analysis assumes that individuals are not sheltered during the accident and passing of the radioactive plume. Thus, the estimated accident impacts presented in this EIS are considered to bound future possible outcomes.

The radiological risks of accidents described in this FEIS are considered to be low because either the likelihood of these accidents would be significantly diminished, or sufficient controls would be applied to ensure the dose consequences are much lower than those presented here. The requirements to reduce the risk of accidents that could result in high consequences are contained in the NRC's regulations in 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," and the DOE's 10 CFR Part 830 "Nuclear Safety Management." In order to obtain a license to possess and use special nuclear material from the NRC, for example, the applicant must show that the risk of each credible high-consequence event is limited through the use of engineered controls, administrative controls, or both. Pursuant to this and other performance requirements, mitigation measures identified in Chapter 5 of this FEIS include those controls identified by the applicant to reduce the risks of potential accidents.

4.3.5.3 Chemical Human Health Risk

An analysis of potential impacts from accidental chemical releases was conducted. The analysis considered maximum inventories of stored chemicals at the proposed facilities and each chemical's physical characteristics (e.g., volatility) and its toxic concentration levels. Liquid storage containers with the largest chemical inventories were assumed to be punctured (e.g., by a forklift), resulting in a spill of the entire chemical contents of the container on an outdoor concrete surface. In general, it was assumed that the spill would occur onto an impervious surface from which evaporation could occur, rather than onto a soil surface where absorption would limit evaporation. (Two chemical releases were modeled as pressurized releases; see below.) Evaporation from the chemical pool was assumed to be of limited duration, not more than an hour, because of rapid mitigative response. The Areal Locations of Hazardous Atmospheres (ALOHA, Version 5.2.3) model (Reynolds 1992) was used with the aid of a liquid pool evaporation algorithm to assess the downwind consequences of such bounding-case spills. An assessment of the accidental release of uranium dioxide powder was also included.

For each release, potential impacts to two populations were evaluated — the off-site general public and SRS employees. For the SRS employee evaluation, a wind speed of 2.2 m/s (4.9 mph), F atmospheric stability class, and a temperature of 25.8°C (78.5°F), was determined to represent the site-specific 95th percentile concentration. This was established on the basis of the ARCON96 model chi/Q value (ratio of concentration to emissions) estimated at a distance of 100 m (330 ft) from the release. For the off-site general public evaluation, the bounding conditions were determined to be a wind speed of 1.3 m/s (3.0 mph), F atmospheric stability class, and a temperature of 25.8°C (78.5°F), representing site-specific, 95th percentile nighttime bounding meteorology. The 95th percentile meteorology was assumed to be a reasonable approximation of conditions that would produce the 95th percentile concentration consistent with the ARCON96 estimate at 100 m (330 ft). Details on the modeling assumptions are provided in Appendix E.

The criteria levels used to assess potential exposures were temporary emergency exposure limits (TEELs) adopted by the DOE Subcommittee on Consequence Assessment and Protective Action (SCAPA) (Craig 2002). TEEL values are available for about 2000 substances; they are derived by using a hierarchy of other available criteria values (Craig et al. 2000). If Emergency Response Planning Guidelines (ERPGs) developed by panels of toxicologists for the American Conference of Governmental Industrial Hygienists (ACGIH) are available, these are used for the TEEL values. If ERPGs are not available, TEELs usually are based on emergency planning and other guideline levels developed for the protection of workers (Craig 2002).

Several TEEL concentration values are available for each chemical (see text box on next page). For the purposes of this analysis, modeled exposures of SRS employees (assumed to be located 100 m [330 ft] from the release location) to levels greater than TEEL-3 for any chemical were defined as large consequence, and levels less than TEEL-3 but greater than TEEL-2 were defined as moderate consequence. The assessment for the off-site general public differed slightly, as discussed below.

The distance from the release location to the SRS boundary (the nearest location for potential exposures of the general public) is 8.2 km (5.1 mi). Since the ALOHA model restricts release durations to 1 hour, the ambient air concentration at that location could not be readily obtained (the concentrations for downwind distances at times exceeding 1 hour are not directly provided in the ALOHA model). Because plume travel time exceeded 1 hour (i.e., the ALOHA limit) for all of the evaporative spill scenarios considered, the estimated site boundary concentration was obtained by extrapolation methods (see Appendix E). To assess impacts to the general public, site boundary concentrations greater than TEEL-2 levels for any chemical were defined as large consequence, and levels less than TEEL-2 but greater than TEEL-1 were defined as moderate consequence. In addition, the maximum distances from the release point to which chemical TEEL-1 and TEEL-2 air concentrations could extend were estimated using the ALOHA model.

Two release scenarios, one involving nitrogen tetroxide and the other involving chlorine, were modeled as pressurized releases. The HGSYSTEM model (Post 1994a,b; Hanna et al. 1997) was used to simulate pressurized jet releases for punctured containers and the downwind dispersion of the released material. As was done with the ALOHA model for the evaporative dispersion cases, all model runs accounted for the influence of dense vapor cloud behavior on downwind dispersion in releases determined to exhibit this behavior.

Temporary Emergency Exposure Limits (TEELs)

TEEL-1: The maximum concentration in air below which it is believed that nearly all individuals could be exposed for up to one hour *without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor*.

TEEL-2: The maximum concentration in air below which it is believed that nearly all individuals could be exposed for up to one hour *without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action*.

TEEL-3: The maximum concentration in air below which it is believed that nearly all individuals could be exposed for up to one hour *without experiencing or developing life-threatening health effects*.

The results of the assessment are summarized in Table 4.16. No accidental releases would result in concentrations exceeding TEEL-1 levels beyond the site boundary. Impacts from these spills on the general public would be small. For all spills, impacts could be minimized with rapid emergency response actions by nearby workers. This response would include quick mitigative action to cover the spill and to minimize evaporation and downwind transport. For SRS employees, impacts could be moderate or large for spills involving chlorine or nitrogen tetroxide. Specific response actions covered under the existing SRS Emergency Response Plan (SRS 2001), including remaining indoors (i.e., sheltering in place) and evacuating (e.g., including rapid evacuation of all nonemergency workers to an upwind location and into designated buildings), would be implemented to minimize worker exposures to spills involving hazardous chemicals of this type. The SRS Emergency Response Plan may be revised to address specific hazards that are not covered in the existing plan subsequent to safety analysis reviews required under DOE chemical safety standards or orders (e.g., DOE-STD-3009-94, DOE Order 420.1).

4.3.5.4 Hydrology

During the scoping process, a concern was raised about groundwater contamination through existing deep boreholes. There are 11 deep boreholes at the SRS. The closest deep borehole is located north of the unnamed tributary that is just north of the proposed MOX facility (see Figure 3.3). Impacts to the groundwater from the proposed facilities have been evaluated. The deep boreholes were determined not to be a credible path by which materials from the proposed facilities could contaminate groundwater, and there would be no discharges to groundwater. Surface spills from the facilities that might travel toward the deep boreholes would be intercepted by the unnamed tributary. Accidental releases that might possibly reach the groundwater would flow in the shallow groundwater aquifer and discharge to Upper Three Runs Creek.

This page is being withheld pursuant to 10 CFR 2.390(a).

Because accidental releases to surface water would be quickly remediated as required by the facility's Spill Prevention Control and Countermeasures Plan, impacts would be negligible. Materials released by leaks or ruptures of vessels and piping used to store and transfer process chemicals and liquid radioactive waste could affect surface water and groundwater. Bulk process chemicals would be stored and chemical mixtures would be prepared in the Reagent Processing Building. DCS has identified a number of chemical process safety controls to prevent significant spills or other accidents that would have the potential to significantly affect the human environment. These measures include administrative controls over segregation and separation of incompatible chemicals, concentration controls on specific reagents, and a process safety instrumentation and control system to measure and control process conditions to ensure safety limits are not exceeded.

Groundwater quality could be indirectly impacted by accidental releases of contaminated effluents or hazardous stored liquids and infiltration of contaminated runoff. Such impacts, however, are expected to be negligible because of adherence to guidelines established in existing NPDES permits and prompt cleanup of any spills as required under the facility's Spill Prevention Control and Countermeasures Plan. Storage vessels for liquid wastes would be located in the Aqueous Polishing Building.

A rupture of the low-level liquid radioactive waste transfer line could release wastewater containing radioactivity at concentrations up to the ETF waste-acceptance criteria levels. DCS, however, has committed to liquid containment features, including containment basins below storage tanks that hold contaminated liquids (stainless-steel-lined floors and portions of walls would be used to create basins in the tank room of the Aqueous Polishing Building) and double-wall pipe and a leak detection system for the transfer line.

The WSB would be connected to the proposed MOX facility and PDCF by stainless steel double-walled pipelines for transfer of stripped uranium wastes and the high-alpha-activity wastes. The waste streams that constitute the high-alpha-activity waste stream include the americium stream, the alkaline wash stream, and the excess acid stream. The combined volumes of these streams would be about 44,200 L/yr (11,700 gal/yr) (DCS 2002a, 2004a). The stripped uranium stream would average about 174,000 L/yr (46,000 gal/yr) during normal operations. The stripped uranium stream would contain only 1% uranium-235 to avoid issues of criticality. To minimize the probability of a pipe failure, both of these waste streams would be transported in double-walled stainless steel pipes. In addition, the pipes would be designed to withstand the effects of a design-basis earthquake and other natural phenomena. If either of these lines ruptured, impacts to surface water or groundwater would be small because of the small quantities of waste involved in the transfer and prompt and thorough cleanup required under the SRS Spill Prevention Control and Countermeasures Plan.

4.3.5.5 Waste Management

Wastes that may be generated from the accident scenarios discussed in this FEIS are expected to be similar in type and of volumes that would be within the bounds of the capacities at the

SRS for waste management. Potential impact to the waste management system at the SRS is expected to be minimal.

4.3.6 Deactivation and Decommissioning

4.3.6.1 Introduction

License termination is considered the final stage of the licensing process for an NRC-licensed facility. License termination entails deactivation and decommissioning of the facility as part of the termination process. Decommissioning involves the removal of the facility safely from service and reduction of residual radioactivity to a level that permits release of the property for unrestricted or restricted use. Termination of the MOX facility license would be governed by 10 CFR 70.38. Decommissioning of the proposed MOX facility would be conducted in accordance with criteria of 10 CFR 20 Subpart E (Radiological Criteria for License Termination). The PDCF and WSB may not be decommissioned after completion of MOX facility operations, but they are included in this evaluation to bound the analysis.

DCS plans to deactivate the proposed MOX facility and request NRC to terminate the license once the facility's mission for disposition of excess plutonium is completed (DCS 2002a). This plan is based on the contract between DOE and DCS that calls for DCS to deactivate the proposed MOX facility and place it in a safe-shutdown condition once operations have ended. In addition, the supporting DOE-owned and -operated support facilities, the PDCF and the WSB, would also require decommissioning once the surplus plutonium mission was completed. The ultimate fate of the facilities would then become the responsibility of DOE. DOE may choose to reuse or decommission the facilities once the surplus plutonium mission has been completed. DOE will make a decision on when and how to decommission the facilities.

Deactivation

Deactivation is the process of removing a facility from operation and placing it in safe-shutdown condition for an extended period of time. Deactivation would involve:

- Removal of unused plutonium and uranium feedstock, process chemicals, and loose surface contamination;
- Depressurization of all facility systems; and
- Sealing of gloveboxes and ventilation systems.

Currently, it is difficult to determine the possible final disposition of the facilities following the completion of their intended mission. The proposed MOX facility would be owned by DOE and operated by DCS under the terms of the DOE-DCS contract and scope of work. The course of decommissioning and future use of all three facilities would depend largely on DOE decisions that would be made at some future date as the facilities approached the end of their operating lives. Since the scoping process identified decommissioning as a significant issue, the potential impacts of decommissioning the facilities are presented below.

4.3.6.2 Decommissioning Process

Options for decommissioning nuclear facilities are discussed generically in NRC's *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities* (NUREG/CR-0586 [NRC 1988]). As stated in that document, it is the objective of the NRC to conduct decommissioning as an end point of the license termination process.

> **Decommissioning**
>
> *Decommissioning* is the process of decontaminating and dismantling the facilities following deactivation and returning the site to an end state that meets the prescribed regulatory criteria. Decommissioning would involve:
>
> - Chemical decontamination,
> - Physical decontamination of equipment, structures, and materials (e.g., disassembly of equipment and enclosures and removal of materials), and
> - Removal of structures and restoration of the site to a prescribed end state.

Other options, such as safe storage, deferred decommissioning, or restricted release, could have been evaluated. However, for safe storage and deferred decommissioning, the doses to workers during decommissioning would be greater because of the decay of transuranic radionuclides (e.g., plutonium-241 and plutonium-238). That is, the radioactivity in a facility would increase because of the in-growth of daughter products. Restricted release was not considered at this time because the "base case" for decommissioning under 10 CFR Part 20, Subpart E, would be unrestricted release. DCS would need to provide additional justification to support a request for restricted release, which at this point in the project would be speculative.

On the basis of the EIS on decommissioning of nuclear facilities (NRC 1988), it is assumed that the decommissioning process for the facilities would include 2 years of preparation and planning, followed by actual decommissioning activities. In general, decommissioning planning would be conducted during the last 2 years of normal plant operation. During that time, detailed plans and procedures would be prepared, a decommissioning staff would be trained, safety and environmental reports would be prepared (if necessary), and effluent control system modifications would be started.

Work would begin immediately following facility shutdown. Chemical decontamination would be followed by physical decontamination of most plant areas, including disassembly of equipment and enclosures and removal of resulting materials, such as structural components. These materials would be packaged and transported off-site as waste. The main facility and service system (e.g., decommissioning equipment and accessories) would be removed last. Some buildings, such as the Administration Building at the proposed MOX facility might not require any decommissioning prior to release for unrestricted use.

4.3.6.3 Decommissioning Impacts

4.3.6.3.1 Radiological Impacts

Because of the uncertainties involved in future operation of the facilities, most of the specific information needed to assess actual decommissioning impacts would depend on the actual operating history of the facilities. Because of the lack of a full-scale MOX facility, PDCF, and WSB, the analysis conducted for this FEIS has been extrapolated from the generic information provided in NRC's final generic EIS for a small mixed oxide fuel fabrication plant (NUREG/CR-0129; NRC 1979) and from NUREG/CR-0586 (NRC 1988). The extrapolation is based on a comparison of the size of the facilities as represented by the total area covered (square meters or square feet) by the MOX Fuel Fabrication Building plus the PDCF and the WSB. The objective of this analysis is to obtain baseline information pertaining to the radiological impact associated with decommissioning activities. Thus, the radiological impact from the proposed MOX facility was estimated to be about 28 times that in the NRC's generic EIS. Given the uncertainties in the decommissioning activities that would be undertaken at the proposed facilities in the future, this assumption provides a reasonable estimate of the decommissioning impacts. The radiological impacts associated with decommissioning are presented in Table 4.17.

Table 4.17. Summary of radiological impacts from routine facility decommissioning

Exposure	Dose[a] [person-Sv (person-rem)]
Occupational	
Deactivation[b]	6.3 (630)
Decommissioning	19 (1,900)
Transportation[c]	0.99 (99)
Total	27 (2,700)
Public	
Deactivation	8.2×10^{-9} (8.2×10^{-7})
Decommissioning	1.8×10^{-7} (1.8×10^{-5})
Transportation[c]	1.2 (120)
Total	1.2 (120)
Grand total	28 (2,800)

[a]Doses are rounded to two significant figures.

[b]Assumed to follow the same preparation process for long-term custodial care (NRC 1998).

[c]Assumes 686 shipments. Estimated from single shipment risks for TRU waste shipments from the SRS to WIPP presented in Monette et al. (1996).

4.3.6.3.2 Nonradiological Impacts

Geology and Soils. Soils covered by buildings and paved surfaces would be reclaimed to support the designated vegetation type after decommissioning. Soil treatments, including grading, disking, and fertilizer applications, would be used following removal of concrete foundations of structures and asphalt from paved parking areas. The movements of trucks and other vehicles involved in removing concrete and major facility components during decommissioning might result in soil compaction in localized areas. The use of chisel plows or other equipment might be required to loosen the soil in areas where compaction was severe. Depending on the final engineering design for the facility sites, some earth moving might be needed. Soils in the storm-water retention area might be moved and/or graded to prevent erosion and to enhance establishment of plant species on areas to be revegetated. Attempts would be made to grade the area to fit with the existing topography of this portion of F-Area at the time of decommissioning.

Hydrology. The types of impacts to surface and groundwater during decommissioning of the facilities would be similar to those occurring during construction. Water would be used for dust suppression when necessary and might be needed during planting until vegetation becomes established. Runoff from areas being graded after the removal of concrete or asphalt would be minimized through use of silt fences or straw bales to control erosion. No impacts are anticipated to groundwater during decommissioning activities. Impacts to surface water during decommissioning would be small because of the measures employed to control runoff.

Air Quality and Noise. The types of air quality impacts expected during decommissioning of the facilities would be similar to those anticipated during facility construction. Vehicles used during decommissioning might create fugitive dust during dry conditions at the SRS. Fugitive dust would be controlled by watering during these periods. As described in Section 4.3.2.1, impacts to air quality would be small.

Noise associated with dismantling and removal of facility structures from F-Area and the SRS would be localized and temporary. Impacts of noise would be similar to those generated by initial construction of the facility (see Section H.2.1 in Appendix H) and would be small.

Ecology. Assuming that full decommissioning occurs and DCS removes the facilities and allows restricted use of the facility areas on the SRS, the following ecological impacts could occur. Although decommissioning plans may call for removal of facility structures, other areas designed to support operations may not be changed. The 4.5 ha (11.0 acres) occupied by the relocated 115-kV power line would remain in use as the power line continued to provide electricity to other F-Area facilities. Also, the 2.0 ha (5.0 acres) of new roads and road upgrades would remain. The 0.6 ha (1.5 acres) occupied by the storm-water basin might also be retained for that use. If storm-water control was not necessary, this area could provide wetland and pond habitats. The remaining areas located within the fenced boundaries of the facilities and along the pipeline rights-of-way could be revegetated. Revegetation goals could include establishing landscaped lawn around buildings, grass and forb species (e.g., similar to the vegetated conditions on the existing spoils pile area within the proposed location for the proposed MOX facility area), or evergreen and mixed forest habitats. The choice of treatment would depend upon the restricted use planned for the area in the future.

During decommissioning activities, wildlife would be affected in a manner similar to what would occur during construction (see Section H.3.1.1.2 in Appendix H). Impacts would primarily be disturbance and displacement caused by noise and human presence. Following decommissioning, a potentially diverse wildlife community could reoccupy the facility areas. Reforestation of the areas would be the most productive for wildlife, while use of the area for new facilities would be least productive for wildlife.

On the basis of the assessment of impacts to ecological resources during construction of the proposed facilities (Section H.3.1, Appendix H), the impacts of decommissioning are expected to be minor.

Land Use. The F-Area is classified as developed/industrial land. Construction of the proposed facilities is consistent with this classification and the SRS Long Range Comprehensive Plan (DOE 2000b). Decommissioning of the facility site for unrestricted use at SRS would not interfere with current uses or anticipated future uses of the F-Area. Lands in adjacent areas on the SRS managed by the U.S. Forest Service would not be adversely affected by decommissioning activities.

Cultural and Paleontological Resources. Decommissioning is not likely to affect any archaeological sites, historic structures, or traditional cultural properties at the proposed project site. Mitigation measures to avoid impacts during construction of the facility at one prehistoric archaeological site that is eligible for listing on the *National Register of Historic Places* (NRHP) are described in Section H.5.1.1 (Appendix H). Prior to decommissioning, a plan would be developed by DOE describing actions that would be taken to avoid or protect any known or new archaeological sites discovered in areas likely to experience surface disturbance or impacts from runoff because of decommissioning activities. The plan would also address other impacts of decommissioning workers such as unauthorized pedestrian traffic or vehicular activity in the vicinity of known sites or eligible sites. If the mitigation measures described in Section H.5.1.1 are implemented during decommissioning, the impacts to cultural resources could be avoided or minimized.

Nonradiological Impacts of Transportation. Decommissioning would require the transport of demolished structures and components to on-site or off-site disposal areas. The transport of structural materials and components would be along existing SRS roads and local South Carolina highways and would not require new roadway construction. Vehicular traffic on the SRS and local roadways related to decommissioning activities is not expected to affect traffic volume or traffic flow patterns on local roads.

Waste Management. The demolition of the facilities would generate solid waste in the form of structural materials such as concrete and steel and contaminated facility components. The exact quantities and classification of waste types cannot be determined at this time; the information presented here on waste types and volumes is based only on projections. The handling and disposal of wastes produced during decommissioning would comply with all regulatory requirements.

Socioeconomics. The types of impacts to socioeconomic and community resources during the decommissioning of the facilities would be similar to those occurring during their construction. The number of workers expected to be needed for decommissioning is about the same as for construction. Socioeconomic impacts from construction are described in Section H.7.1 (Appendix H). No adverse impacts are anticipated to local communities relative to housing demand for workers or community services from decommissioning activities. Assuming that they would have sufficient notice of the completion of decommissioning impacts, local communities should be able to plan for the loss of revenue generated by the work force. The projected costs of decommissioning are discussed below.

Decontamination and Decommissioning Costs. Uncertainties surrounding the precise nature of activities and, consequently, the magnitude of the cost associated with decommissioning of the proposed MOX facility have meant that no direct estimates of these costs have been made to date. However, estimates have been made on the basis of the costs of decommissioning efforts for a similar facility at the RFETS in Colorado (DCS 2001). Facilities currently being decommissioned at the RFETS have supported activities that are broadly similar to those likely to take place in a MOX fuel fabrication facility and in the associated aqueous polishing facility. These activities at the RFETS have included the manufacture of plutonium weapons components, including casting and machining in dry gloveboxes, and the recovery of plutonium from plutonium residue in "canyon" rooms. On the basis of the volume and types of wastes generated during the decommissioning of those buildings, estimates of the direct costs of decommissioning of the proposed MOX facility and related facilities are about $377 million (FY 2003 dollars).

In addition to the direct costs of the facilities, a number of indirect costs would also be incurred. These costs include site security, residue and fuel deactivation and removal, environmental programs, project management, and costs associated with borrowing funds to finance the project (DCS 2001). Significant contingency allowances would also have to be included.

On the basis of data gathered from other, similarly large nuclear fuel cycle-related projects, it can be concluded that the indirect costs are likely to be roughly approximate to the direct costs of construction and operation. It has also been estimated that decommissioning costs of similar projects are equivalent to about 80% of project capital cost (DOE 1995). Design and construction costs for the MOX, PDCF, and WSB facilities, including contingency, are estimated to be $1,929 million (NNSA 2002). Using both approaches, the total decommissioning cost for the three facilities would, therefore, lie in the range of $758 million to $1,543 million (2003 dollars).

4.3.7 Environmental Justice

4.3.7.1 Introduction

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (Volume 59, page 7629 of the *Federal Register* [59 FR 7629]), issued by President Clinton on February 11, 1994, requires federal agencies to incorporate environmental justice as part of their missions. Specifically, it directs executive branch agencies to address, as appropriate, any disproportionately high and adverse human health or environmental effects of their actions, programs, or policies on minority and low-income populations. Although independent agencies, such as the NRC, were only requested to comply with Executive Order 12898, the NRC, in a letter dated March 31, 1994, stated it would endeavor to carry out the measures set forth in the Executive Order and accompanying memorandum as part of its efforts to comply with the requirements of NEPA. The NRC has developed guidelines for environmental justice analyses described in *Environmental Review Guidance for Licensing Actions Associated with NMSS Programs* (NRC 2001, NRC 2003).

The analysis of the potential impacts of the no-action and proposed action alternatives on environmental justice communities near the SRS uses demographic data from the 2000 census to describe the distribution of minority and low-income populations in the vicinity of the SRS. The definitions of minority and low-income population groups as used in this analysis are as follows:

- **Minority.** Beginning with the 2000 census, where appropriate, the census form allows individuals to designate multiple population group categories to reflect their ethnic or racial origin. Persons are included in the minority category if they classify themselves as belonging to any of the following racial groups: Hispanic, Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander. In addition, persons who classify themselves as being of multiple racial origin may choose up to six racial groups as the basis of their racial origins. The "minority population" therefore incorporates all persons, including those classifying themselves in multiple racial categories, except those who classify themselves as not of Hispanic origin and as White or "Other Race" (U.S. Bureau of the Census 2002).

- **Low-Income.** Individuals who fall below the poverty line are classified as low-income. The poverty line takes into account family size and age of individuals in the family. In 1999, for example, the poverty line for a family of five with three children below the age of 18 was $19,882 in annual income. For any given family below the poverty line, all family members are considered as being below the poverty line for the purposes of analysis (U.S. Bureau of the Census 2002).

Data on minority and low-income populations are available at the county, census tract, block group, and block level. To fully evaluate the potential environmental justice impacts of the proposed action alternative, the distribution of minority and low-income populations was analyzed at the census block group level. The analysis was based on guidelines for environmental justice analyses described in *Environmental Review Guidance for Licensing Actions Associated with NMSS Programs* (NRC 2001). An 80-km (50-mi)-diameter buffer zone around F-Area at the SRS was used as the basis for the analysis so as to include potential adverse human health or socioeconomic impacts related to the construction and operation at the SRS. Accidental chemical and radiological releases, for example, have the potential to affect minority and low-income population groups located some distance from the site, depending on the size and nature of potential releases and on meteorological conditions. The actual extent of any such effects would depend on the magnitude and nature of any release at the site.

In addition to demographic data, the NRC solicited comments and information regarding the potential for the proposed action to cause disproportionate impacts to environmental justice communities at the public scoping meetings (see Section 1.4.1). The comments received at these meetings are presented in Appendix I, Section 2.2.13. In summary, environmental justice impacts were a concern to many stakeholders. It was stated that contamination could affect fishing resources that might be used for subsistence by low-income and minority population groups some distance downstream of the site. This information further supported NRC's decision to use a larger assessment area for environmental justice impacts. It was also stated that many low-income people rely to a greater extent on food produced from gardens.

Guidelines for performing environmental justice reviews are described in NRC's NUREG-1748 (NRC 2001). The analysis method is multistep and consists of first determining if a site has a potential environmental justice concern based on the identification of low-income and minority populations that could be affected by the proposed action. Next, a determination is made as to whether possible impacts would disproportionately impact low-income or minority populations. In cases where the low-income and minority populations are located next to the site, potential impacts could be disproportionate. In other cases, specific behavior of low-income and minority populations, such as the consumption of a greater portion of homegrown crops and other food items, for example, may result in a disproportionate impact. Finally, if it is determined that there would be a potential impact, an assessment would be made as to whether the impact of any aspect of construction and operation of the proposed facilities, including accidents, on low-income or minority populations would be both "high and adverse."

Block group level data for minority and low-income populations for all block groups within 80 km (50 mi) of F-Area are shown in Tables 4.18 and 4.19. Data for each population group are compared with the state and county minority and low-income totals. The environmental justice impacts of the transportation of MOX fuel were not considered because of the uncertainty surrounding the routes that would be selected and the timing and quantity of MOX fuel shipments. NRC guidelines suggest that disproportionate effects on minority and low-income populations should be considered if the minority or low-income populations in block groups are more than 20 percentage points higher than the state and county levels, or where the local minority or low-income population exceeds 50%. Using data in Table 4.18, adding 20 percentage points to the state average would mean that disproportionate effects on minority populations should be considered if the percentage of minorities in a block group is greater than 57.2% in Georgia and 53.8% in South Carolina. Disproportionate effects on low-income populations should be considered if the percentage of the low-income persons in a block group is greater than 34.7% in Georgia and 35.4% in South Carolina (Table 4.19). Minority and low-income percentages in each block group were also compared with the county minority and low-income averages by adding 20 percentage points to the corresponding county minority and low-income percentages. This analysis considered block groups with minority and low-income populations more than 20 percentage points above the state or county value as block groups that have environmental justice populations. Any block group where minority and low-income populations exceeded 50% of the block group population was also considered in the analysis.

Figures 4.2 and 4.3 show the census block groups for the 80-km (50-mi) buffer zone area. The shaded areas are those block groups where minority and low-income individuals are 20 percentage points higher than the state or county averages, or greater than 50% of the total population in the block group.

Table 4.18. Minority population characteristics in the vicinity of the SRS

County	White	Hispanic	Black	American Indian or Alaskan Native	Asian	Native Hawaiian or other Pacific Islander	Other	Two or more races	Total minority	Percent minority
Georgia										
Bulloch	2,850	138	1,152	3	9	1	25	22	1,212	29.8
Burke	10,433	316	11,343	51	57	3	141	215	11,810	53.1
Columbia	72,862	2,297	9,952	276	2,997	80	703	1,376	15,384	17.4
Emanuel	674	17	274	1	0	0	0	6	281	29.4
Jefferson	3,041	101	2,713	7	15	1	56	52	2,844	48.3
Jenkins	4,827	287	3,472	13	18	8	177	60	3,748	43.7
Lincoln	571	3	129	1	3	0	1	7	141	19.8
McDuffie	3,862	100	1,115	18	17	3	28	50	1,231	24.2
Richmond	91,006	5,545	99,391	552	3,000	249	2,024	3,553	108,769	54.4
Screven	8,234	147	6,963	22	40	8	31	76	7,140	46.4
Warren	579	14	324	3	1	0	0	3	331	36.4
Within 80-km buffer	198,939	8,965	136,828	947	6,157	353	3,186	5,420	152,891	43.5
State	5,327,281	435,227	2,349,542	21,737	173,170	4,246	196,289	114,188	2,859,172	34.9
South Carolina										
Aiken	101,745	3,025	36,442	566	905	36	1,181	1,677	40,807	28.6
Allendale	3,068	181	7,960	10	14	7	95	57	8,143	72.6
Bamberg	6,075	118	10,411	27	32	1	23	89	10,583	63.5
Barnwell	12,956	327	9,990	81	91	8	182	170	10,522	44.8
Colleton	605	102	261	0	0	0	64	20	345	36.3
Edgefield	13,962	503	10,209	81	59	8	107	169	10,633	43.2
Hampton	6,259	482	8,276	28	22	1	102	69	8,498	57.6
Lexington	40,976	957	6,085	186	117	10	517	477	7,392	15.3
McCormick	1,312	21	1,736	2	2	1	3	13	1,757	57.2
Orangeburg	9,888	127	7,983	121	26	4	44	199	8,377	45.9
Saluda	9,679	1,159	5,011	37	4	0	511	111	5,674	37.0
Within 80-km buffer	206,525	7,002	104,364	1,139	1,272	76	2,829	3,051	112,731	35.3
State	2,695,560	95,076	1,185,215	13,718	36,014	1,628	39,926	39,950	1,316,452	32.8

Table 4.19. Low-income population characteristics in the vicinity of the SRS

County	Low-income population	Percent low-income
Georgia		
Bulloch	711	17.3
Burke	6,348	28.7
Columbia	4,462	5.1
Emanuel	214	22.9
Jefferson	1,155	19.6
Jenkins	2,419	28.4
Lincoln	128	18.8
McDuffie	796	15.6
Richmond	37,522	19.5
Screven	3,043	20.1
Warren	142	15.6
Within 80-km buffer	56,940	16.6
State	1,033,793	12.6
South Carolina		
Aiken	19,388	13.9
Allendale	3,466	34.5
Bamberg	4,403	27.8
Barnwell	4,834	20.9
Colleton	212	21.5
Edgefield	3,407	15.5
Hampton	2,747	22.8
Lexington	5,517	11.4
McCormick	492	16.3
Orangeburg	3,260	17.9
Saluda	2,374	15.7
Within 80-km buffer	50,100	16.2
State	547,869	13.7

4.3.7.2 Impacts of the No-Action Alternative

For all the storage sites, radiological and nonradiological risks from continued storage of surplus plutonium would be small regardless of the racial and ethnic composition of the populations surrounding the sites, and independent of the economic status of individuals constituting the populations. Continued storage would have no disproportionately high and adverse effects on minority or low-income populations.

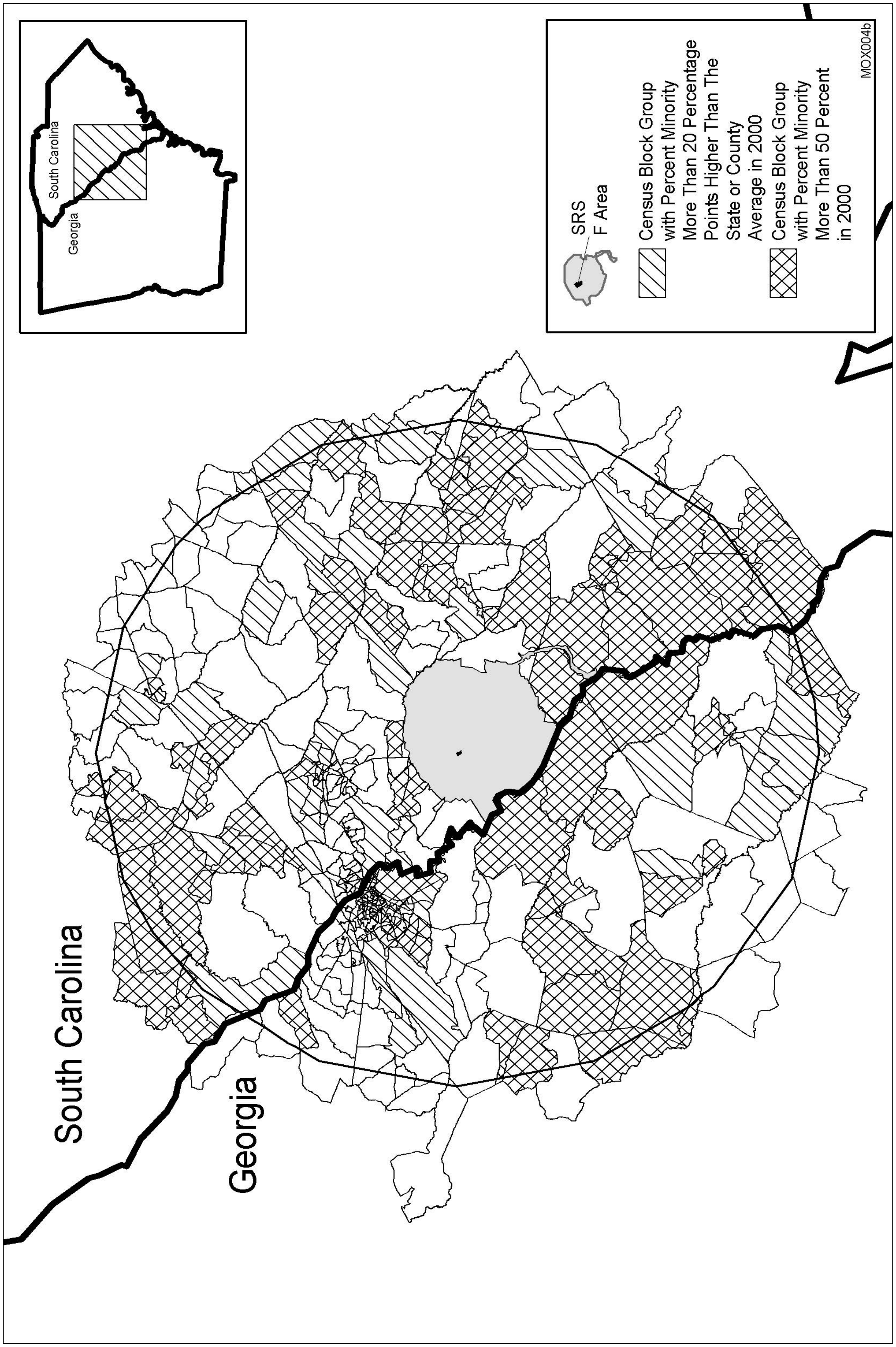

Figure 4.2. Minority population concentration in census block groups within an 80-km (50-mi) radius of the SRS F-Area (*Source*: U.S. Bureau of the Census 2002).

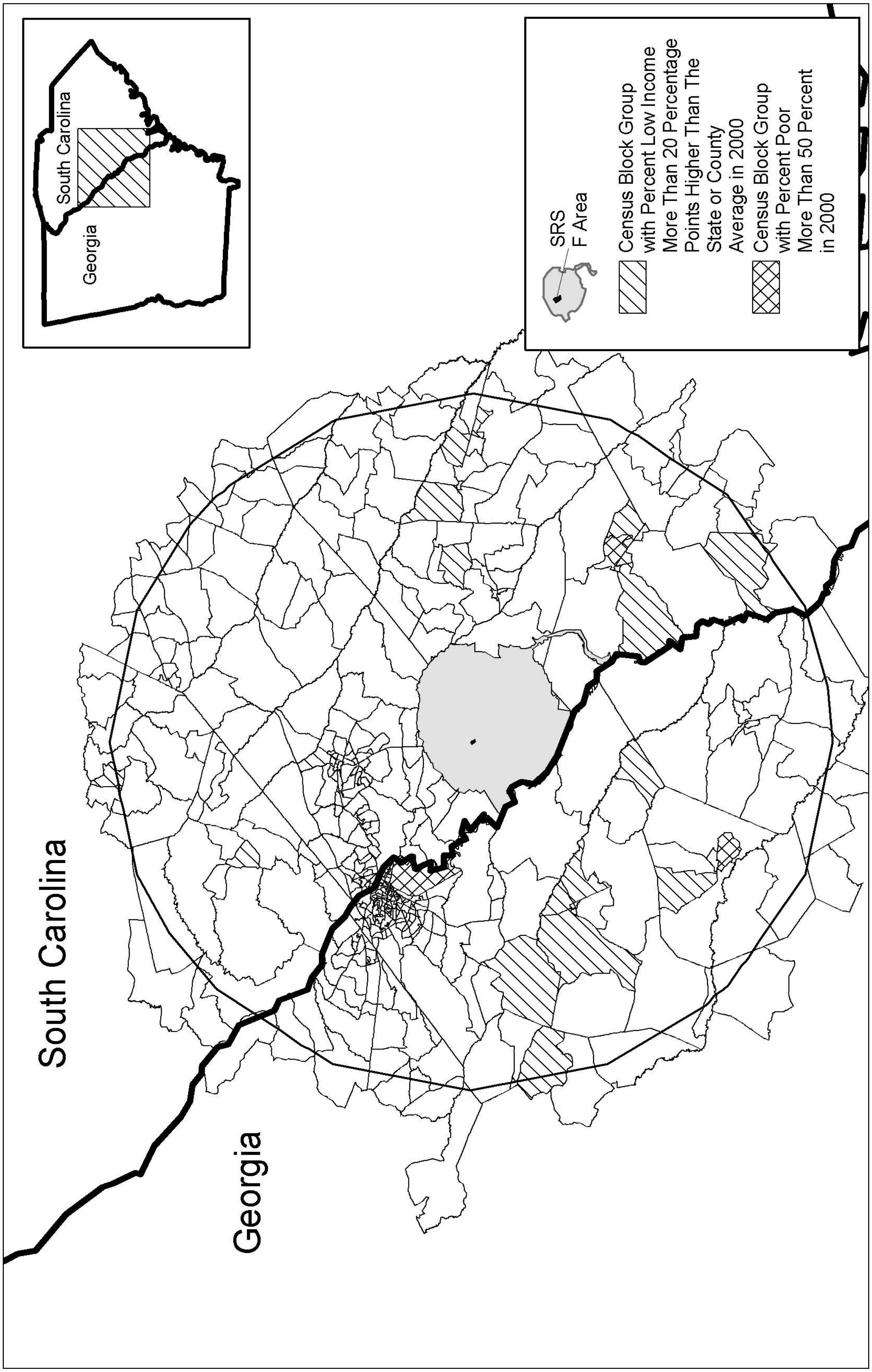

Figure 4.3. Low-income population concentration in census block groups within an 80-km (50-mi) radius of the SRS F-Area (*Source*: U.S. Bureau of the Census 2002).

4.3.7.3 Impacts of the Proposed Action

As discussed above, the analysis of environmental justice impacts is a multistep process. As depicted by the shaded areas in Figures 4.2 and 4.3, low-income and minority populations meeting the definition of environmental justice populations are present within the 80-km (50-mi) assessment area. The next step is to determine whether any impacts would be disproportionate to the low-income or minority populations. Generally, impacts are larger the closer a person is to the source of the impact. Therefore, low-income and minority populations could be disproportionately impacted if they were located closer to the source of the impact than the general population. As depicted in Figures 4.2 and 4.3, the majority of the border of the SRS is populated by predominately minority populations. In addition, specific behavior may result in disproportionate impacts. For example, during the scoping meetings and public meetings on the DEIS, commenters noted that some low-income and minority people relied heavily on homegrown foods and fish from the Savannah River. In addition, it was reported that some in the environmental justice community did not understand the impacts discussed in the DEIS. On the basis of the location of the low-income and minority populations and specific behavior, the NRC concludes that impacts to low-income and minority populations could be disproportionate. The following sections discuss whether the impact of any aspect of construction and operation of the proposed facilities, including accidents, on low-income or minority populations would be both “high and adverse.”

4.3.7.3.1 Construction

No radiological risks and only very low chemical exposure and risk are expected during construction. Chemical exposure would be limited to toxic air pollutants released at levels below applicable standards and would not result in any high adverse health impacts. Because the health impacts on the general population within the 80-km (50-mi) assessment area during construction would be negligible, impacts on the minority and low-income population would be small.

4.3.7.3.2 Routine Operations

Radiological impacts to the general public during routine operation of the proposed facilities would be minimal and would not cause any adverse health impacts. The facilities are expected to produce an annual latent cancer risk of approximately 2×10^{-9} for the MEI member of the public. The annual collective dose to members of the public living and working within 80 km (50 mi) of SRS associated with the facilities is expected to produce an LCF risk of approximately 0.0009 or less. In addition, no surface releases that might enter local streams or interfere with subsistence activities by low-income or minority populations are expected to occur. Because the health impacts of routine operations on the general public would be small and there would be no releases that would affect any water or food used for subsistence, there would be no disproportionately high adverse impact on low-income or minority population groups within the 80-km (50-mi) assessment area.

4.3.7.3.3 Accidents

An airborne release following an accident at the proposed facilities has the potential for causing up to 3 LCFs in the area surrounding SRS in the short term because of inhalation exposure. Up to 100 LCFs could occur following the ingestion of contaminated crops. These estimated latent cancer fatalities apply to the entire population within a given sector, which would include both environmental justice populations and non-environmental justice populations. (See discussion in Section 4.3.5 on the accident assessment methodology). If an accident producing such an airborne release were to occur, people living closer to SRS would be impacted to a greater degree than those living farther away from SRS. In the unlikely event of such an accident at the proposed facilities, many of the communities most likely affected would be minority or low income, given the demographics within the 80-km (50-mi) assessment area (see Figures 4.2 and 4.3). In addition, following a hypothetical accident severe enough to produce such a significant airborne release, impacts would be larger if contaminated crops were ingested. In the long-term, the impacts to low-income and minority groups could be higher because of the reliance on homegrown foods. On the basis of the above estimate of accident impacts and considering that low-income and minority populations would be more likely to rely on homegrown foods, the NRC concludes that the impacts to low-income and minority populations could be high and adverse in the event of an accident as described above. However, it is highly unlikely that such an accident would occur. Therefore, the risk to any population, including low-income and minority communities, is considered to be low.

In the event that accidents producing significant contamination occurred as described above, appropriate measures are expected to be taken to ensure that the impacts to all populations, including low-income and minority populations, would be minimized (see Section 5.2.12). The extent to which low-income or minority population groups would be affected would depend on the amount of material released and the direction and speed at which airborne material was dispersed from the facility by the wind. Although the overall risk would be very small, the greatest short-term risk of exposure following an airborne release would be to the population located to the west-northwest of SRS. The greatest 1-year exposure risk would be to population groups residing to the southwest of the site following the ingestion of contaminated crops. With no ingestion, the greatest 1-year risk would still be to the west-northwest. Airborne releases following an accident would likely have a larger impact area than would an accident that released contaminants directly onto the soil surface. A surface release entering local streams could temporarily interfere with subsistence activities by low-income and minority populations located within a few kilometers downstream of SRS.

Monitoring of contaminant levels in soil and surface water following an accident would provide the public with information on the extent of any contaminated areas. Analysis of contaminated areas to decide how to control use of high health risk areas would reduce the potential impact to local residents.

4.3.7.3.4 Decommissioning

Impacts of decommissioning are not expected to disproportionally affect low income or minority populations in the SRS vicinity. A detailed analysis of impacts would be prepared by DOE in a NEPA document specifically on decommissioning and site closure if plans call for full decommissioning of the facilities. Important elements of the environmental analysis in the DOE NEPA document would likely address the disposal process and locations of disposal sites for structural materials and facility components resulting from decommissioning.

4.3.8 Sand Filter Technology Option

Sand filters are air filtration systems used to prevent the release of radioactive material from nuclear facilities to the atmosphere. In a sand filter, the airborne radioactive material is forced through large beds of stone, gravel, and sand that capture and retain radioactive material. Filtered air is discharged to the atmosphere from a nearby stack.

As discussed in Sections 1.4.1 and 2.2.5, the use of sand filters was identified during the EIS scoping process as a potential substitute for final HEPA filters. Differences in impacts between sand filters and HEPA filters are discussed below. Specifically, this section presents the impacts to human health, air quality, hydrology, waste management, potential accident impacts, and facility decommissioning.

Relative to radiological impacts during routine operations, those human receptors who would be affected by such a change would be the proposed MOX facility workers, SRS employees, and the public. However, the differences in emissions between the two filter types is not significant. Thus, the impacts presented in Section 4.3.2.2 on routine operational impacts from the proposed MOX facility to SRS employees and the public would hold for both sand filters and the proposed HEPA filters. In the case of the proposed MOX facility workers, exposure would occur from maintenance activities during normal operations. Monitoring to ensure adequate performance would be required for both filter types. However, HEPA filters, unlike sand filters, would require periodic replacement in addition to monitoring (Orr 2001). The additional exposure in the case of HEPA filters would be minimized with the use of a bag-in/bag-out system (one that isolates the filters from personnel and the environment during replacement) and the maintenance of practices to limit releases of radioactivity to levels ALARA (Orr 2001).

With regard to chemical risks, the difference in chemical removal efficiency between HEPA filters and sand filters is small. Therefore, the impacts presented in Section 4.3.2.2 would be representative for either filter type.

Because air quality impacts associated with the proposed MOX facility would be dominated by the emission of gaseous chemical compounds, and neither HEPA filters nor sand filters are effective for gases, sand filters do not present a clear advantage over HEPA filters. Air quality impacts would be mitigated by other off-gas treatment systems associated with the proposed action.

If sand filters were chosen over HEPA filters at the proposed MOX facility, excavation would be needed for the filter foundations. Excavation is not expected to extend to a depth likely to encounter groundwater. The depth of the sand filter would depend on spatial configuration and topography at the specific site selected for the filter. A surface area of 3,162 m^2 (33,650 ft^2) would be required for the sand filter (Orr 2001). Operation of a sand filter at the proposed MOX facility would not impact groundwater resources. The filter would be covered to prevent precipitation from enhancing recharge of the underlying aquifers and would have a concrete wall and bottom.

The impact to waste management practices was also evaluated with regards to the type of air filters that could be used during proposed MOX facility operations. The waste volume and associated disposal costs from routine operations using HEPA filters versus use of sand filters are compared in Table 4.20. TRU waste and LLW would be generated if HEPA filters were used, and primarily TRU waste would be generated if sand filters were used.

Relative to radiological impacts resulting from accidents, sand filters may provide a larger margin of safety for SRS employees and the public. Two of the four accidents evaluated, the internal fire event and the explosion event, have the potential to damage HEPA filters. If the major vent duct work itself remained intact for these accidents, filter efficiency would not be lost if sand filters were used, and the impacts for the internal fire event and the explosion event could be approximately 100 times lower than the impacts presented for HEPA filters in Section 4.3.5. (Appendix E presents more information on the amount of radioactivity released from each accident considered.) DCS has committed to a strategy of making explosions highly unlikely if they could result in high consequences to SRS employees and members of the public. By preventing explosions, DCS would prevent impaired function of the facility HEPA filters. Further, DCS would maintain safety controls in the proposed MOX facility that would either prevent fires, or for some areas, ensure that fires are contained to single fire areas that would limit the amount of radioactive material involved a fire. Where fires are limited to fire areas, DCS would ensure that the facility HEPA filters would continue to function in the high temperature and soot environment created by the bounding fire.

The decommissioning impacts described in Section 4.3.6 were based on the proposed use of HEPA filters. However, if a sand filter was used, there is the possibility that it could be left in

Table 4.20. Comparison of waste volume and disposal cost for HEPA and sand filters

Parameter	HEPA filter	Sand filter
Waste amount	2,178 filters	9,543 m^3
Disposal cost[a]	$9,333,000	$8,411,750
Type of waste	TRU, LLW	TRU

[a]Estimated disposal cost for HEPA filters is based on the number of filters required, while the cost for the sand filters is based on total volume of sand and rock requiring disposal.

place, incurring little additional decommissioning work. Otherwise, there could be significant impacts, such as economic costs and human health risks, from excavating the contaminated material and possibly transporting and disposing of significant amounts of low-level or transuranic waste, depending on the level of contamination (Orr 2001).

In conclusion, the technology option to install sand filters would not clearly result in lower net environmental impacts than the use of HEPA filters. By selecting sand filters, DCS could reduce environmental impacts in the areas of human health risk to facility workers and accident mitigation. However, controls on HEPA filter change-out and a DCS safety strategy to prevent accidents that would challenge HEPA filter function provide an equivalent reduction of impacts.

4.4 Indirect Impacts

4.4.1 Transportation

This assessment is based on the transportation assessment presented in the NRC's NUREG-0170 report (NRC 1977). Since that assessment was conducted, computer models and basic assumptions have been refined, but the overall approach to estimating transportation impacts has remained the same.

4.4.1.1 Scope of the Analysis

The technical approach for estimating transportation risks involves use of several computer models and databases. For assessment of normal transport, risks were calculated for the collective populations of all potentially exposed individuals, as well as for an MEI receptor. Potentially exposed populations include those persons living and working along the transport route, those present at vehicle stops, and those on the road near the shipment. The accident assessment included consideration of the probabilities and consequences of a range of possible transportation-related accidents, including low-probability accidents that have high consequences, and high-probability accidents that have low consequences. The details of the transportation analysis are provided in Appendix C. Transportation impacts are presented in Section 4.4.1.2.

Transportation concerns raised during the scoping process for this EIS (see Appendix I) included the impacts of transporting MOX feed materials (depleted uranium hexafluoride [UF_6] and the surplus plutonium metal) transport. As discussed below, impacts from the transportation of depleted uranium and surplus plutonium metal (pit material) feed materials were analyzed. Impacts of transporting the plutonium dioxide from the proposed PDCF to the proposed MOX facility are not considered because of the short distance involved and the absence of public roads in this area (DCS 2002a). The NRC intended to evaluate truck and rail transportation impacts of shipping fresh MOX fuel from the SRS (see Appendix I). However, this FEIS evaluated only truck shipments of such fuel because of the added security provided through the use of the Safeguards Transporter, as described in Appendix C, Section C.2.3.

The transportation risk assessment conducted for operation of the proposed MOX facility involved estimating the potential human health risks during transport of feed and waste materials associated with the MOX fuel fabrication process. The risk assessment also considered the risks associated with the transport of the MOX fuel following fabrication.

Transport of the depleted uranium feed materials analyzed included shipment of depleted UF_6 from Portsmouth, Ohio, to Wilmington, North Carolina, and depleted uranium dioxide (UO_2) from Wilmington to the proposed MOX facility at the SRS. Assessment of the transport of plutonium pit material considered shipments from existing storage sites to the SRS. Of the 34 MT (37.5 tons) of plutonium expected to be processed into MOX fuel, 7.3 MT (8.0 tons) would be initially available at the SRS site. Under a separate action (DOE 2002a), approximately 6 MT (6.6 tons) of surplus plutonium is to be shipped from RFETS to SRS (Roberson 2002), which currently has 1.3 MT (1.4 tons) (DOE 1996a). The proposed action would therefore require the shipment of another 26.7 MT (29.4 tons) of plutonium, approximately 21.3 MT (23.4 tons) of which is expected to come from the Pantex Plant in Texas. This FEIS analyses the transportation impacts of the Pantex shipments and the remaining 5.4 MT (5.9 tons) of plutonium whose origins are not yet determined. However, the remaining plutonium would come from storage at other DOE sites. For the purposes of this FEIS, the analysis assumed that the remaining 5.4 MT (5.9 tons) of plutonium would come from the Hanford Site, the plutonium storage site farthest from the SRS. Thus, the actual transportation impacts are expected to be lower than those presented here because some plutonium from closer storage sites is expected to be used. Impacts of shipping TRU waste from the WSB to the Waste Isolation Pilot Plant (WIPP) in New Mexico were evaluated for two cases that bound the potential number of shipments. No volume reduction of the TRU waste is analyzed for the first option, resulting in approximately 2,300 truck shipments over the life of the project. The second option analyzes a case involving a volume reduction of TRU waste by a 3:1 ratio, shipments being constrained by a wattage limit.

Additionally, the FEIS evaluates the impacts of shipping all the fresh MOX fuel from the SRS to a surrogate commercial nuclear plant. The fresh MOX fuel is expected to be used in reactors in the eastern to midwestern portion of the United States. For purposes of impact assessment, a midwestern site was chosen for the surrogate nuclear plant because such a location maximizes the distances necessary to transport the fuel, thus providing conservative estimates of potential impacts. A surrogate nuclear power plant was chosen because no licensed nuclear plant has applied to NRC for authority to use MOX fuel. Thus, the impacts presented here are expected to bound the impacts for future shipments of fresh MOX fuel.

For all shipments, risks were estimated for truck transport for both normal (incident-free) and accident conditions. In both cases, “vehicle-related” and “cargo-related” impacts were evaluated.

Vehicle-related risks result simply from moving any material from one location to another, independent of the characteristics of the cargo. For example, increased levels of pollution from vehicular emissions during normal conditions may affect human health. Similarly, accidents during transportation may cause fatalities from physical trauma.

Cargo-related risk, on the other hand, refers to risk attributable to the characteristics of the cargo being shipped. The radiological cargo-related risks from the transportation of depleted uranium, surplus plutonium, fresh MOX fuel, and TRU waste would be caused by exposure to ionizing radiation. Exposures to radiation occur during both normal transportation and during accident conditions. In the case of the depleted uranium materials considered, cargo-related risks also include chemical hazards during accident conditions.

The risks from exposure to hazardous chemicals during transportation-related accidents can be either acute (result in immediate injury or fatality) or latent (result in cancer that would present itself after a latency period of several years). The acute health end point — potential irreversible adverse effects — was evaluated for the assessment of cargo-related population impacts from transportation accidents. Accidental releases during transport of the uranium compounds (UF_6 and UO_2) were evaluated quantitatively. The analysis of UF_6 effects included consideration of the formation of hydrogen fluoride (HF) from the reaction of UF_6 with moisture in the air. Chemical health effects from transportation of plutonium compounds were not assessed because the radiological impacts are far greater than any chemical impacts.

Unlike the case for radiological exposure, the acute chemical effects evaluated were assumed to exhibit a threshold nonlinear relationship with exposure; that is, some low level of exposure can be tolerated without inducing a health effect. To estimate risks, chemical-specific concentrations were developed for potential irreversible adverse effects. All individuals exposed at these levels or higher following an accident were included in the transportation risk estimates. In addition to acute health effects, the cargo-related risk of excess cases of latent cancer from accidental chemical exposures could be evaluated. However, none of the chemicals that might be released in any of the transportation accidents involving UF_6, UO_2, plutonium, or the MOX fuel would be carcinogenic. As a result, no predictions for excess chemically induced latent cancers are presented in this assessment for accidental chemical releases.

4.4.1.2 Transportation Impacts

The estimated exposures and the associated human health effects are discussed in this section and summarized in Table 4.21.

4.4.1.2.1 Routine Transportation

Radiological risks during routine transportation would result from the potential exposure of people to low levels of external radiation near a loaded shipment. DOT and NRC regulations — 49 CFR Part 173.441 (*Radiation Level Limitations*) and 10 CFR Part 71.47 (*External Radiation Standards for All Packages*) — were set to maintain these external radiation levels at a value considered to be protective of the public. The maximum allowable external dose rate is 0.1 mSv/h (10 mrem/h) at 2 m (6.5 ft) from the outer lateral sides of the transport vehicle. In this analysis, the external dose rates expected are approximately 0.0024 mSv/h (0.24 mrem/h), 0.0076 mSv/h (0.76 mrem/h), 0.048 mSv/h (4.8 mrem/h), and 0.040 mSv/h (4.0 mrem/h) at 1 m

(3.3 ft) for the UF_6, UO_2, MOX fuel, and TRU waste shipments, respectively (Biwer et al. 1997; DCS 2001; DOE 1997b). Since the regulatory maximum is approximately 0.14 mSv/h (14 mrem/h) at a distance of 1 m (3.3 ft), the external dose rates from the depleted uranium shipments, the MOX fuel shipments, and the TRU waste shipments are expected to be less than 6%, 35%, and 30% respectively, of that regulatory maximum. For this analysis, the external dose rate for the shipments of plutonium metal were set to the regulatory maximum, but it is expected that the dose rate from these shipments would actually be similar to those for the fresh MOX fuel and TRU waste.

Combined total exposures of 3.1 to 5.6 person-Sv (310 to 560 person-rem) and 2.1 to 5.3 person-Sv (210 to 530 person-rem) were estimated for the public and the transportation crews, respectively, from all shipments. The resulting expected LCFs were 0.2 to 0.4 and 0.1 to 0.3, respectively (see Table 4.21). These impacts to the public would be insignificant because the exposure would be spread out over several years among all the people along the transportation routes. If no TRU waste volume reduction occurs, TRU waste shipments from the WSB to WIPP would have the highest average individual dose to the public, 0.0025 mSv (0.53 mrem), estimated from a total collective dose of 3.0 person-Sv (300 person-rem) spread over 566,000 persons along the route. Thus, the routine radiological impacts to the public for the entire shipping campaign would be negligible, an average member of the public would receive only 0.15% or less of the value for exposure to background radiation in one year.

For an MEI member of the public (defined as being located 30 m [98 ft] away from a shipment passing at a speed of 24 km/h [15 mph] [Neuhauser and Kanipe 1992]), the greatest radiological risk would be from the plutonium metal shipments, as shown in Table 4.22. In this case, a risk of 6×10^{-10} (a chance of less than 1 in 1 billion) of contracting a fatal cancer is 0.0003% of the value for an annual exposure to background radiation. However, the value for potential exposure to multiple shipments would be correspondingly higher. For example, if the same MEI were present for three shipments of depleted UO_2, that individual would receive a dose of approximately 1.1×10^{-6} mSv [$3 \times (3.7 \times 10^{-7}$ mSv)].

For transportation crew members, the largest estimated single shipment dose to one transportation crew member was 0.0013 Sv (0.13 rem) for shipments of plutonium from the Hanford Site to the PDCF. In this case, the risk of contracting a fatal cancer is 1 in 13,000.

A total of up to 2 latent fatalities were estimated from vehicle emissions for the entire shipping campaign. Thus, approximately 2 fatalities or less might be expected from vehicle emissions. This vehicle-related impact is insignificant because the proposed action truck travel on U.S. highways for the high end of the entire shipping campaign, 8,200,000 km (5,090,000 mi) as shown in Table 4.21, is only 0.0038% of similar truck travel on an annual basis in the United States, 217,550,000,000 km (135,179,000,000 mi) (BTS 2002).

Table 4.21. Total collective population transportation risks

Parameter	Depleted UF_6	Depleted UO_2	Pu metal	TRU waste[a]	MOX fuel	Total campaign[a]
Origin site	Portsmouth, OH	Wilmington, NC	Storage sites	WSB	MOX facility	
Destination site	Wilmington, NC	MOX facility	PDCF	WIPP	surrogate reactor	
Shipment summary						
Shipments	110	60	430	299-2,314	598	1,497-3,512
Distance (km)[b]	103,000	26,500	1,130,000	730,000-5,650,000	1,280,000	3,280,000-8,200,000
Population impacts						
Cargo-related[c]						
Radiological impacts						
Dose risk (person-Sv)[d]						
Routine crew	0.0061	0.0045	0.72	0.46-3.6	0.93	2.1-5.3
Routine public						
Off-link	0.00044	0.00013	0.12	0.019-0.15	0.038	0.18-0.30
On-link	0.0011	0.00035	0.35	0.058-0.45	0.094	0.50-0.89
Stops	0.0045	0.0018	1.7	0.31-2.4	0.34	2.4-4.4
Total	0.0060	0.0022	2.2	0.39-3.0	0.48	3.1-5.6
Accident[e]	0.0025	0.00049	0.00063	0.063	0.16	0.23
Latent cancer fatalities[f]						
Crew	0.0004	0.0003	0.04	0.03-0.2	0.06	0.1-0.3
Public	0.0005	0.0002	0.1	0.03-0.2	0.04	0.2-0.4
Chemical impacts						
Irreversible adverse effects[g]	1.3×10^{-7}	0	NA[h]	NA	NA	1.3×10^{-7}
Vehicle-related[i]						
Emission fatalities	0.04	0.008	0.3	0.2-1	0.6	1-2
Accident fatalities	0.003	0.0012	0.028	0.017-0.13	0.029	0.078-0.20

Table 4.21. Continued

[a]The number of TRU waste shipments will depend on the waste treatment process used (DCS 2004a). The largest volume reduction estimated would result in the fewest number of shipments. The largest number of shipments corresponds to the minimum amount of TRU waste treatment necessary for shipment.

[b]To convert km to mi, multiply by 1.609.

[c]Cargo-related impacts are impacts attributable to the radioactive or chemical nature of the waste material.

[d]To convert person-Sv to person-rem, multiply by 100.

[e]Accident dose risk is a societal risk and is the product of accident probability and accident consequence.

[f]Latent cancer fatalities are calculated by multiplying dose by the FGR 13 health risk conversion factor of 0.06 fatal cancer per person-Sv (6×10^{-4} fatal cancer per person-rem) (Eckerman et al. 1999).

[g]Potential for irreversible adverse effects from chemical exposures. Exposure to HF or uranium compounds is estimated to result in fatality of approximately 1% or less of those persons experiencing irreversible adverse effects (Policastro et al. 1997).

[h]NA = not applicable.

[i]Vehicle-related impacts are impacts independent of the cargo in the shipment.

Table 4.22. Routine single-shipment impacts to a maximally exposed individual[a]

Shipment type	Dose [mSv (mrem)]	Risk of developing a latent fatal cancer
Depleted UF_6	2.3×10^{-7} (2.3×10^{-5})	1×10^{-11}
Depleted UO_2	3.7×10^{-7} (3.7×10^{-5})	2×10^{-11}
Pu metal	1×10^{-5} (1×10^{-3})	6×10^{-10}
MOX fuel	1.5×10^{-6} (1.5×10^{-4})	9×10^{-11}
TRU waste	2.4×10^{-6} (2.4×10^{-4})	1×10^{-10}

[a]Individual is located 30 m (98 ft) from a passing shipment traveling at 24 km/h (15 mph).

4.4.1.2.2 Accident Impacts

The total radiological collective population accident dose risk to the public from all shipments was estimated to be 0.23 person-Sv (23 person-rem). The resulting estimated LCFs are 0.01 for the entire shipping campaign.

Chemical impacts would be negligible; only 1.3×10^{-7} irreversible adverse effect from depleted UF_6 shipments is expected for the entire shipping campaign. As discussed in Appendix C (Section C.2.6), this value corresponds to approximately 1×10^{-9} fatality.

Total fatalities from direct physical trauma as a result of accidents were estimated to be up to 0.20. Thus, no fatalities are expected from accidents for the entire shipping campaign.

4.4.1.3 Highly Enriched Uranium

As described in Section 2.2.2.2, HEU is a by-product of the plutonium pit disassembly process. This recovered HEU from the PDCF would be shipped to the Y-12 facility at the Oak Ridge Reservation for declassification, storage, and eventual disposition. The transportation risks for these shipments were analyzed and included in estimates presented in the SPD EIS for transport of all radioactive material associated with the conversion of 33 MT (36.4 tons) of plutonium to MOX fuel as part of Alternative 3 (see Table L-6 in DOE 1999a). The total radiological transportation risks for Alternative 3 were 0.024 and 0.038 LCFs expected for transportation workers and the public, respectively. Thus, the transportation risks for the HEU shipments are considered to be insignificant because they represent only a small portion of an insignificant impact.

4.4.1.4 Spent MOX Fuel

Transportation of the spent MOX fuel to a final disposal site would be required after irradiation in a commercial nuclear reactor. The types of transportation risks posed would be the same as those considered above for the uranium and plutonium feed materials, the fresh MOX fuel, and the TRU waste. These risks include the radiological cargo-related risks from routine transport and hypothetical accidents and the vehicle-related risks, such as traffic accident fatalities and potential latent fatalities from vehicle emissions.

Estimating specific transportation risks for the spent MOX fuel is premature at this time because of the uncertainty in the actual location of both the commercial reactors that would be used for irradiation of the fresh MOX fuel and the final disposal site. As discussed in Section 4.4.1.1, the actual commercial reactors that would be used to irradiate the fresh MOX fuel are not yet known. The only disposal site currently under consideration in the United States is the proposed geologic repository at Yucca Mountain in Nye County, Nevada (DOE 2002d). For purposes of complying with NEPA requirements, it is assumed that spent MOX fuel would eventually be shipped to the proposed Yucca Mountain repository. However, the DOE's application for a license to operate the Yucca Mountain repository has not yet been submitted to the NRC. There is no assurance that the DOE's application, if submitted, would be approved.

On a per kilometer traveled basis, the routine radiological and vehicle-related transportation risks for spent MOX fuel would be similar to those estimated in this FEIS for fresh MOX fuel, plutonium metal, or TRU waste. The transportation risks of commercial spent nuclear fuel (SNF) and spent MOX fuel transport in particular were estimated in DOE's EIS concerning disposal of SNF and high-level waste at Yucca Mountain (DOE 2002d). In the mostly legal-weight truck scenario, approximately 53,000 truck shipments were estimated to result in approximately 12 LCFs to workers, 3 LCFs to the public, and 5 traffic fatalities. A rough estimate of the transportation risks of the spent MOX fuel can be obtained based on average shipment risks calculated from these results to show that no fatalities would be expected. Shipment of all the spent MOX fuel, approximately 598 shipments assuming three assemblies per cask, might be expected to result in approximately 0.1 worker LCFs, 0.03 public LCFs, and 0.056 transportation fatalities. Actual impacts would be lower or higher depending on the actual shipment distances relative to the average in the Yucca Mountain EIS (DOE 2002d). Thus, no significant impacts would be expected because the estimated risks are only a very small fraction of the radiological and vehicular risks to which the public are exposed to on a routine basis as discussed in Section 4.4.1.2.1.

4.4.2 Conversion of Uranium Hexafluoride to Uranium Dioxide

As discussed in Section 1.2.2, it is assumed that the conversion of uranium hexafluoride to uranium dioxide would take place at the Global Nuclear Fuel-Americas, LLC facility in Wilmington, North Carolina. The impacts of the general conversion process are described in the environmental assessment for the last license renewal of that facility (NRC 1997). At that time, the Wilmington facility was using the ammonium diuranate (ADU) process and was planning to begin using a new dry conversion process (DCP). The ADU process is a “wet” process that has higher impacts than the DCP. The GE facility currently uses the DCP. The environmental assessment includes a discussion of the impacts from both the ADU process and DCP. Therefore, it is believed that the impacts summarized below would bound impacts from the conversion process if another facility was ultimately selected.

No measurable impacts have been observed to the air, surface water, or vegetation due to releases from the Wilmington facility. Impacts to the shallow groundwater aquifer have occurred. The Wilmington facility produces gaseous, liquid, and solid effluent streams. Gaseous effluents are controlled by the use of HEPA filters and scrubbers permitted by the State of North Carolina, as necessary. Liquid effluents are controlled by the use of treatment systems and wastewater retention basins designed to reduce the concentration of contaminants prior to discharge. Solid wastes are managed through segregation, recycling, off-site disposal, and incineration. Discharges are permitted and are monitored to ensure compliance with permit requirements. Impacts to a hypothetical MEI and to the collective population are summarized in Table 4.23.

4.4.3 MOX Fuel Use

This section evaluates on a generic basis the impacts of using MOX fuel in reactors by summarizing analyses performed by the DOE in the SPD EIS (DOE 1999a).

Table 4.23. Comparison of human exposure for ammonium diuranate (ADU) and dry conversion processes (DCPs)

Pathway/receptor	ADU dose	DCP dose
Air		
Maximally exposed individual [mSv/yr (mrem/yr)]	0.001 (0.1)	0.0005 (0.05)
Collective population [person-Sv (person-rem)]	0.0009 (0.09)	0.00045 (0.045)
Liquid		
Maximally exposed individual [mSv/yr (mrem/yr)]	0.007 (0.7)	0.001 (0.1)
Collective population [person-Sv (person-rem)]	NA[a]	NA
Total		
Maximally exposed individual [mSv/yr (mrem/yr)]	0.008 (0.8)	0.00015 (0.15)
Collective population [person-Sv (person-rem)]	0.0009 (0.09)	0.00045 (0.045)

[a]Not applicable because liquid effluent in the river quickly dilutes to background levels; therefore, the collective dose impact is negligible.

The DOE's analysis is provided in Section 4.28 and Appendix K.7 of the SPD EIS. Impacts resulting from both normal operations and postulated accidents were evaluated for six reactors, two each at the Catawba, McGuire and North Anna nuclear stations. The range of impacts at each of these reactors were considered to reasonably bound the impacts of reactors that could use MOX fuel. Therefore, the range impacts is considered to represent a generic analysis. This range includes impacts from both ice condenser-type reactors (i.e., Catawba and McGurie) and non-ice condenser-type reactors. It was assumed that up to 40% of the fuel assemblies in a generic reactor would contain MOX fuel and that the remaining assemblies would contain the type of low-enriched uranium (LEU) fuel now used by commercial reactors. The impacts resulting from the use of MOX fuel in such a hybrid reactor core were estimated and compared with the impacts that would result from the use of a reactor core containing only LEU fuel.

The impacts from normal operations would be the same whether the reactor core contained 40% MOX fuel or 100% LEU fuel. The public surrounding such a generic reactor was estimated to receive a collective dose in the range of 0.057 person-Sv/yr (5.7 person-rem/yr) to 0.203 person-Sv/yr (20.3 person-rem/yr). The estimated number of annual LCFs produced by such a dose would be less than 0.01. No individual would be expected to receive more than 0.0073 mSv/yr (0.73 mrem/yr) due to reactor operations under normal conditions.

Some of the beyond-design-basis accidents were estimated to cause prompt fatalities in the highly unlikely event that they occurred. The change in the number of prompt fatalities due to the use of MOX fuel was estimated to range from 0 to 28 additional fatalities (815 versus 843 in the worst accident).

These doses are a small fraction of the annual average background dose. For comparison, as discussed in Section 3.10, the average annual natural background radiation dose to an individual in the United States is 3.6 mSv (360 mrem).

The SPD EIS (DOE 1999a) also analyzed potential MOX fuel use impacts from both postulated design-basis and beyond-design-basis accidents. The impacts were estimated in terms of both the consequences (the impacts that would result if the accident occurred) and risks (taken to be the consequences multiplied by the probability of occurrence of the accident). The risk was estimated over a 16-year campaign. The risk, over the entire 16-year period, of a LCF associated with design-basis accidents to the public surrounding a reactor using all LEU fuel ranged from 2.19×10^{-4} to 8.98×10^{-4}. The change in risk of a LCF associated with a reactor using 40% MOX fuel ranged from about 6% lower to 3% greater. For beyond-design-basis accidents, the campaign risk of a LCF to the public surrounding a reactor using all LEU fuel ranged from 0.144 to 5.25×10^{-5}. The change in risk of a LCF associated with a reactor using 40% MOX fuel ranged from about 7% lower to 14% greater.

The analysis in this EIS does not specifically consider impacts from the use of the lead test assembly (LTA) program. The LTA program consists of fabricating, transporting, using in a reactor, and analyzing a limited number of fuel assemblies. The DOE estimated the impact of the LTA program in the SPD EIS. The LTA program is considered to be independent of the proposed action. That is, the NRC decision regarding the proposed MOX facility is not affected by the DOE's decision on how to make and test the LTAs.

On February 27, 2003 (as amended September 23, 2003), Duke Power submitted a license amendment request to irradiate four MOX fuel lead test assemblies in the spring of 2005 in its Catawba Nuclear Station Units 1 & 2 (Docket Nos. 50-413, 50-414). The NRC is currently reviewing this license amendment request. In addition, in order for any specific commercial reactor to use MOX fuel on a production scale, an amendment to a 10 CFR Part 50 license, issued by the NRC, would be required. The NRC would perform its own site-specific NEPA analyses in evaluating any license amendment application it may later receive seeking authorization to use MOX fuel.

Impacts of transporting fresh MOX fuel to reactors is presented in Section 4.4.1.2.1, and impacts of transporting spent MOX fuel to a geologic repository is presented in Section 4.4.1.4. The impacts of disposing of the MOX fuel is included in the FEIS for Yucca Mountain (DOE 2002d).

4.5 Cumulative Impacts

This section assesses potential cumulative impacts of construction and operation of the proposed MOX, PDCF, and WSB facilities. Cumulative impacts are distinguished from the direct and indirect impacts of these facilities, which are discussed in Sections 4.3 and 4.4 and Appendix H. Direct effects are caused by the proposed action and occur at the same time and place. Indirect effects are caused by the proposed action and occur later in time or are farther removed in distance but are still reasonably foreseeable.

> **Cumulative Impacts**
>
> *Cumulative impacts* are potential impacts when the proposed action is added to other past, present, and reasonably foreseeable future actions.

Cumulative impacts were determined by adding the expected impacts of past, present, and reasonably foreseeable future actions to the projected direct and indirect impacts of the proposed MOX, PDCF, and WSB facilities. The impacts of construction and normal operations of the proposed facilities were evaluated for each impact area and are presented in Section 4.3. The impacts of past and present actions were determined from site environmental reports and other available documents (e.g., recent EISs). Reasonably foreseeable future actions include among others, those that would occur if the proposed MOX facility is built and operated, and include actions to be undertaken by the DOE as part of its surplus plutonium disposition program. The impacts of reasonably foreseeable future actions were taken from recently published NEPA analyses. Although the cumulative impact analysis focused on impacts at the SRS and vicinity (Section 4.5.1), an evaluation of cumulative impacts of off-site transportation activities is also included (Section 4.5.2).

4.5.1 Cumulative Impacts at the SRS

A review was conducted of past, present, and reasonably foreseeable future activities on the SRS. Past impacts were included in the cumulative impact assessment only if the residual effects of past actions are still in existence (e.g., past land use changes that are still in effect). Past impacts that have come and gone (e.g., operational impacts of decommissioned facilities) were not included in the cumulative impact assessment. The impacts of present activities and residual past activities at the SRS were determined from annual environmental reports that document the results of ongoing monitoring activities (e.g., Arnett and Mamatey 2001), as well as descriptions of the SRS baseline conditions in various recent DOE EISs. The impacts of past and present activities at the SRS are described qualitatively for each impact area in Chapter 3.

Nuclear facilities within an 80-km (50-mi) radius of the SRS include Georgia Power's Vogtle Electric Generating Plant across the river from the SRS; Chem-Nuclear Inc., a commercial low-level waste burial site just east of the SRS; and Starmet CMI, Inc. (formerly Carolina Metals), located southeast of the SRS, which processes uranium-contaminated metals. Radiological impacts from the operations of the Vogtle Electric Generation Plant, a two-unit commercial nuclear power plant, are small, but they are included in this cumulative impact 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 affect radiation levels in air or liquid pathways in the vicinity of the SRS.

The counties surrounding the SRS host numerous industrial facilities (e.g., Bridgestone Tire, textile mills, paper product mills, and manufacturing facilities) with permitted air emissions that cumulatively affect regional air quality. South Carolina Electric and Gas Company's Urquhart Station, a three-unit, 250-megawatt, coal- and natural-gas-fired steam electric plant, is located near the SRS in Beech Island, South Carolina. All of these facilities contribute to ambient air quality at the SRS and thus are included within the SRS baseline used in the analysis of cumulative air quality impacts.

A number of construction and operating permits for industrial facilities in Aiken, Barnwell, Allendale, and Edgefield Counties have recently been filed with the South Carolina Department of Health and Environmental Control Bureau of Air Quality. No new permits have been applied for in Augusta-Richmond, Columbia, and Burke Counties in Georgia. In addition, a number of road projects are planned in the area. These include relatively minor improvements in the Aiken and North Augusta, South Carolina, areas that are part of the Augusta Regional Transportation Study and would take place in 2003 through 2007. Additional road projects in the area include improvements to a 13-km (8-mi) portion of US 78 from Montmorenci, South Carolina, to Windsor, South Carolina (to the east of Aiken), and the extension of I-520 across the Savannah River into North Augusta. This latter project would take place in 2006 through 2009.

Construction of new facilities and roads would result in short-term air quality impacts and would only contribute to the cumulative impact of MOX facilities if the construction period of facilities overlapped with the MOX construction or operational period. Impacts to air quality resulting from operations of new facilities and roads would result in changes to regional air quality. It is difficult to adequately predict the contribution of these facilities and roads to cumulative air quality impacts with the information available. All facilities would require permitting, and this permit process would take into consideration regional air quality NAAQS compliance.

Reasonably foreseeable future actions at the SRS were identified by reviewing recent NEPA documents for the site. A brief synopsis of future projects at the SRS that are considered in the cumulative impact analysis is presented in the following paragraphs:

- *Final Defense Waste Processing Facility Supplemental Environmental Impact Statement,* DOE/EIS–0082–S (DOE 1994). The Defense Waste Processing Facility (DWPF) has been constructed at the SRS and is currently processing sludge from SRS HLW tanks. However, SRS baseline data do not include the impacts of all planned DWPF operations, including the processing of salt solution from these tanks. Therefore, the cumulative impact analysis includes some effects of DWPF in the impacts of past and present activities and some in the impacts of reasonably foreseeable future actions.

- *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement,* DOE/EIS-0240 (DOE 1996b). The cumulative impact analysis incorporates an alternative at the SRS that would blend highly enriched uranium to 4% low-enriched uranium as uranyl nitrate hexahydrate (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). DOE plans to process certain plutonium-bearing materials currently being stored at the RFETS (64 FR 8068; February 18, 1999, and 66 FR 4803; January 18, 2001). These materials are plutonium residues and scrub alloy remaining from nuclear weapons manufacturing operations. DOE has decided to ship certain residues from the RFETS to the SRS for plutonium separation and stabilization. The separated plutonium would be stored at the SRS pending disposition decisions. Environmental impacts from using the F-Canyon to chemically separate the plutonium from the remaining materials at the SRS are included in the cumulative impact analysis.

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

- *Surplus Plutonium Disposition Final Environmental Impact Statement,* DOE/EIS-0283 (DOE 1999a). The SPD EIS analyzed implementation of DOE's disposition strategy for surplus plutonium. The decision to site the facilities to implement this strategy at the SRS (as described in 65 FR 1608, January 11, 2000) is the basis for the proposed action analyzed in this EIS. The SPD EIS was used in some cases to determine the impacts of the Pit Disassembly and Conversion Facility for inclusion in the cumulative impact analysis.

- *Savannah River Site Spent Nuclear Fuel Management Final Environmental Impact Statement,* DOE/EIS-0279 (DOE 2000c). The selected alternative in the Record of Decision (ROD) for the Spent Nuclear Fuel Management EIS is to prepare for disposal of about 97% by volume (about 60% by mass) of the aluminum-based fuel considered in the EIS (48 MT [53 tons] heavy metal), using a melt and dilute treatment process (65 FR 48224; August 7, 2000). The impacts of this process are included in the cumulative impact analysis. The remaining 3% by volume (about 40% by mass) would be managed using conventional processing in existing SRS chemical separation facilities. As part of the preferred alternative, DOE will develop and demonstrate the melt and dilute technology. Following development and demonstration of that technology, DOE will begin detailed design, construction testing, and startup of a new treatment and storage facility to combine with a new dry storage facility. The SNF will remain in existing wet storage until treated and will then be placed in dry storage.

- *Savannah River Site High-Level Waste Tank Closure Final Environmental Impact Statement,* DOE/EIS-0303 (DOE 2002b). DOE evaluated three alternatives for tank closure. All of these alternatives would start after bulk waste removal. DOE decided (as described in 67 FR 53784; August 19, 2002) to implement the preferred alternative identified in the EIS (i.e., stabilize tanks and fill with grout). The impacts of this alternative are presented in this cumulative impact analysis.

- *Savannah River Site Waste Management Final Environmental Impact Statement,* DOE/EIS-0217 (DOE 1995). This EIS provides a basis for the selection of a sitewide approach to managing present and future (through 2024) wastes generated at the SRS. These wastes would come from ongoing operations and potential actions, new missions, environmental restoration, and decontamination and decommissioning programs. The EIS evaluated 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 an HLW evaporator in the H-Area Tank Farm. In addition, it evaluated the Consolidated Incineration Facility (CIF) for the treatment of mixed waste, including incineration of benzene waste from the in-tank precipitation (ITP) process. (The CIF has suspended operations and the ITP process is to be replaced by an alternative evaluated in DOE 2001.) The first ROD stated that DOE would configure its waste management systems according to the moderate treatment alternatives described in the EIS (60 FR 55249; October 30, 1995). The second ROD (62 FR 27241; May 9, 1997) 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 Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel,* DOE/EIS-0306 (DOE 2000d). DOE plans to treat all spent nuclear fuel from the Experimental Breeder Reactor-II (EBR-II) and sodium-bonded spent nuclear fuel at Argonne National Laboratory-West (ANL-W) (located at INEEL) (65 FR 56565, September 19, 2000). Fermi-1 sodium-bonded spent nuclear fuel will be stored pending a decision on alternative treatments. DOE does not plan to implement any of the alternatives proposed for the SRS. However, some of the impact projections from other EISs (e.g., cumulative waste generation from the High-Level Waste Tank Closure EIS [DOE 2000a]) include impacts at the SRS from sodium-bonded spent nuclear fuel, and these impacts were excluded from the cumulative impact analysis.

- *Savannah River Site Salt Processing Alternatives Final Supplemental Environmental Impact Statement,* DOE/EIS-0082-S2 (DOE 2001). A process to separate the high-activity and low-activity waste fractions in high-level waste solutions is planned to replace the in-tank precipitation process assessed in the Defense Waste Processing Facility EIS (DOE 1994). The Salt Processing EIS evaluates four alternatives: small tank precipitation; ion exchange; solvent extraction; and direct disposal in grout. The proposed MOX facility cumulative impact analysis includes maximum impacts of the solvent extraction process as selected in the DOE ROD for this project (66 FR 201, p. 52752, October 17, 2001).

- *Environmental Assessment for the Construction and Operation of the Highly Enriched Uranium Blend-Down Facilities at the Savannah River Site,* DOE/EA-1233 (DOE 2000e). DOE plans to construct and operate a low-enriched uranium (LEU) loading station and modifications to the existing HEU blend-down facilities. The process will convert off-specification HEU (60% uranium-235) to less than 20% uranium-235 for use as commercial fuel. The environmental assessment (EA) for this facility indicated that impacts would be either negligible or unmeasurable. A Finding of No Significant Impact was issued on November 3, 2000.

- *Draft Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility*, DOE/EIS-236-S2 (DOE 2003b). A modern pit facility (MPF) has been proposed by DOE’s National Nuclear Security Administration to manage and maintain the U.S. nuclear weapons stockpile. DOE has prepared a Supplement to the Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility. This MPF EIS evaluates the environmental impacts associated with constructing a new MPF at four alternate sites, including the SRS, and across a range of pit production capabilities. The MOX facility cumulative impact analysis incorporates the impacts of the highest pit production rate (450 pits/year).

For all impact areas but employment, it was conservatively assumed that the impacts of past, present, and future activities would occur simultaneously. In reality, there would be less overlap of impacts in time (e.g., the impacts of some projects would be declining during the operational life of the facility), and cumulative impact, therefore, actually would be less than is presented here. Impacts to the MEI were also determined using a conservative approach that assumed the same MEI would be exposed to all concurrent actions (see Section 4.3.1.1.2 for the location of MEI for the proposed MOX facility). In reality, the MEIs for different activities vary and are dependent on the location of the activity (Simpkins 2000).

4.5.1.1 Cumulative Impacts of the MOX, PDCF, and WSB Facilities

Cumulative impacts of the facilities at the SRS were evaluated in detail for (1) air quality; (2) human health; (3) waste generation; (4) resource use (land, electricity, and water); and (5) employment. These impacts were evaluated on the basis of the anticipated effects of facility construction and normal operations (as presented in Section 4.3) and the potential for contributions to existing cumulative impacts on the SRS. The analysis focused primarily on normal facility operations over an assumed 10-year operating period. Construction impacts were considered in the cumulative impact analysis only with respect to the amount of land developed, because other construction impacts would be too short-lived to contribute substantially to cumulative impacts to any resources. Additionally, standard mitigation practices employed during construction (e.g., dust control measures, erosion control) would likely reduce these impacts to negligible levels.

Topics Evaluated and Impact Criteria Used in the Cumulative Impact Analysis

- ***Air quality:*** % NAAQS for criteria pollutants.
- ***Human health:*** Radiological dose to off-site MEI, off-site population, and SRS workers and resultant latent cancer fatalities.
- ***Waste generation:*** Generation rate of various waste types relative to existing SRS capacity.
- ***Resource use:*** Amount of land developed relative to total SRS area; amount of electricity and water used relative to existing SRS capacity.
- ***Employment:*** Number of jobs at the SRS.

Impacts to water quality, geologic resources, ecological resources, aesthetic and scenic resources, and cultural resources are not treated explicitly in the cumulative impact analysis because direct and indirect impacts to these resources are expected to be small (see Sections 4.3 and Appendix H). Facility operations would not contribute to the cumulative impacts of SRS activities on water quality because liquid effluents would be discharged to surface water under existing NPDES permit guidelines. No impacts are anticipated to aesthetic and scenic resources because the facilities would be visually consistent with surrounding SRS industrial facilities and would not be visible from off-site. Impacts to geologic, ecological, and cultural resources are expected to be small and would be limited to the immediate vicinity of the facilities (which would be located on a partially developed site), thus reducing the potential for cumulative impact. Any cumulative impacts to these resources would be proportional to the cumulative impact projected for land development at the SRS.

Cumulative impacts to air quality were evaluated for five pollutants — TSP, PM_{10}, NO_2, SO_2, and CO. Normal operations of the MOX, PDCF, and WSB facilities would result in small contributions (2% or less) to cumulative concentrations of these air pollutants (see Table 4.24). For four air pollutants (annual total suspended particulates, 24-hour PM_{10}, 3-hour SO_2, and 24-hour SO_2), the cumulative total concentrations would be above 90% of the NAAQS and, therefore, approaching noncompliance. However, even without the contributions from operations of the proposed facilities, the cumulative totals for these four pollutants would be above 90% of the NAAQS. The cumulative total concentration of $PM_{2.5}$ could not be

Table 4.24. Estimated cumulative impacts to air quality from MOX, PDCF, and WSB facility operations and other activities at the SRS[a]

Source	Pollutant concentrations ($\mu g/m^3$)								
	TSP,	PM_{10}		NO_2,	SO_2			CO	
	annual	24 h	annual	annual	3 h	24 h	annual	1 h	8 h
SRS baseline[b, c]	74.6	138	25.9	26.3	1,246	355	31.1	10,363	6,867
MOX facility, PDCF, and WSB	0.002	1.3	0.002	0.07	22	4.9	0.004	116	26
SNF management[d]	0.02	0.1	0.02	3.4	1.0	0.1	0.02	9.8	1.3
HEU disposition[e]	0.05	0.01	0.01	0.01	0.7	0.3	0.02	0.1	0.07
Tritium extraction facility[f]	0.0002	0.01	0.00009	0.006	0.09	0.001	0.00009	3.6	0.5
Plutonium residues[g]	0.0	0.0	0.0	0.04	0.0	0.0	0.0	0.0	0.0
Salt processing[h]	0.001	0.07	0.001	0.03	0.4	0.05	0.0005	18.0	2.3
Tank closure[i]	0.005	0.08	0.004	0.03	0.2	0.04	0.002	1.2	0.3
Modern Pit Facility[j]	0.18	0.33	0.07	2.4	1.9	0.83	0.17	6.8	4.7
Total concentration ($\mu g/m^3$)	74.9	139.9	26.0	32.2	1,247.6	361.5	31.3	10,518.2	6,902.5
MOX, PDCF, and WSB contribution (%)	0.00	0.9	0.01	0.23	1.8	1.4	0.01	1.1	0.4
NAAQS ($\mu g/m^3$)	75	150	50	100	1,300	365	80	40,000	10,000
% of standards	99.6	93.3	52.0	32.3	96.0	99.0	39.2	26.3	69.0

[a]Maximum predicted off-site cumulative ground-level concentrations of nonradiological pollutants.

[b]SRS baseline includes the impacts of existing SRS facilities (SRS maximum) and regional emissions (background) from Table 4.8. These values are hypothetical levels that are based on maximum permitted emissions from SRS sources and do not necessarily represent actual air quality conditions.

[c]Includes Defense Waste Processing Facility operations.

[d]*Source:* DOE (2000c).

[e]*Source:* DOE (1996b).

[f]*Source:* DOE (1999c).

[g]*Source:* DOE (1998).

[h]*Source:* DOE (2001) using maximum impact alternative.

[i]*Source:* DOE (2002b).

[j]*Source:* DOE (2003b).

determined because information was not available for many of the future actions considered here. However, the facilities would contribute a very small amount of $PM_{2.5}$ (0.009% of the annual standard) and only when emergency generators were used. It should be noted that all of the air quality analyses are based on very conservative assumptions (e.g., maximum concentrations for all facilities), and it is not likely that NAAQS exceedances would occur at the SRS.

During normal operations, the contribution of the MOX, PDCF, and WSB facilities to cumulative radiological dose to the public would be small (7% or less of total dose; see Table 4.25). The cumulative dose to an MEI would increase by 1% as a result of facility operations. The estimated risk of a LCF resulting from cumulative dose to the MEI is extremely small (4×10^{-7}). The estimated number of LCFs resulting from cumulative collective dose to the off-site population is 0.02. These very small numbers mean that statistically, radiological doses from plant operations would not be expected to cause any latent cancer fatalities in the off-site population.

Cumulative collective dose to workers at SRS would increase approximately 9% as a result of MOX, PDCF, and WSB facility operations. The number of expected LCFs among workers resulting from cumulative dose (that resulting from dose contributions from the SRS baseline, the proposed action, and other reasonably foreseeable future actions) is 1.7. For most types of waste, facility operations would contribute relatively small volumes to the cumulative waste generation volumes at the SRS (see Table 4.26), and existing waste treatment facilities at the SRS have sufficient capacity to treat this cumulative total (see Section 4.3.4.2). The largest proportionate increase would be in the amount of nonhazardous solid waste (approximately 19% increase).

The cumulative impacts of the facilities to land development, electricity usage, and groundwater usage at the SRS would be quite small and well within existing SRS capacity (see Table 4.27). Construction of the facilities would result in a slight increase (1.7%) in the amount of developed land at the SRS, but the cumulative amount of developed land on the SRS would remain quite small (3.9% of the total site). Facility operations would use 186,000 MWh/yr of electricity (3.6% of SRS capacity). Cumulative electricity demand resulting from facility operations and all existing and planned actions would be only 28% of SRS capacity. Facility operations would use 76 million L/yr (20.1 million gal/yr) of groundwater (0.02% of SRS capacity). Cumulative groundwater demand would be only 4.8% of SRS capacity.

Determination of the cumulative impacts on the SRS workforce is complicated by the fact that employment is not expected to be constant during the life of the facility and other existing and planned actions at the SRS discussed in the beginning of Section 4.5.1. The analysis presented here considered the time lines of workforce projections for the SRS baseline and reasonably foreseeable future actions and the year in which the workforce would be highest. The results of these conservative analyses are presented in Table 4.27. Overall, employment at the SRS has decreased from 22,070 in September 1993 to 14,193 in September 2000. Projections indicate that site employment will continue to decline to approximately 10,000 by

Table 4.25. Estimated annual cumulative radiological dose and latent cancer fatalities resulting from MOX, PDCF, and WSB facility operations and other activities at the SRS

	Dose to maximally exposed individual[a]				Collective dose to off-site population				Collective dose to workers	
Source	Air pathway (rem)	Liquid pathway (rem)	Total dose (rem)	Latent cancer fatalities[b]	Air pathway (person-rem)	Liquid pathway (person-rem)	Total dose (person-rem)	Latent cancer fatalities[b]	Total dose (person-rem)	Latent cancer fatalities[b]
SRS baseline[c]	4.0×10^{-5}	1.4×10^{-4}	1.8×10^{-4}	1.1×10^{-7}	2.3	3.9	6.2	3.7×10^{-3}	163	0.1
MOX, PDCF, and WSB	4.0×10^{-6}	–[d]	4.0×10^{-6}	2.4×10^{-9}	1.6	–[d]	1.6	9.4×10^{-4}	262	1.6×10^{-1}
SNF management[e]	1.5×10^{-5}	5.7×10^{-5}	7.2×10^{-5}	4.3×10^{-8}	0.6	0.2	0.8	4.5×10^{-4}	55	3.3×10^{-2}
HEU disposition[f]	2.5×10^{-6}	–[d]	2.5×10^{-6}	1.5×10^{-9}	0.2	–[d]	0.2	9.6×10^{-5}	11.3	6.8×10^{-3}
Tritium extraction facility[g]	2.0×10^{-5}	–[d]	2.0×10^{-5}	1.2×10^{-8}	0.8	–[d]	0.8	4.6×10^{-4}	4.0	2.4×10^{-3}
Plutonium residue management[h]	5.7×10^{-7}	–[d]	5.7×10^{-7}	3.4×10^{-10}	0.006	–[d]	0.006	3.7×10^{-5}	7.6	4.6×10^{-3}
Defense waste processing facility[i]	1.0×10^{-6}	–[d]	1.0×10^{-6}	6.0×10^{-10}	0.07	–[d]	0.07	4.2×10^{-5}	118	7.1×10^{-2}
Salt processing[j]	3.1×10^{-4}	–[d]	3.1×10^{-4}	3×10^{-9}	18.1	–[d]	18.1	1.1×10^{-2}	29	1.7×10^{-2}
DOE complex miscellaneous components[k]	4.4×10^{-6}	4.2×10^{-8}	4.4×10^{-6}	2.7×10^{-11}	0.007	2.4×10^{-4}	0.007	4.3×10^{-6}	2	1.2×10^{-3}
Tank closure[l]	2.5×10^{-8}	–[d]	2.5×10^{-8}	1.5×10^{-11}	0.0014	–[d]	0.0014	8.4×10^{-7}	1,600	1.0
Modern Pit Facility[m]	8.0×10^{-9}	–[d]	8.0×10^{-9}	4.8×10^{-12}	1.3×10^{-6}	–[d]	1.3×10^{-6}	7.8×10^{-10}	560	3.4×10^{-1}
Vogtle Nuclear Power Plant[n]	5.4×10^{-7}	5.4×10^{-5}	5.5×10^{-5}	3.3×10^{-8}	0.04	0.003	0.05	2.7×10^{-5}	–[d]	–[d]
Total	4.0×10^{-4}	2.5×10^{-4}	6.5×10^{-4}	3.9×10^{-7}	23.6	4.1	27.7	0.02	2,812	1.7
MOX, PDCF, and WSB contribution to total (%)	1.0	0.00	0.62	0.62	6.7	0.00	5.7	5.7	9.3	9.3

See next page for footnotes.

Table 4.25. Continued

[a]The MEIs for different facilities for the same pathway and the MEIs for different pathways for the same facility are likely to be different individuals. Therefore, simple addition of doses for all MEIs to estimate the total MEI dose is not accurate, but it is shown here to be conservative, (i.e., to present impacts that are overestimates of what would actually happen).

[b]Latent cancer fatalities are calculated by multiplying dose by the FGR-13 health risk conversion factor of 6×10^{-4} fatal cancer per person-rem (Eckerman 1999).

[c]SRS baseline includes the impacts of existing facilities and the residual impacts of past activities. Values are from Arnett and Mamatey (2001).

[d]Less than minimum reportable levels.

[e]*Source:* DOE (2000c); SNF = spent nuclear fuel.

[f]*Source:* DOE (1996b).

[g]*Source:* DOE (1999c).

[h]*Source:* DOE (1998).

[i]*Source:* DOE (1994).

[j]*Source:* DOE (2001).

[k]*Source:* DCS (2002a).

[l]*Source:* DOE (2002b).

[m]*Source:* DOE (2003b).

[n]*Source:* NRC (1996).

Table 4.26. Estimated cumulative waste generation at the SRS resulting from operation of the MOX, PDCF, and WSB facilities and other activities at the SRS

Source	Total waste generation over 30-year period (m^3)			Annual waste generation	
	Low-level waste	Hazardous-mixed waste	Transuranic waste	Nonhazardous solid waste (m^3)	Nonhazardous liquid waste (L)
SRS baseline[a, b]	120,000	3,900	6,000	6,670	4.2×10^8
MOX, PDCF, and WSB facilities[c]	28,838	120	4,431	4,140	6.0×10^7
Salt processing[d]	920	56	0	–[e]	Negligible
Environmental restoration and D&D activities[d]	62,000	6,200	0	NA[f]	NA
Modern Pit Facility[g]	150,900	290	33,900	6,900	8.2×10^7
Other future actions[h,i]	21,750	4,013	10,100	4,105	2.2×10^7
Total volume	384,408	14,580	54,521	21,815	5.8×10^8
MOX, PDCF, and WSB contribution to total (%)	7.5	0.8	8.1	19.0	10.4
SRS treatment capacity	534,900	534,900	–[j]	–[k]	1.0×10^9
Total volume as % of SRS capacity	71.9	2.7	–[j]	–[k]	58.0

[a]SRS baseline includes the impacts of existing facilities and the residual impacts of past activities.

[b]High-level, low-level, hazardous-mixed, and transuranic waste volumes from DOE (2001); nonhazardous solid and liquid waste volumes from DCS (2002a).

[c]Total waste generation for MOX, PDCF, and WSB operations over a 10-year period, the operational period of these facilities.

[d]*Source:* DOE (2001).

[e]Value presented in DOE (2001) as 61 metric tons/yr.

Footnotes continued on next page.

Table 4.26. Continued

[f]NA = not available.

[g]Source: DOE (2003b).

[h]30-year waste generation volumes include life-cycle waste associated with DWPF operations (DOE 1994), HLW tank closure (DOE 2002b), SNF management (DOE 2000c), Tritium Extraction Facility (DOE 1999c), plutonium residues (DOE 1998), HEU disposition (DOE 1996b), commercial light water reactor waste, and weapons components that could be processed at the SRS. Values presented were derived from values provided in DOE (2001), but were adjusted to remove the contribution from SPD facilities (included in salt processing values) and sodium-bonded SNF management, which no longer involves SRS operations.

[i]Nonhazardous waste volumes include waste generated by activities associated with HEU disposition (DOE 1996b), Tritium Extraction Facility (DOE 1999c), DWPF operations (DOE 1994), and HLW tank closure (DOE 2002b).

[j]Transuranic waste is transported off-site for disposal at the WIPP facility.

[k]Nonhazardous solid waste is recycled or disposed of at on-site and off-site facilities.

Table 4.27. Estimated cumulative impacts to resource use and employment from MOX, PDCF, and WSB facility operations and other activities at the SRS

Source	Land area		Electricity		Groundwater		Employment	
	Developed area (acres)	% Total SRS area	Average annual usage (MWh/yr)	% Total SRS capacity	Average annual usage (L/yr)	% Total SRS capacity	Number of workers	% SRS total
SRS baseline[a]	7,241[b]	3.7	411,000	9.3	1.7×10^{10}	4.7	13,227	78.2
MOX, PDCF, and WSB facilities	123	0.06	186,000	4.2	7.6×10^{7}	0.02	490	2.9
SNF management[b]	0	0.00	15,800	0.4	2.1×10^{8}	0.06	520	3.1
HEU disposition[c]	0	0.00	5,000	0.1	1.9×10^{7}	0.005	125	0.7
Tritium extraction facility[d]	3	0.002	20,600	0.5	NA[e]	NA	400	2.4
Plutonium residue management[f]	0	0.00	1,329	0.03	1.6×10^{7}	0.005	NA	NA
Defense waste processing facility[g]	105	0.05	32,000	0.7	NA	NA	60	0.4
Salt processing[h]	0	0.00	24,000	0.6	1.2×10^{7}	0.003	220	1.3
Tank closure[i]	0	0.00	0	0.0	8.7×10^{6}	0.002	85	0.5
Modern pit facility[j]	171	0.09	545,600	12.4	5.0×10^{8}	0.1	1,797	10.6
Total	7,643	3.9	1,241,329	28.2	1.8×10^{10}	4.8	16,924	100.0

[a]SRS baseline includes the impacts of existing facilities and the residual impacts of past activities.

[b]*Source:* DOE (2000c); SNF = spent nuclear fuel.

[c]*Source:* DOE (1996b).

[d]*Source:* DOE (1999c).

[e]NA = not available.

[f]*Source:* DOE (1998).

[g]*Source:* DOE (1994).

[h]*Source:* DOE (2001).

[i]*Source:* DOE (2000a).

[j]Source: (DOE 2003b).

2010 (DOE 1999c). Facility construction would result in a peak workforce of 1,000 in 2005. Facility operations would support 490 workers annually (3.2% of the total projected for the SRS).

4.5.1.2 Cumulative Impacts of the No-Action Alternative

The no-action alternative would be a decision by the NRC not to approve the proposed MOX facility. Because all the surplus plutonium would remain at the DOE sites, the facilities planned for processing this surplus plutonium at the SRS — the proposed MOX facility, PDCF, and the WSB — would not be constructed. Since none of the surplus plutonium from other DOE sites would be stored at the SRS, none of the projected impacts of these facilities (as presented in Section 4.5.1.1) would occur.

4.5.2 Cumulative Impacts of Transportation

Cumulative impacts of transportation were estimated by adding the contributions from four sources:

- Historical shipments of spent nuclear fuel and radioactive waste;
- Reasonably foreseeable future actions involving the transportation of radioactive materials;
- Spent fuel shipments to a geological repository at Yucca Mountain, Nevada;
- General transportation of radioactive materials not related to any particular action; and
- Transportation of surplus plutonium and depleted uranium to the SRS, fresh MOX fuel from the SRS to a surrogate Midwest nuclear power plant, and TRU waste to the WIPP.

Estimates of contributions from the first four sources to the collective occupational dose and dose to the general population were summarized in the EIS for a geological repository at Yucca Mountain (DOE 2002d). These estimates are presented in Table 4.28. The future SNF shipments listed in Table 4.28 include potential spent MOX fuel shipments to the repository.

The shipment risks from spent MOX fuel are similar to those for typical SNF. Therefore, these risks are expected regardless of the fuel type, normal LEU or MOX, that will be used in existing nuclear power plants in the future. The estimated dose resulting from the proposed action is similar to that resulting from historical shipments of spent nuclear fuel and radioactive waste, 100 times smaller than that resulting from reasonably foreseeable future actions and 1,000 times less than general transportation. The contribution to cumulative occupational and general population dose associated with the proposed action is expected to be insignificant.

Table 4.28. Estimated cumulative transportation impacts of facility operations and shipment of radioactive materials from other sources (1943 to 2048)

Category	Collective occupational dose [person-Sv (person-rem)]	Latent cancer fatalities	Collective dose to the general population [person-Sv (person-rem)]	Latent cancer fatalities
Historical shipments[a]	3.3 (330)	0.2	2.3 (230)	0.1
Reasonably foreseeable future actions[a]	197 (19,670)	12	498 (49,770)	30
Spent fuel shipments to geologic repository[a]	88 (8,800)	5	16 (1,600)	1
General transportation (1943 to 2048)[a]	3,300 (330,000)	198	2,900 (290,000)	174
MOX shipments[b]	2.1-5.3 (210-530)	0.1-0.3	3.3-5.6 (330-560)	0.2-0.4
Total	3,600 (360,000)	200	3,400 (340,000)	200

[a]*Source:* DOE (2002d).

[b]Doses represent total for all shipments associated with the MOX program. (See Table 4.20 [total campaign].)

4.6 Cost-Benefit Analysis

4.6.1 Introduction

This section compares the costs and benefits of the proposed action with the costs and benefits of the no-action alternative. The cost-benefit analysis sets forth the various environmental impacts (both negative and positive) of the proposed action, and the economic costs and benefits of building and operating the proposed MOX facility, the PDCF, and the WSB. Costs and benefits are assessed at both the national and regional levels. At the national level, the overall costs of proposed MOX facility construction and operation are compared with the benefits of plutonium supply reduction. The benefits to national security from plutonium supply reduction are substantial, but these benefits are not quantifiable in terms of dollars and cents.

The national benefits associated with the proposed action that are quantifiable include project expenditures during construction and operation of the proposed MOX facility, the PDCF, and the WSB. Various sectors in the national economy would provide the materials, equipment, and services needed to build and operate these facilities. However, because of the preliminary nature of the data needed to calculate impacts, no quantitative estimate of the impacts of construction and operation of the proposed MOX facility on the national economy was included in this EIS. A significant national benefit of the proposed action would be the avoided cost of continued plutonium storage. These costs are estimated to be approximately $256 million per year (2003 dollars) (NNSA 2002). Another national benefit of the proposed action would be the generation of additional supplies of electricity. However, this analysis does not assign a specific economic value to the electricity that would be generated by the irradiation of MOX fuel given the uncertainty surrounding the associated costs, in particular, the cost of power plant infrastructure upgrades.

There would also be regional costs and benefits associated with construction and operation of the proposed MOX facility. At the regional level, excluding costs and benefits that cannot be quantified, the proposed MOX facility would produce an overall net benefit of $1,940 million (see Table 4.29).

4.6.2 National Costs and Benefits

The primary national benefit of construction and operation of the proposed MOX facility would be a reduction in the supply of weapons-grade plutonium available for unauthorized use. Once the plutonium component in MOX fuel has been irradiated in commercial nuclear reactors, the isotopic composition of the plutonium would be more proliferation resistant. Moreover, since the plutonium would then be part of the resultant high-level nuclear waste, the plutonium would no longer be available for other uses. Compared with the no-action alternative — in which the weapons-grade plutonium would continue to be stored at several existing DOE locations — converting surplus plutonium into MOX fuel and irradiating it better ensures its security, since it would reduce the number of locations where the various forms of plutonium are stored (DOE 1997a). Converting surplus weapons-grade plutonium into MOX fuel is thus viewed as better ensuring that weapons-usable material would not be obtained by rogue states and terrorist groups. Implementing the proposed action would promote the above nonproliferation objectives.

A significant benefit of the MOX program would be the avoided cost of continuing to store the plutonium inventory. These costs are estimated to be approximately $256 million per year (2003 dollars) (NNSA 2002).

For the no-action alternative, although the costs and benefits of continued storage of plutonium in the present DOE locations are not re-evaluated in this analysis, these issues are discussed in the SPD EIS (DOE 1999a). Some of the impacts of the no-action alternative represent impacts of each entire DOE site, not just the impacts of continued storage. Continued storage of plutonium by the DOE at its present locations would not be expected to produce additional LCFs. Annual LCFs of approximately 0.002 in the surrounding population of the storage sites were estimated. The annual collective dose to members of the public (i.e., those living and working within 80 km [50 mi] of the SRS) produced by routine operation of the proposed MOX facility, the PDCF, and the WSB would be expected to result in an LCF rate of approximately 0.0009/yr or less. Therefore, continued storage would result in higher annual impacts.

Table 4.29. Summary of project costs and benefits in the REA (in millions of 2003 dollars, except where noted)

Item	MOX facility[a]
Costs	
Internal costs	
Construction	6
Operation	3
Short-term external costs (construction)	
Housing shortages	2% of vacant rental housing units would be required
Overcrowding in local public facilities	Minimal
Inflation	Minimal
Noise and congestion	Minimal
Water and sewage systems	Minimal
Long-term external costs (operations)	
Housing values	Less than 1% of vacant owner occupied housing would be required
Cost of providing public services	Less than 1% increase in revenues would be required
Deterioration in recreational values	Minimal
Restrictions to water and land	Minimal
Aesthetic values	Minimal
Cultural and historical sites	Minimal
Total REA costs	9
Benefits	
Avoided cost of continued plutonium storage	14
Total tax revenues	110
Economic activity in the REA	
Construction	
Annual average employment	1,020 jobs
Total income	370
Total regional product	760
Operations	
Annual average employment	1,270 jobs
Total Income	640
Total regional product	1,180
Other benefits	
Enhancement of recreational values	Minimal
Increased knowledge of the environment	Minimal
Total REA benefits	1,950
Net REA benefit	+1,940

[a]Data may not add to totals because of independent rounding.

The national costs associated with the proposed action are the total life-cycle costs, which include research and development and pre-capital costs, design and construction costs, operating costs, deactivation costs, and contingency costs. Decommissioning costs are not included given the uncertainty surrounding their magnitude. The total cost of the proposed action is estimated to be $4,064 million (in 2003 dollars), with $2,238 million to cover the cost of the proposed MOX facility and $1,825 million for the PDCF and WSB (NNSA 2002). A significant item included in the estimated total cost of the proposed facilities is the credits associated with the value of the MOX and HEU fuel. These items amount to $1,002 million over the life of the project (NNSA 2002).

4.6.3 Regional Costs and Benefits

The various quantifiable costs and benefits of the proposed MOX facility in the REA are identified in Table 4.29. Costs and benefits are presented for construction and operation, including decommissioning, over a 20-year project life. On balance, the proposed MOX facility would provide a net benefit (total benefits minus total costs) to the REA. The net benefit of the proposed MOX facility would be approximately $1,940 million. Sections 4.6.3.1 and 4.6.3.2 provide a more detailed description of the costs and benefits of the proposed MOX facility.

4.6.3.1 Regional Costs

Both potential internal and external costs are included in the assessment. Potential external costs include both long-term and short-term costs. Long-term external costs can also be associated with potential accidents at the proposed facilities. The impacts of accidents associated with the proposed facilities on agriculture, water, and fisheries resources, and subsequently on the economies of communities surrounding SRS, would be small. In the case of the most serious accidents, potential damage to crops under the plume in the event of an airborne release and the subsequent damage to water resources from the associated runoff would be small because the amount of radioactive material deposited per unit area would be relatively small. Dilution of runoff would occur fairly rapidly in the affected rivers and streams and would not cause any significant risk to the economies of the communities downstream of the location of the proposed facilities. Any interdiction of crops as a result of the deposition of radioactive material would be a limited, one-time event, and if it were to occur at all, would only affect a small number of farm communities.

Although the probability of severe accidents is very low, if such accidents did occur, the people living within 80 km (50 mi) of the SRS would likely be affected. The extent to which the surrounding population would be affected would depend on the amount of material released and the direction and speed at which airborne material was dispersed by wind conditions at the time of the accident. While the overall risk to the surrounding population would be very low (since the probability of severe accidents occurring would be very low), the greatest short-term risk of exposure would be to population groups located to the west-northwest of SRS, while the greatest 1-year risk would be to the southwest of SRS from crop contamination.

Routine operation of the proposed facilities is expected to produce an annual latent cancer risk of about 1 in 250 million for the maximally exposed member of the public. The annual collective dose (associated with the facilities) to members of the public living and working within 80 km (50 mi) of SRS is expected to produce an LCF risk of approximately 0.0009 or less.

No adverse impacts from chemical exposure of workers at the proposed facilities are anticipated. Less than one fatality and approximately 410 worker injuries are expected during the 10-year operating period of the proposed facilities.

Routine proposed facilities operations are expected to produce insignificant impacts to air quality and would not exceed any ambient air quality standards for criteria pollutants at SRS. Maximum levels of $PM_{2.5}$ in the vicinity of SRS already exceed the applicable levels, and facility construction would create an additional 0.07% of the present standard; facility operations would contribute 0.009%.

Water consumption during operation of the proposed MOX facility, PDCF, and WSB would represent an increase of about 5% of the water demand for the A-Area loop in 2000 and about 2% of the excess A-Area loop capacity. Discharges to surface water from the WSB during facility operations would comply with the NPDES permit guidelines.

Waste management systems at SRS would not be adversely affected by wastes generated by the proposed facilities. Adequate storage capacity and handling procedures are in place at SRS to process hazardous wastes generated during both construction and operation. Nonhazardous liquid and solid wastes would not adversely affect the Central Sanitary Waste Treatment Facility.

Other long-term external costs would include the potential impact of the proposed MOX facility, PDCF, and WSB (proposed facilities) on deterioration in recreational values, access restrictions to water or land (including any income lost), aesthetic impacts, impacts on local cultural and historical sites, decreased housing values, and the increased cost of providing local public services.

No impacts to recreational values, local aesthetic quality, or local water or land access would be expected from the proposed facilities. The location of the proposed facilities is close to the center of the SRS, and no recreation opportunities are currently available to the public in the vicinity. The proposed facilities would not change the industrial nature of the F-Area, and since the closest viewing location is about 8 km (5 mi) to the south, no changes in aesthetic quality would be expected (see Appendixes G and H). Construction of the facilities would occur on land already owned by the federal government and would have no impact on water or land access.

Impacts to housing values resulting from facility construction and operation, or to the cost of providing local public services are unlikely because of the relatively small number of long-term new residents that would be expected to move into the REA from elsewhere. Sufficient local housing is likely to be available to absorb new residents. Only 2% of vacant rental housing would be needed for workers during construction and less than 1% of vacant owner-occupied housing would be needed during operations. Changes in local public expenditures to maintain existing levels of public services would likely be small, with five additional local public service employees likely to be required (see Appendixes G and H).

The impacts of MOX fuel transportation, including those on property values, were not considered because of uncertainty surrounding the routes that would be used and the timing of shipments.

Short-term external costs include the contribution of the proposed facilities to housing shortages; local inflation, noise, and congestion; impacts on the local water supply and sewage systems; and crowding in local public schools, hospitals, and other local public facilities.

The proposed facilities would not produce any significant costs in the REA at the SRS in the short term. Sufficient vacant rental units would be available in the REA for use by construction workers, and sufficient owner occupied units would be available to operations employees (see Section G.2.7 in Appendix G). Inflation in prices in the local area is not likely because much of the equipment, materials, and services required would be specialized, and a significant portion would be obtained from outside the REA. Material and equipment expenditures assumed to be made locally would not likely push local industries to capacity, and no labor shortages would be likely. Any construction and managerial positions not filled from within the local labor market would be taken by workers moving to the area from other labor markets in the southeastern United States (see Appendixes G and H).

Noise and congestion from construction activities for the proposed facilities would likely be minor. Additional traffic generated during construction and operation would be unlikely to cause any additional traffic congestion on the major road segments surrounding the site, given the relatively small incremental increase in traffic from the proposed action (see Appendix H). Relatively small utility requirements would mean that no impacts would be expected on the local water supply and sewage systems. Local public schools, hospitals, and other local public facilities are not expected to suffer any overcrowding because of the relatively small number of new residents expected during the construction and operation under the proposed action (see Appendix H).

Internal costs are the life-cycle costs of design, construction, and operation of the project borne by the federal government. The internal costs of the proposed action in the REA are approximated using a cost localization factor that apportions total life-cycle project costs on the basis of the ratio of REA population to total national population. Internal costs apportioned to the REA using this method are small, amounting to $9 million for the proposed action.

4.6.3.2 Regional Benefits

The potential benefits of construction and operation of the proposed facilities include economic benefits — such as employment, income, and gross regional product — and various additional potential benefits — such as enhancement of recreational values, environmental enhancement in support of the protection of wildlife and wildlife habitat, and increased knowledge of the environment.

A significant benefit of the proposed action would be the avoided costs of continued plutonium storage. At the national level, these costs are estimated to be approximately $256 million per year (NNSA 2002) and would be incurred for as long as the material continued to be stored. Application of the same localization factor used in Section 4.6.3.1 to estimate the regional portion of plutonium storage costs avoided with the construction and operation of a MOX facility indicates that $14 million would be saved over what it would cost if plutonium was stored in existing facilities for an additional 25 years.

The measurement of the local employment and income economic benefits is based on the use of regional economic multipliers. These multipliers capture the indirect (off-site) effects of on-site activities associated with construction and operation.

To estimate employment benefits, life-cycle cost estimates were used (NNSA 2002) in association with data on the relationship between direct and indirect (off-site) employment benefits associated with construction and facility operations at the SRS. Data on the relationship between direct and indirect employment for a MOX facility were taken from the SPD EIS (DOE 1999a; see Appendix F, Section 9.2 for more information on the methodology used). By using direct (on-site) facilities employment data taken from the ER (DCS 2002a) as the basis for calculation, the indirect employment impacts during the construction and operation of the proposed facilities were estimated by application of the direct-to-indirect employment multiplier for the project at the SRS from the SPD EIS. The direct impacts of no action were estimated by using the relationship between total annual cost during construction and operation and direct employment for the proposed action. Indirect impacts were then estimated by application of the direct-to-indirect employment multiplier for a proposed MOX facility at the SRS from the SPD EIS (DOE 1999a).

The impacts on regional income of construction and operation were estimated by using employment impact estimates together with average regional income multipliers for the REA taken from IMPLAN regional economic data (MIG Inc. 2001). IMPLAN input-output economic accounts show the flow of commodities to industries from producers and institutional consumers. The accounts also show consumption activities by workers, owners of capital, and imports from outside the region. The IMPLAN model contains 528 sectors representing industries in agriculture, mining, construction, manufacturing, wholesale and retail trade, utilities, finance, insurance and real estate, and consumer and business services. The model also includes information for each sector on employee compensation; proprietary and property income; personal consumption expenditures; federal, state, and local expenditures; inventory and capital formation; and imports and exports.

The benefits of the proposed facilities to the economy of the REA would be significant (see Table 4.29). In the peak year of construction, 1,820 workers would be required for the proposed action. On average, 1,020 jobs would be created for the proposed facilities during the construction period. During operations, 1,270 workers would be required in each year. The facility would also contribute significantly toward personal income within the REA. The proposed facilities would produce $370 million in income over the construction period and $640 million during operations (see Appendix H).

No taxes are paid by the federal government (income, property, or sales taxes), and contractors constructing and operating a facility on behalf of the federal government are currently exempt from local sales taxes in Georgia and South Carolina. Although local tax revenues, primarily state income and sales tax revenues, paid by federal government employees, contractors, and their employees would increase, the increase would be relatively small. During both construction and operation, the proposed facilities would produce approximately $110 million in tax revenues in the REA.

The gross regional product (GRP) provides the best measure of the overall benefits of both alternatives to the economy of the REA. The GRP is the sum of value added in the production of all goods and services in a year and measures the overall level of economic activity in the REA. The proposed facilities would produce $1,950 million in GRP in the REA over the entire life of the project.

4.7 Resource Commitment

Construction of the proposed facilities would result in some impacts that cannot be avoided. Impacts may be irreversible if the future uses of the resource are limited. This section addresses unavoidable, irreversible, and irretrievable impacts of constructing and operating the facility and the relationship between short-term uses of F-Area and the SRS for the facility and long-term productivity. A summary of unavoidable impacts is presented in Table 4.30.

4.7.1 Unavoidable Adverse Environmental Impacts

Geology and Soils. Impacts to geology and soils from construction and operation of the proposed MOX facility, PDCF, and WSB are expected to be insignificant. Restoration work, consisting of final grading and revegetation, would reclaim over half of the 41.9 ha (103.5 acres) of land in the F-Area that would be disturbed during construction. The 41.9-ha (103.5-acre) disturbed area is assumed to include 2 ha (4.9 acres) for laydown area for constructing the PDCF, and 9.7 ha (24 acres) for a laydown area for constructing the WSB.

Some land in the area would be permanently altered because of constructing buildings, roads, and parking lots. The proposed MOX facility would permanently alter 6.9 ha (17 acres) of land, the PDCF would permanently alter 1.2 ha (3 acres), and the WSB would permanently alter about 2.5 ha (6.2 acres). Because soils in the affected areas are not unique within the SRS, and the permanently altered areas represent only about 7% of the land available in F-Area (160 ha [395 acres]) and only about 0.01% of the 80,292 ha (198,400 acres) of land area at SRS (DCS 2002a), overall physical impacts on soil would be insignificant.

Table 4.30. Unavoidable impacts of constructing and operating the proposed facilities

Resource	Unavoidable impacts
Geology and soils	• Construction excavation work may result in release of contaminated materials
Surface water	• Potential impacts to surface water quality by release of nonhazardous discharge effluent, sediment, contaminated runoff, or accidental release of oil or construction equipment fuel
Ecology	• Initial loss of up to 50.0 ha (123.4 acres) of woodland and grassland habitat in F-Area. Over 30 ha (75 acres) would be landscaped following construction.
Land use	• A worst-case accident at the facility could result in minor land use impacts outside of the SRS
Cultural and paleontological resources	• Construction would directly affect two prehistoric archaeological sites that are eligible for listing on the *National Register of Historic Places*
Waste management	• Small impact to waste management system at the SRS
	• Volumes of TRU and hazardous waste produced by facilities would represent 3% of the WIPP disposal capacity and 2% of the SRS treatment and storage capacity, respectively.
	• Nonhazardous liquids produced would be about 6% of the capacity at SRS.
Human health risk	• Annual radiological impacts to SRS employees from exposure to radioactive air pollutants are expected to be small at 1×10^{-5} LCFs/yr for the MOX facility and WSB collectively and 2×10^{-5} for the PDCF. The risk from the public's exposure to radioactive air pollutants is also expected to be small, at 4×10^{-5} annual LCFs for MOX and WSB combined, and 9×10^{-4} for the PDCF facilities.
	• MOX facility workers would have an expected lifetime LCF of about 1 chance in 1,000.
	• 122 lost workday injuries annually during a 3-5-year construction period
	• 41 lost workday injuries annually during 10 or more years of operations
Socioeconomics	• Increase in employment of 0.1 of a percentage point during construction
	• In-migrating workers during construction and operations would require 2% and <1% of vacant housing in the ROI

The potential exists that accidental releases of contaminated material during construction and normal operations might adversely affect receiving soils. However, if good engineering practices were used and any accidental spills were cleaned up promptly and thoroughly, chemical impacts to soil would be insignificant.

Surface Water. Impacts to surface water are expected to be negligible. Because surface water would not be used to supply water for construction or operations, there would be no impacts to surface water levels or flows.

Surface water quality could potentially be impacted by nonhazardous discharge effluent, sediment, contaminated runoff, and accidental releases. However, good engineering practices, compliance with existing NPDES permits, and prompt, thorough cleanup of accidental releases would help to ensure that impacts to surface water quality during construction and normal operations would be insignificant.

Groundwater. The groundwater system beneath the SRS would be directly affected (i.e., used) during construction and normal operations of the proposed facilities because it is the only source of water for these activities. However, the impact to existing groundwater supplies would be small. Projected total water use for the proposed and existing facilities in the A-Area loop, which obtains water from wells in both A-Area and F-Area, represents about 3% of the existing capacity during the construction phase. There would be no releases to underlying aquifers.

No direct impacts to groundwater quality (as opposed to quantity) are expected from construction or normal operations; there would be no releases to underlying aquifers. Water use during operation of the facilities represents an increase of about 5% of the water demand for A-Area loop in 2000 and about 2% of the excess A-Area loop capacity. Groundwater quality could be impacted by discharges to an NPDES outfall and accidental releases of contaminated material. However, impacts are expected to be negligible because of good engineering practices, prompt and thorough cleanup of any spills, and adherence to NPDES permit requirements.

Air Quality. Emissions associated with the construction and normal operation of the proposed facilities would have a negligible effect on air quality. Concentrations of pollutants would remain below standard levels. For both construction and normal operations, contributions of the proposed facilities to TSP, PM_{10}, $PM_{2.5}$, CO, SO_2, NO_2, and PAH concentrations would be 5.0% or less of applicable standard levels.

Noise. Potential noise impacts from construction and operation of the proposed facilities should be negligible at all off-site locations.

Ecology. Impacts of construction on ecological resources would primarily result from the loss and alteration of up to 50.0 ha (123.4 acres) of habitat. The woodland and grassland habitats that would be impacted represent a small fraction of those types of habitats at the SRS. Overall, the adverse impacts related to construction are expected to be limited to the immediate project vicinity and should not affect the viability of any vegetation types or wildlife populations at the SRS.

Sediment and erosion control measures implemented during site preparation and construction should prevent impacts to surface waters, aquatic and wetland resources, and protected fish species. No federally listed species have been reported in the areas that will be disturbed by construction. The SRS has established habitat management areas for the federally and state-endangered red-cockaded woodpecker, but the proposed facilities would not be located within any of these areas.

No adverse impacts to ecological resources are expected from operations of the proposed facilities.

Land Use. Land use of the entire F-Area is currently classified as developed/industrial. Since the facilities would be industrial, no adverse effects to land use would result from their construction or routine operation. If an operational accident occurred, F-Area would remain in developed/industrial land use. A worst-case accident could result in minor impacts to lands outside of the SRS. Future F-Area land use is expected to remain developed/industrial.

Cultural and Paleontological Resources. Construction of the proposed facilities would directly affect two prehistoric sites that are eligible for listing on the NRHP. Data recovery plans have been implemented, excavation has been completed, and monitoring will be conducted during ground-disturbing construction activities. Five additional eligible sites are located in the vicinity of the construction area. Mitigation measures would be taken to ensure that these sites were not disturbed directly or indirectly by construction activities.

No historic structures, traditional cultural property, or fossil-bearing strata have been identified in the project area; therefore, there would be no MOX-related impacts to such resources during construction.

Routine operations are unlikely to affect archaeological resources. However, the potential exists that storm-water detention releases resulting from a heavy rainfall could cause erosion in the area of an eligible site. Periodic monitoring of this site may be required.

An operational accident might affect archaeological resources by restricting access to sites that require regular monitoring. Such an accident might also affect traditional plant resources that might be present on the SRS.

Transportation. The existing road network at the SRS can readily accommodate the additional traffic expected during construction. In addition, the increased construction traffic would have negligible impacts on noise and air emissions. For operations, the impacts of transportation of the uranium and plutonium metal feed materials to the SRS, shipping fresh MOX fuel to a surrogate nuclear power plant site, shipping TRU waste to WIPP, and shipping spent MOX fuel were considered.

For routine transportation, the expected LCFs from radiation exposure could be up to 0.3 each for the public and transportation crews. A total of up to 2 latent fatalities were estimated from vehicle emissions. Thus, up to 2 fatalities might be expected from routine transportation activities.

It is estimated that the radiological transportation risk from accidents is 0.01 LCF over the course of the entire shipping campaign. Chemical impacts from accidents would be negligible: 1.3×10^{-7} irreversible adverse effect (approximately 1×10^{-9} fatality) from depleted UF_6 is expected for the entire shipping campaign. None of the chemicals that might be released in any transportation accident are known to be carcinogens.

Total fatalities from direct physical trauma from accidents were estimated to range as high as 0.20. This value indicates that no fatalities are expected from accidents for the entire shipping campaign.

Infrastructure. Construction activities and normal operational activities are not expected to adversely impact current SRS infrastructures. Projected electrical power, water, and fuel needs are well within existing capacities. The existing infrastructure would require a coordinated upgrading to support all phases of the surplus disposition program at the SRS: the proposed MOX facility, PDCF, and the WSB.

Waste Management. The impacts of facility construction waste on existing SRS waste management capacities would be minimal. The types and volumes of wastes generated would be similar to those that would be expected during the construction of an industrial facility. These wastes would be managed in accordance with current SRS waste management practices. Hazardous waste would be shipped off-site to commercial RCRA permitted facilities. The nonhazardous liquid waste generated would represent less about 6% of the SRS capacity for treatment. Solid waste would be shipped to off-site facilities for recycling or disposal.

Wastes generated by facility operations would have a small to moderate impact on the waste management system at the SRS. Estimated volumes for TRU waste would represent about 13% of SRS storage capacity and 2.6% of the WIPP storage capacity. Estimated volumes for solid low-level waste and hazardous waste would represent about 21% and less than 2% of the SRS disposal and storage capacities, respectively. Nonhazardous liquid wastes generated by facility operations are estimated to be about 6% of the capacity of the Central Sanitary Wastewater Treatment Facility. Nonhazardous solid wastes would be shipped off-site for recycling or disposal.

Human Health Risk. Less than 1 facility annually is predicted during the construction and normal operation phases of the facility. An estimated 122 lost workday injuries would occur annually over the 5-year construction period, and 41 annually over the assumed 10 or more years of operations.

No radiological impacts or adverse health impacts from emissions of toxic air pollutants are expected during the construction phase of the proposed facilities, and no adverse impacts to SRS employees and the public from exposure to emissions of toxic air pollutants are expected during normal operations. Annual radiological impacts to SRS employees for exposure to air emissions from the MOX and WSB facilities collectively and the PDCF are expected to be very small, approximately 1×10^{-5} and 2×10^{-5} LCF/yr, respectively. Similarly, the risk to the public would be small at 3×10^{-10} and 9×10^{-10} LCF/yr.

Hydrazine is the only chemical, aside from the radionuclides, that would be used in MOX processing that is listed as a hazardous air pollutant under the Clean Air Act. During routine operations, off-gas treatment systems would be expected to keep hydrazine emissions to very low levels that would not cause adverse health impacts to the off-site public or noninvolved workers.

Socioeconomics. The potential socioeconomic impacts from constructing and operating the proposed facilities would be insignificant. The increase in the annual average employment growth rate would be less than 0.1 of a percentage point over the duration of construction; even less during the operation phase.

In-migration of 350 people during the peak construction year would have only a marginal effect on population growth requiring 2.0% of the available vacant rental housing units in the region of influence (ROI) for construction and less than 1% of the available vacant owner occupied housing units for facility operations.

There would be no significant impact on public finances or the need for additional local public service employees during construction or normal operation.

Minor impacts would occur to agriculture and commercial fishing as demand for their products increase during construction and normal operation. No significant impacts on agriculture and downstream fisheries are expected from facility operations.

Any impacts associated with the transportation of fresh MOX fuel, including impacts on property values, would be minimal.

Environmental Justice. There would be no unavoidable environmental justice impacts from routine operations.

Aesthetics. The addition of the proposed facilities would not adversely affect the overall aesthetics of the F-Area or the SRS. The size and appearance of facility structures would be similar to those of existing buildings adjacent to the F-Area and would maintain the industrial nature of the F-Area.

Cumulative Impacts. Cumulative impacts of normal operations of the proposed facilities at the SRS were evaluated for air quality, health and safety, waste generation, resource use, and employment. Cumulative impacts for water quality, geologic resources, ecological resources, aesthetic resources, and cultural and paleontological resources were not explicitly addressed because direct and indirect impacts to these resources are expected to be negligible.

Cumulative impacts to air quality from proposed facility operations are not expected to be significant. On the basis of conservative assumptions, facility operations are projected to contribute 2% or less to cumulative concentrations of criteria air pollutants.

During normal operations, the facilities' contribution to cumulative radiological doses to the off-site population would be low (5.7% of the total). A cumulative dose to a MEI would increase by 1.0%. No LCFs are expected from the cumulative dose to the MEI or to the off-site population. Transportation of radioactive materials associated with facility operations would not contribute significantly to cumulative impacts (collective occupational dose, dose to the general public, and LCFs).

For most types of waste, facility operations would contribute 10% or less of the cumulative waste volumes generated at the SRS; existing waste treatment facilities will be able to handle this cumulative total. The largest proportionate increase would be in the amount of nonhazardous solid waste (18.8% of total).

The cumulative impacts of the proposed facilities to land development, electricity usage, and groundwater usage at the SRS would be quite small and well within existing SRS capacities.

Construction activities would result in a peak workforce of 1,000 in the peak construction year, or about 6% of the cumulative SRS employees. Facility operations would support 490 workers annually (2.9% of the total projected workforce for the SRS) and result in a cumulative total of 16,924 employees at the SRS.

4.7.2 Irreversible and Irretrievable Commitments of Resources

This section addresses the major irreversible and irretrievable commitments of resources associated with the no-action alternative and proposed action as described in Chapter 2. A commitment of a resource is irreversible when its primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources neither renewable nor recoverable for use by future generations.

The 23.6 ha (58.3 acres) within which the proposed MOX facility, PDCF, and WSB would be built and the estimated 15.5 ha (38.3 acres) needed for infrastructure upgrades (e.g., pipeline and powerline rights-of-way, storm-water basin, batch plant, and roads) would be precluded from other uses until the NRC license to operate the facility was terminated (i.e., about 20 years into the future). About 3.6 ha (8.9 acres) of mostly woodland vegetation surrounding the proposed MOX facility site border would require grading for facility construction. Existing habitats would be eliminated, and ecological succession that would typically lead to progression from grassland to woodland vegetation would not occur. Although ultimate decommissioning of the facility could result in removal of all structures and paved surfaces, it is unlikely that woodland habitat comparable in quality to that north and west of the F-Area could become reestablished in less than 50 to 70 years.

Construction and operation activities would involve use of materials that could not be recovered or recycled. Soil excavated to produce the cement used in concrete would be irretrievably lost. Concrete and steel represent the bulk of construction materials. Other major construction materials that would be irretrievably lost or difficult to recycle include aluminum, lumber, piping materials, and electric wires and cables (DCS 2002a).

Water would be used for dust suppression during construction. Except for the water chemically bound in the production of concrete, water needed for construction and operation would eventually be recycled through the atmosphere and surface waters for distribution elsewhere. Water used during operation would be treated and discharged to the environment. Water obtained from groundwater supplies would be replaced through natural recharges of local aquifers. An estimated 760 million L (201 million gal) of water would be needed during the 10-year operating life of the facilities. Construction water requirements would total about 695 million L (185 million gal). A list of resources that would be required for the proposed MOX, PDCF, and WSB facilities is provided in Table 4.31.

Construction, operation, deactivation, and decommissioning of the project site would require a commitment of financial and human resources. Commitments of machinery, construction equipment vehicles, and fossil fuels (e.g., fuel oil and diesel oil) would be needed during the life of the project. None of these resources is expected to be in short supply in the vicinity of the SRS.

No valuable mineral resources are known to be present at the project site or immediate vicinity that could by affected by facility construction and operation security requirements in the F-Area.

4.7.3 Relationship between Short-Term Uses of the Environment and Long-Term Productivity

Short-term uses of the environment for the proposed action include (1) using a 23.6-ha (58.3-acre) area in F-Area for the proposed facilities, and (2) using an additional 15.5 ha (38.3 acres) of land for infrastructure upgrades and a process pipeline right-of-way needed to transport liquid high-level alpha waste from the proposed MOX facility. These uses would allow the U.S. government to fulfill its obligations in a September 2000 agreement with the Russian government to convert surplus weapons-grade plutonium no longer needed for defense purposes into MOX fuel for irradiation in nuclear reactors.

The proposed action would result in favorable short-term effects for the local economy, specifically for the nearby communities of Aiken and North Augusta, South Carolina, and Augusta, Georgia. These communities would benefit from the increase in income generated by direct jobs and workers in support industries in the SRS vicinity.

The use of 39.1 ha (96.6 acres) of land (up to 50.0 ha [123.4 acres] would be disturbed by construction) on the SRS for the facility is consistent with the SRS Long Range Comprehensive Plan (DOE 2000b) and use of the F-Area for processing nuclear materials. The proposed project would require clearing of up to 14.8 ha (36.4 acres) of woodland. Clearing would

Table 4.31. Irreversible and irretrievable commitments of resources for the proposed MOX, PDCF, and WSB facilities

Resource	Consumption
Construction[a]	
Electricity	85,500 MWh
Fuel oil	7.624 million L (1,960,000 gal)
Water	695 million L (185 million gal)
Concrete	149,300 m^3 (195,240 yd^3)
Steel	36,367 MT (40,100 tons)
Operations[b,c]	
Electricity	1,860,000 MWh
Water	760 million L (201 million gal)
Fuel oil	5,362,600 L (1,376,000 gal)
Plutonium	34 MT (37.5 tons)
Depleted uranium	665 MT (726 tons)
Argon	3.7 m^3 (129 million ft^3)
Argon-methane	103,930 m^3 (3.67 million ft^3)
Dodecane	29,144 L (7,700 gal)
Helium	96,570 m^3 (3.41 million ft^3)
Hydrogen	105,070 m^3 (3.71 million ft^3)
Hydrogen peroxide	20,060 L (5,300 gal)
Hydrazine (35%)	15,140 L (4,000 gal)
Hydroxylamine nitrate	348,220 L (92,000 gal)
Manganese nitrate	45.4 kg (100 lb)
Nitric acid	49,205 L (13,000 gal)
Nitrogen	45,310 million m^3 (1.6 billion ft^3)
Nitrogen tetroxide	37,380 million m^3 (1.32 million ft^3)
Oxalic acid dehydrate	40,363 kg (89,000 lb)
Oxygen	20,110 m^3 (710,000 ft^3)
Porogen	2,993 kg (6,600 lb)
Silver nitrate	1,088 kg (2,400 lb)
Sodium carbonate	1,995 kg (4,400 lb)
Sodium hydroxide (10M)	189 L (50 gal)
Tri-butyl phosphate	28,009 L (7,400 gal)
Zinc stearate	2,798 kg (6,170 lb)

[a]Consumption amounts are based on a 5-year construction period.

[b]Represents total volumes for the MOX and PDCF facilities.

[c]Consumption amounts are based on facility operations for an assumed 10-year period. The data on chemicals are only for the proposed MOX facility.

eliminate wildlife habitat in these woodlands. Infrastructure upgrades for electrical supply and additional roadways built for the proposed project would have long-term benefit to F-Area for ongoing and future projects. If DOE decides to decommission the proposed facilities and remove all structures and paved surfaces, the site could be reclaimed to woodland vegetation. Reclamation would require about 50 to 70 years to establish woodlands comparable in species composition to areas that would be cleared for construction.

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5 MITIGATION

5.1 Introduction

This chapter addresses potential means to mitigate adverse environmental impacts from the proposed action as required by Appendix A of Title 10, Part 51, of the *Code of Federal Regulations* (10 CFR Part 51). Mitigation measures for the proposed Pit Disassembly and Conversion Facility (PDCF) have been considered by the U.S. Department of Energy (DOE) in its Surplus Plutonium Disposition Environmental Impact Statement (SPD EIS) (DOE 1999) and January 11, 2000, Record of Decision (DOE 2000, 2002) and are not repeated in this document. The recent DOE supplemental analysis (DOE 2003) discusses impacts related to operation of the proposed Waste Solidification Building (WSB) but does not identify any mitigation measures for the WSB. Therefore, for completeness, the discussion of mitigation measures in this EIS includes potential measures for the WSB. A full discussion of potential mitigation measures for each resource area is provided in Section 5.2, and these measures are summarized in Table 5.1. It is important to note that while potential mitigation measures for the WSB are identified in this EIS, the NRC does not have the regulatory authority to implement mitigation measures for DOE facilities. For the purpose of reaching a final NRC staff decision on its proposed action, the NRC assumes that the DOE will not implement the mitigation measures identified herein that pertain to the proposed WSB.

Under Council of Environmental Quality (CEQ) regulation 40 CFR 1500.2(f), federal agencies shall to the fullest extent possible use all practicable means consistent with the requirements of the National Environmental Policy Act (NEPA) and other essential considerations of national policy to restore and enhance the quality of the human environment and avoid or minimize any possible adverse effects of their actions on the quality of the human environment. The CEQ regulations define mitigation to include the following: (1) avoiding the impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (5) compensating for the impact by replacing or providing substitute resources or environments. This definition has been used in defining potential mitigation measures.

The NRC staff has reviewed the mitigation measures and has concluded that no additional mitigation measures are required beyond the regulatory requirements and those measures identified by DCS.

5.2 Mitigation Measures

The NRC staff evaluated proposed mitigation measures identified by Duke Cogema Stone & Webster (DCS) (2003) and identified other potential measures that could reduce or eliminate adverse environmental impacts of the proposed mixed oxide (MOX) facility and WSB (as

Table 5.1. Summary of DCS mitigation commitments and additional measures identified by NRC staff for reducing or avoiding impacts[a]

Technical area	Mitigation	Measures proponent
Soils and Hydrology	• Control of pollutants in stormwater discharges during construction will be addressed as provided in the Storm Water Pollution Prevention Plan that Duke Cogema Stone & Webster (DCS) will file with its notice of intent to discharge stormwater during construction under the South Carolina National Pollutant Discharge Elimination System (NPDES) General Permit for stormwater discharges from construction activities (Permit No. SCR100000). Filing of a Storm Water Pollution Prevention Plan is required by Part IV, "Storm Water Pollution Prevention Plans," in Permit No. SCR100000. The South Carolina Department of Health and Environmental Control (SCDHEC) has issued the NPDES General Permit for stormwater discharges from construction activities as provided in South Carolina Regulations (SC Regulation R.61-9.122.28).	REG
	• Erosion and sediment controls will be implemented as provided in the Storm Water Pollution Prevention Plan that DCS will file with its notice of intent to discharge stormwater during construction under the South Carolina NPDES General Permit for stormwater discharges from construction activities (Permit No. SCR100000). Filing of a Storm Water Pollution Prevention Plan is required by Part IV, "Storm Water Pollution Prevention Plans," in Permit No. SCR100000. The SCDHEC has issued the NPDES General Permit for stormwater discharges from construction activities as provided in SC Regulations R.61-9.122.28.	REG
	• Creation of foundations and building of structures for the proposed mixed oxide (MOX) facility, and Waste Solidification Building (WSB) (hereafter "the facilities") will be limited to the upper soil layers, thus minimizing impacts to groundwater.	DCS
	• Good engineering practices will be used during operation and construction to minimize chemical impacts to soils.	DCS
	• Sanitary wastes generated during construction will be collected with a combination of portable toilets and semipermanent facilities connected to the Central Sanitary Waste Treatment Facility.	DCS
	• Regular monitoring of the double-walled liquid high-alpha waste pipeline will be conducted to detect leaks.	DCS

Table 5.1. Continued

Technical area	Mitigation	Measures proponent
Ecology	• The right-of-way for the 610-m (2,000-ft) pipeline to convey liquid high-alpha-activity waste and stripped uranium waste for the proposed MOX facility to the WSB will be less than 7.6 m (25 ft) wide and thus will minimize vegetation removal.	DCS
	• Before construction activities begin, the site would be surveyed for migratory bird nests.	DCS
	• Measures should be taken to protect trees on the MOX site not selected for removal and not controlled after site clearing by the U.S. Department of Agriculture (USDA) Forest Service — Savannah River. If such trees or other landscape features not controlled by the USDA Forest Service — Savannah River are accidentally scarred or damaged, they should be replaced in a manner consistent with the Savannah River Site Natural Resources Management Plan.	NRC
	• Construction crews would receive environmental briefings as appropriate to alert them to specific areas of concern (e.g., possible harassment and other adverse impacts to wildlife species during the construction period) and to explain the reasons for such concern.	NRC
	• Impacts during the clearing of vegetation should be controlled by the USDA Forest Service — Savannah River, consistent with the Savannah River Site Natural Resources Management Plan.	NRC
	• Following construction, site restoration (e.g., soil stabilization and revegetation) would be conducted in compliance with appropriate U.S. Department of Energy (DOE) policies for reclamation of construction areas.	DCS
	• Access roads should be sited on previously disturbed areas where possible to minimize sensitive vegetation removal.	NRC
Air Quality and Noise	• DCS will have a Construction Emissions Control Plan, which will implement a number of good engineering practices to reduce fugitive dust emissions consistent with the requirements in SC Regulation R.61-62.6, “Control of Fugitive Particulate Matter.”	REG
	• Particulate emissions from the silo hopper and concrete mixer used in the cementation process during operation of the WSB will be required to meet the conditions specified in the SCDHEC permit.	REG

Table 5.1. Continued

Technical area	Mitigation	Measures proponent
Infrastructure	• Road upgrades for ingress and egress of the proposed MOX site will be conducted in existing traffic rights-of-way.	DCS
Land Use	• No mitigation measures are needed to reduce impacts of the proposed action on land use.	
Waste Management	• No mitigation measures are needed to reduce impacts of the proposed action on the Savannah River Site (SRS) waste management system.	
Human Health Risk	• Radiation doses to workers during construction will be kept to a minimum by using administrative limits and ALARA (as low as reasonably achievable) programs, including worker rotations.	REG
	• Exposure to hydrazine will be limited by complying with SCDHEC emission standards.	REG
	• To minimize adverse effects to facility and SRS workers from exposure to nitrogen tetroxide, DCS should comply with the requirements in the Occupational Safety and Health Administration's (OSHA's) Process Safety Management Rule (29 CFR 1910.119).	REG
	• The radiation exposure of radiographers will be monitored or badged during construction.	REG
	• The radiography contractor will follow the contractor's existing U.S. Nuclear Regulatory Commission (NRC) or agreement-state license in evaluating and monitoring radiographer exposure.	REG
	• Radiation and chemical exposures of facility workers during operations would be kept to a minimum through (1) use of engineering controls to keep airborne chemical concentrations below applicable occupational exposure limits, and (2) use of enclosed operations to the extent possible.	DCS
	• To minimize adverse effects to facility and SRS workers in the event of an accidental release of process chemicals identified as presenting moderate or high risks to workers (as identified in Section 4.3.5.3), DCS has committed in its Construction Authorization Request (CAR) to integrate any emergency preparedness plans for the proposed MOX facility with the DOE SRS Emergency Response Plan.	DCS
	• Construction workers should be protected from inadvertent radiation and chemical exposures by soil testing and analysis prior to excavation to ascertain that levels of radiation and inorganic or organic chemicals in soils would not present a health hazard during construction activities.	NRC

Table 5.1. Continued

Technical area	Mitigation	Measures proponent
Cultural and Paleontological Resources	• Periodic monitoring of nearby eligible archaeological sites shall be conducted to check for possible erosion.	DOE
	• Additional mitigation measures, such as avoidance agreements, shall be determined in consultation with the South Carolina State Historic Preservation Office (SCSHPO).	DOE
	• If inadvertent discoveries of cultural resources occur during site construction, mitigation would follow the guidelines of 36 CFR 800.11 and/or 43 CFR 10.4.	REG
Aesthetics	• No mitigation measures are necessary to reduce aesthetic impacts of the proposed action.	
Socioeconomics	• No mitigation measures are necessary to reduce impacts to socioeconomic factors.	
Environmental Justice	• DCS should work closely with SRS to implement procedures to protect low-income and minority groups in the event of an accidental chemical or radiological release from the proposed facilities that impact areas beyond the SRS boundary.	NRC
	• DCS should conduct focused public information campaigns to provide important information to low-income and minority groups/communities. Included in these campaigns would be descriptions of existing monitoring programs, and information on the nature, extent, and likelihood of any airborne release from the facility. The campaigns would also include a description of the relevant risks associated with the proposed facilities. These campaigns should include information on sheltering and other protection strategies that may be needed, including detailed descriptions of any evacuation procedures that may be required.	NRC
	• DCS should provide public information to local agencies and groups representing low-income or minority groups on existing soil or groundwater contamination monitoring programs and the nature, extent, and likelihood of surface release. Key information would include the extent of any likely damage to drinking water supplies and subsistence resources, and the relevant preventative measures that may be taken.	NRC
	• DCS should meet with local communities providing emergency response services and other emergency facilities to discuss additional measures to ensure that the low-income and minority populations in their jurisdictions are located and fully prepared in the event that sheltering or evacuation procedures are required, in addition to public information campaigns targeting low-income and minority groups. This would include the development of spatial databases providing information on the locations of low-income and minority populations, local resources available to emergency response agencies, and any evacuation routes that might be required.	NRC

Table 5.1. Continued

[a]The mitigation measures are commitments made by DCS that were identified in the ER (DCS 2002) and other potential measures identified by the NRC staff in preparing this EIS. Under the column "Measures proponent," "DCS" refers to the applicant, "DOE" refers to the U.S. Department of Energy, "NRC" refers to the U.S. Nuclear Regulatory Commission, and "REG" refers to a regulatory requirement or a permit/license condition that DCS would be required to implement.

indicated in Table 5.1). The applicant, DCS, has proposed design features and other activities to reduce impacts for the proposed MOX facility. In Table 5.1, the proponent for these mitigation measures is designated as "DCS." In addition, compliance with federal and state regulations, permits, and guidelines will reduce potential impacts (see Chapter 6 for a discussion of applicable environmental regulations and permits). For example, the South Carolina National Pollutant Discharge Elimination System (NPDES) general permit requires the implementation of a Storm Water Pollution and Prevention Plan that would mitigate potential impacts to surface waters from construction activities. The regulations, permits, and guidelines typically recommend best management practices. These practices (i.e., mitigation measures) would be determined during the permitting process, which would occur in the future. For that reason, general types of activities that would comprise best management practices are discussed. The proponent for these mitigation measures is designated as "REG," and for other mitigation measures proposed by the NRC staff, the proponent is designated as "NRC" in Table 5.1. Not all NRC-suggested mitigation measures are within the NRC's regulatory authority.

5.2.1 Hydrology

Surface water resources could be adversely affected by construction of the proposed MOX facility and WSB. Introducing pollutants or erosion into surface waters could impact the quality of the surface water and aquatic organisms. Several design features that would mitigate impacts to surface water were proposed by DCS and the DOE. During construction of the proposed MOX facility and WSB, no direct discharges of contaminated water into Upper Three Runs Creek, Four Mile Branch, or their tributaries, are expected to occur. Sanitary wastes would be collected with a combination of portable toilets and semipermanent facilities connected to the Savannah River Site (SRS) Central Wastewater Treatment Facility. All wastewater would be treated in the sitewide treatment system before release under existing NPDES permits, thus minimizing impacts to surface waters.

Potential impacts from stormwater discharges during construction would be mitigated by compliance with the Storm Water Pollution Prevention Plan that is required by South Carolina Department of Health and Environmental Control (SCDHEC) regulations. DCS plans to file this plan in its notice of intent to discharge storm water during construction under the South Carolina NPDES General Permit for stormwater discharges from construction activities (Permit No. SCR100000). Under the General Permit, best management practices would be followed to divert the flow of runoff water away from exposed soils, store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas to the degree attainable. Such practices might include, but not necessarily be limited to, use of silt fences, earth dikes, drainage swales, sediment traps, check dams, temporary or permanent sediment basins, temporary seeding, permanent seeding, mulching, use of geotextiles, sod stabilization, vegetative buffer strips, protection of trees, and preservation of mature vegetation. Because groundwater would be used as the source of water during construction, groundwater could be adversely affected during construction of the facilities. Because the capacity of the existing wells at SRS are sufficient to meet the needs of the project, further mitigation would not significantly reduce the impacts associated with using groundwater during construction. While construction could directly impact groundwater quality if any of the buildings or structures extended below the surface of the groundwater, the design for the proposed MOX facility and WSB do not involve encroachment on groundwater. Groundwater could be indirectly impacted by infiltration of contaminated surface water or surface spills during construction. These impacts would be mitigated by following appropriate good engineering practices and following the provisions of the required Stormwater Pollution Prevention Plan as discussed above.

During normal operation of the proposed MOX facility and WSB, surface water would not be used. The primary mitigation activities for surface water quality would be ensuring that releases of effluent meet NPDES permit guidelines. Design features proposed by DCS and the DOE include this mitigation strategy. Mixed, hazardous, and radioactive wastes in liquid form would be sent off site for disposition, or sent to SRS waste management facilities, or would be treated and processed at the WSB prior to being discharged to surface waters or converted into a solid waste. See Section 4.3.4 for a further discussion of how such solid wastes would be managed. Stormwater run-off from paved areas would be collected by the stormwater system. The stormwater would be temporarily retained in a detention basin to reduce the amounts of oils and other pollutants from entering surface water. The uncontaminated HVAC condensate would also be discharged to the stormwater system in accordance with SCDHEC standard stormwater permit conditions. The detention basin would also reduce the flow into surface waters following precipitation events.

Water for normal operations would be obtained from existing SRS wells. Because the quantity of water required for operations is within the capacity of the existing wells, further mitigation would not significantly reduce the impacts of using the groundwater during operations. The design features for the project do not include direct releases to underlying aquifers. However, the quality of groundwater could be affected indirectly by receipt of contaminated surface water. As discussed above, design features have been proposed by DCS and the DOE to limit contamination of surface water. Operation of a sand filter, if used, would not directly impact groundwater because the filter would be covered to prevent infiltration and it would have a concrete wall and bottom.

Deactivation and decommissioning could also impact water resources at the site. These impacts would be mitigated by using the methods discussed above for construction.

Accidents could impact surface water and groundwater directly and indirectly. Impacts to surface water would primarily be indirect. These impacts would be produced by contaminated runoff from spill areas. DCS has committed to preparing and implementing a Spill Control and

Countermeasures Plan during operation. A similar plan would be prepared for the WSB. Mitigation would be accomplished by following best management practices in these plans that would include prompt cleanup and removal of contaminated materials. Direct impacts to groundwater could occur if there were a failure in the underground pipelines carrying liquid waste from the proposed MOX facility to the WSB. The impacts would be mitigated by regular monitoring of the system to detect leaks for the double-walled pipelines, and developing contingency plans to remediate any spills promptly and thoroughly.

Further mitigation was not identified by the NRC that would significantly reduce the impacts to surface water or groundwater.

5.2.2 Soils

Soils could be affected by construction activities, normal operations, activities associated with deactivation and decommissioning, and accidents. Several design features proposed by DCS and the DOE were considered to be mitigation measures. The locations selected for the proposed MOX facility and the WSB contain soils that are not unique to the SRS, and there are no soils classified as prime farmlands. In addition, the grading and landscape plans would be designed in part to reduce future erosion following construction activities and limit slope instability.

To a great extent, the impacts of construction on soils would be mitigated by the following SCDHEC regulations (see discussion in Chapter 6) that require installation of sediment detention basins that would catch and hold runoff water. These detention ponds would be situated in strategic locations and would be designed to control the release of storm-water runoff at a rate equal to or slightly less than that of the predevelopment conditions. In addition, following good engineering practices will be required by the Stormwater Pollution Prevention Plan that DCS will file with the State of South Carolina in its Notice of Intent to discharge stormwater during construction under the General Permit for stormwater discharges (Permit No. SCR100000). Such practices could include silt fences, sediment traps, check dams, etc., and would mitigate the consequences of construction including impacts associated with potential spills.

During normal operations, there would be no planned direct discharges of water to the soil, and stack emissions of contaminated particulates would be filtered. These mitigation measures would minimize adverse impacts to the soil.

During deactivation and decommissioning, impacts could once again occur to soils through mobilization of contaminants by water or wind. Mitigation activities for this phase of the project would be the same as those outlined for construction.

Accidents during the lifetime of the facilities could also adversely impact soils. Following the Spill Control and Countermeasures Plan as discussed in Section 5.2.1 would mitigate these potential impacts.

Further mitigation was not identified by the NRC that would significantly reduce the impacts to soils.

5.2.3 Ecology

Construction of the proposed MOX facility and WSB and associated infrastructure would disturb up to 50.0 ha (123.4 acres) of land in the F-Area of the SRS. Several design features proposed by DCS and the DOE were considered to be mitigation measures. The location of the facilities would mitigate many of the construction impacts to ecological resources. The site selected for the facilities would be largely in previously disturbed or developed locations, and there are no designated wetlands or Carolina bays within the areas to be disturbed. For example, a portion of the construction activities for the proposed MOX facility would take place in an area where spoils for previous F-Area construction has been stored, and most of the WSB would be located within “facility” land (e.g., landscaped areas). Also the new, widened, and realigned roads would be located within previously cleared rights-of-way. In addition, the facilities would not be located within either the red-cockaded woodpecker management area or its supplemental management area. Clearing of vegetation should be conducted in accordance with the Savannah River Site Natural Resources Management Plan by the U.S. Department of Agriculture (USDA) Forest Service. Complying with this plan will minimize impacts to ecological resources. Following construction, the cleared and graded areas not covered with facilities, parking lots, or roads would be landscaped. This landscaping would provide habitat for some wildlife species, mitigating the loss of habitat from constructing the facilities.

As discussed in Section 5.2.1, complying with the Storm Water Pollution Prevention Plan would mitigate impacts of ecological resources. Best management practices for soil erosion and sediment control would be used to prevent runoff and dust from entering sensitive habitats and nearby streams (e.g., unnamed tributaries to Upper Three Runs Creek), and direct construction disturbance of nearby streams would be avoided.

Potential mitigation measures to protect ecological resources were identified by the NRC. DCS should take action at the construction site to prevent the workforce from removing vegetation in excess of that needed for construction clearing. To ensure protection of vegetation during construction, DCS should designate an environmental supervisor to supervise vegetation clearance. Any accidentally scarred or damaged trees should be replaced consistent with the Savannah River Site Natural Resources Management Plan. Construction crews should also receive environmental briefings as appropriate to alter them to specific areas of concern (e.g., possible harassment and other adverse impact to wildlife species during the construction period, identification of spills and notification of supervisors) and to explain the reasons for such concerns. In addition, following construction, site restoration (e.g., soil stabilization and revegetation) should be done in compliance with appropriate DOE policies for reclamation of construction areas.

During normal operations, the major mitigation factor would be to limit releases of contaminants (chemicals and radioactive materials) to the environment. The mitigation measures discussed in Section 5.2.1 would also mitigate impacts to ecological resources.

Impacts of deactivation and decommissioning would be mitigated by using the same methods described for construction, particularly those for erosion and sediment control.

Accidents could also impact ecological resources at the proposed facilities. These impacts would be produced primarily by contaminated runoff water entering sensitive habitat. Additional impacts could occur through air emissions from an accident. Mitigation measures would include following the Spill Control and Countermeasures Plan discussed in Section 5.2.1. These mitigation measures would reduce the likelihood of bioaccumulation and biomagnification in the food chain.

The NRC staff has reviewed the mitigation measures for ecological resources and has concluded that no additional mitigation measures are required beyond the regulatory requirements and the measures identified by DCS.

5.2.4 Air Quality

During construction of the proposed MOX facility and WSB, emission of criteria pollutants (carbon monoxide, nitrogen dioxide, and sulfur dioxide [CO, NO_2, and SO_2]), total suspended particulates (TSP), and volatile organic compounds (VOCs) would require mitigation. Of these, suspended particles would be the principal concern. Suspended particles could be produced by fugitive dust from earthmoving activities, fugitive dust from the concrete batch plant, and exhaust emissions from diesel-powered construction equipment and from worker and delivery vehicles. Most of this dust would be generated within the construction site; dust created along roadways in the SRS would be naturally mitigated by dispersal. To a great extent, the impacts of construction on air quality would be mitigated by the following SCDHEC regulations (see discussion in Chapter 6). South Carolina Regulations (SC Regulations R.61-62.6, Control of Fugitive Particulate Matter) require DCS to have a Construction Emissions Control Plan. This plan would implement a number of good engineering practices to reduce fugitive dust emissions. These would include applying, as appropriate, standard dust control practices, such as watering or sweeping roads and water exposed areas. Particulate emissions from the silo hopper and concrete mixer used during the cementation process to construct the WSB would be controlled as provided in a State of South Carolina Permit to Construct the concrete batch plant. The State of South Carolina Permit to Construct would provide for controls on particulate emissions consistent with the requirements in SC Regulations R.61-62.5, Standard No. 4, “Emissions from Process Industries.”

During normal operations, air quality impacts would be produced by process emissions, testing of emergency diesel generators, trucks moving materials and wastes, and employee vehicles. Several design features proposed by DCS and the DOE were considered to be mitigation measures. These impacts would be mitigated by using an air filtration system (e.g., high-efficiency air particulate [HEPA] filters or sand filter) to remove radioactive particulates prior to discharge of process exhaust air to the atmosphere and by using internal scrubbers to reduce chemical gas concentrations. Parking lots and access roads would be paved to minimize the emission of fugitive dust during normal operations.

Mitigation activities for deactivation and decommissioning would be similar to those used for construction. These strategies would be primarily aimed at reducing fugitive dust.

In the event of an accident, adverse impacts to the air would be mitigated by the air filtration systems and prompt and thorough cleanup, if necessary.

Further mitigation was not identified by the NRC that would significantly reduce the impacts to air quality.

5.2.5 Noise

Noise is unwanted sound that interferes with or interacts negatively with the human or natural environment. Construction of the proposed MOX facility and WSB could adversely affect the level of noise. These adverse impacts would be mitigated by locating the facilities away from the SRS public boundary and sensitive receptors. The siting of the facilities is considered a design feature that mitigates noise impacts. The level of noise could also be a concern for federally listed or endangered species; however, none are known to occur in F-Area. As discussed in Section H.3.1.1, noise levels could startle small mammals and frighten birds. Generally, these disturbances would be short-term and localized. Construction workers could also be adversely affected by the levels of noise. Compliance with Occupational Safety and Health Administration (OSHA) regulations to implement appropriate hearing protection measures would mitigate noise impacts to workers. These measures include the use of standard silencing packages on construction equipment, administrative controls, engineering controls, and personal hearing protection devices.

During normal operations, noise would be produced by cooling systems, vents, motors, generators, material-handling equipment, employee vehicles, and truck traffic. Impacts of these noises on the public would be mitigated by the location of the facilities (about 8.7 km [5.4 mi] from the site boundary).

Operation workers could also be exposed to noise levels higher than the acceptable limits specified by the OSHA in its noise regulation (29 CFR 1926.52). Appropriate mitigation programs would be implemented according to pertinent OSHA standards to minimize impacts on workers. These programs include the use of administrative control, engineering controls, and personal hearing protection devices.

Mitigation measures used during deactivation and decommissioning of the facilities would be similar to those employed for construction.

Further mitigation was not identified by the NRC that would significantly reduce the impacts from noise.

5.2.6 Infrastructure

Upgrades of roadways to and from the proposed MOX site would be conducted in existing traffic rights-of-way.

5.2.7 Waste Management

During construction of the proposed MOX facility and WSB, hazardous and nonhazardous wastes would be generated. Impacts of hazardous and nonhazardous wastes would be mitigated by managing them in accordance with the hazardous waste management practices in place at the SRS and following applicable state and federal regulations. These practices are discussed in Section 4.3.4. The regulations address collecting, handling, storing, sampling, treating, and disposal of the various types of waste minimize impacts to numerous resources including hydrology, soils, air quality, ecology and human health.

Impacts of wastes generated during normal operations of the facilities would be similarly mitigated by managing them in accordance with the hazardous waste management practices in place at the SRS and following applicable state and federal regulations.

During deactivation and decommissioning, impacts of generated wastes would be mitigated in the same ways as discussed above. Impacts of wastes produced by accidents would be mitigated by rapid and thorough cleanup and by following the prescribed SRS waste management practices.

Further mitigation was not identified by the NRC that would significantly reduce the waste management impacts.

5.2.8 Human Health Risk

As discussed in the previous sections, complying with various regulations will mitigate impacts to construction workers. Impacts of fugitive dust on workers would be mitigated by following the Construction Emissions Control Plan. Occupational hazards (e.g., chemical exposure, noise, physical hazards) to workers would be mitigated by following OSHA guidelines. Impacts from hazardous wastes generated during facility construction would be mitigated by appropriately packaging and shipping the material off-site for commercial recycling, treatment, or disposal. Exposure to hazardous materials such as paints and solvents would be mitigated by following good engineering practices, such as using good ventilation and cleaning up small spills promptly and thoroughly. Wastewater generated during construction would be transported to the CSWTF for treatment prior to release.

During construction of the proposed MOX facility and WSB, workers could be adversely affected by exposure to soil or groundwater previously contaminated by radioactivity or chemicals. Potential mitigation measures were identified by the NRC staff to mitigate the possibility that workers could be exposed to the previously disturbed soils that may be contaminated. As discussed in Section 4.3.1, DCS has conducted limited testing of the previously disturbed soils. Impacts from contaminated soil should be mitigated by conducting further sampling of the soil for radioactive contamination before excavation begins at the site. In addition, workers should be monitored, as appropriate, to ensure that radioactive doses are maintained at levels as low as reasonably achievable.

During normal operations of the proposed MOX facility and WSB, workers could be impacted by exposure to internal and external radiation. These impacts would be mitigated by complying with NRC regulations including instituting monitoring, enforcing administrative limits, and developing ALARA programs that would include worker rotations. DCS has incorporated several design features into the proposed MOX facility design to mitigate exposure to workers and the public. These include, but are not limited to, containment (e.g., gloveboxes), shielding, and air filtration.

During normal operations, workers at the proposed MOX facility and WSB could also be impacted by chemical exposure. Complying with OSHA guidelines and SCDHEC regulations would mitigate adverse impacts from chemicals. Health risks from occupational exposures through all pathways (i.e., inhalation, skin contact [dermal], and ingestion) would be mitigated by using enclosed operations (e.g., gloveboxes) as much as possible. In addition, workplace exposure to such chemicals as hydrazine, that are used in the plutonium polishing process to separate plutonium from the solvent, would be monitored to ensure that airborne concentrations within the facility were kept below the occupational exposure limit. Off-gas treatment systems would be used to limit hydrazine emissions to very low levels that would mitigate adverse human health impacts.

During the fuel fabrication process at the proposed MOX facility, purified plutonium dioxide would be mixed with depleted uranium dioxide. Impacts from this process would be mitigated by performing the mixing in closed containers located in gloveboxes that would confine contamination to inaccessible areas. Air exhaust from the gloveboxes would be passed through HEPA filters to collect particulate emissions.

During normal operations, occupational hazards to workers at the proposed MOX facility and WSB would be mitigated by following OSHA guidelines.

DCS has committed to establishing a protocol with the DOE to integrate DCS's emergency plans with the existing SRS emergency preparedness program. The consequences of accidents (fire, explosion, load handling, and criticality) on human health would be mitigated by following SRS emergency procedures. For fires, key features would include fire barriers, minimizing combustibles and ignition sources, installing ventilation systems with fire dampers and HEPA filters, using nitrogen blanket systems, providing only qualified canisters and containers, incorporating fire suppression and detection systems, developing and following appropriate emergency procedures, providing worker training, and equipping and training local fire brigades. For explosions, the following mitigation devices would be available: scavenging air systems, hydrogen monitoring systems, temperature control systems, chemical addition and concentration control systems, sampling systems, process shutdown controls, operator training, and operations and maintenance procedures. Key mitigation features for load handling include load path restrictions, crane-operating procedures, maintenance procedures, operator training, qualified canisters, reliable load-handling equipment, and ventilation systems with HEPA filters. Key mitigation features for criticality accidents include geometry, mass, and moderation controls.

Mitigation activities for the deactivation and decommissioning of the facilities would be essentially the same as those discussed for construction.

The NRC staff has reviewed the mitigation measures for human health impacts and has concluded that no additional mitigation measures are required beyond the regulatory requirements and the measures identified by DCS.

5.2.9 Cultural, Historical, and Paleontological Resources

Construction of the proposed MOX facility and WSB would directly impact two prehistoric archaeological sites that are eligible for listing on *National Register of Historical Places.* There are no known fossil-bearing strata within the area of the project, and although there are about 400 historic sites or sites with historic components, none of them are located within the location of the proposed facilities.

Impacts of construction to two prehistoric archaeological sites were mitigated in part through data recovery as described in a data recovery plan that was submitted and approved by the South Carolina State Historic Preservation Office (SCSHPO) (Long 2002). When construction activities begin, the removal of fill on the site areas will be monitored by staff members of the SRARP (Gould 2002).

Five additional eligible sites are located in the vicinity of the planned construction, but no direct impacts to these sites are expected. However, indirect impacts could still affect these sites. Possible mitigation activities for these indirect impacts include awareness training for workers so that they would not inadvertently disturb the sites, possible restrictions on where heavy machinery is allowed, and periodic monitoring by staff members of the SRARP to check for possible surface erosion or evidence of other impacts from an increase in F-Area activities (e.g., unauthorized pedestrian or vehicle activity at the archaeological sites). The need for an avoidance agreement for one site or additional mitigation activities for potential erosion at several of the sites should be determined in consultation with the SCSHPO.

Inadvertent discoveries of cultural resources could also occur during site construction. Mitigation of any adverse impacts to these sites would follow the guidelines of 36 CFR 800.11 (historic properties) and/or 43 CFR 10.4 (Native American human remains, funerary objects, objects of cultural patrimony, and objects that are sacred).

During normal operations, archaeological resources are unlikely to be affected. Therefore, no mitigation activities would be required.

Potential impacts of deactivation and decommissioning eligible archaeological sites or historic structures would have to be evaluated at the time of decommissioning. Mitigation measures would be determined in consultation with the SCSHPO.

Further mitigation was not identified by the NRC that would significantly reduce the impacts to cultural, historical, and paleontological resources.

5.2.10 Aesthetics

Construction, operation, deactivation, and decommissioning of the structures associated with the proposed MOX facility and WSB would have a minimal effect on the scenic character of the surrounding area and would be consistent with the VRM Class IV designation of the area. The buildings would be low-rise structures with heights of less than 30 m (100 ft). This height would be similar to that of other buildings in the area. The tallest new structure would be a stack that is 37 m (120 ft) above the existing grade. Impacts of these buildings on visual resources would be mitigated by the presence of trees and rolling terrain that would effectively screen them from view, and the distance of the facility from the nearest publicly accessible viewpoints located on State Highway 125 and SRS Road 1, both approximately 6 km (4 mi) away.

Further mitigation was not identified by the NRC that would significantly reduce the impacts.

5.2.11 Socioeconomics

Construction of the proposed MOX facility and WSB would have a minor beneficial socioeconomic impact on the region. Therefore, further mitigation would not significantly reduce the impacts. Although the region should benefit from the construction, the peak demand for workers could adversely affect other construction activities in the area. These impacts would be mitigated by the short duration of the peak demand for workers (a few months). In addition, given that a majority of workers would be hired from the existing regional labor pool, impacts from worker relocation to area businesses, public services, and facilities would be mitigated.

Transportation impacts during construction would be primarily associated with construction labor. To minimize conflicts with other SRS activities, the work schedule would be coordinated and staggered with other SRS activities to minimize the number of vehicles entering and exiting the SRS during peak commuting periods.

Normal operations of the facilities would require approximately 480 new permanent positions and an additional 780 indirect jobs. Given the population and its rate of growth, no significant socioeconomic impacts are expected, and further mitigation would not significantly reduce the impacts.

The impacts of deactivation and decommissioning of the facility would be similar to those for construction, and mitigation activities would be similar to those previously discussed. No mitigation of socioeconomic impacts would be required for accidents, unless residents were evacuated and prevented from quickly returning to their homes. Such impacts would be mitigated, to the extent possible, by rapid cleanup of the accident.

5.2.12 Environmental Justice

As discussed in Section 4.3.7, impacts to the environmental justice community would not be high and adverse from construction and normal operations associated with the proposed action. Mitigation measures discussed above in Section 5.2.8 would mitigate impacts to the general public including the environmental justice community. Therefore, further mitigation would not significantly reduce impacts specific to the environmental justice community.

Section 4.3.7 discusses possible impacts to the environmental justice community from accidents. In developing mitigation measures for these potential impacts, the NRC considered that accident impacts are different from impacts from construction or normal operations. That is construction and normal operations impacts would occur, if the facilities were authorized to be constructed, but the likelihood of accident impacts is less certain. In addition, mitigation of accident impacts for the general public would also mitigate potential impacts to the environmental justice community. Considering these factors, the NRC identified the following potential mitigation measures specifically to address disproportionate impacts to the environmental justice community from potential accidents.

Various procedures might be used to reduce the potential impacts to low-income and minority groups in the event of an accidental chemical or radiological release from the facilities. As discussed in Sections 4.3.5 and 4.3.7, the potential impacts associated with accidents would be lower if the population exposed to population exposed to a contaminate plume did not ingest crops that could be contaminated. In addition, seeking shelter indoors would reduce the inhalation and direct exposure associated with contaminate plumes. Because the mitigation activities for part of the environmental justice community involve knowing what to do in case of an accident, the NRC believes that education and public outreach are potential methods to mitigate these potential impacts. The potential mitigation activities include development and implementation of the following:

- Focused public information campaigns to provide technical and environmental health information directly to low-income and minority groups, or to local agencies and representative groups; and

- Additional programs directed at local communities providing emergency response services and other emergency facilities to incorporate additional measures to protect low-income and minority populations.

Included in the public information campaigns would be descriptions of existing air and groundwater monitoring programs; the nature, extent, and likelihood of any future airborne or groundwater release from the facilities; and the likely characteristics of environmental and health impacts. Key information would include the extent of any likely damage to drinking water supplies and subsistence resources and the relevant preventive measures that may be taken.

The additional programs under the second group of measures would ensure that the low-income and minority population in local government jurisdictions are located and fully prepared in the event that sheltering or other protection strategies may be required and would ensure that detailed descriptions of evacuation routes that may be used have been developed and distributed. In addition to public information campaigns targeting low-income and minority groups, these programs would include the development of spatial database programs for use by local emergency response planners. These databases would provide information on the locations of low-income and minority populations and the locations of relevant local resources available to emergency response agencies, and would have detailed descriptions of evacuation routes that might be required.

The NRC staff has reviewed the mitigation measures for environmental justice and has concluded that no additional mitigation measures are required beyond the regulatory requirements and the measures identified by DCS.

5.3 References for Chapter 5

DCS (Duke Cogema Stone & Webster) 2002. *Mixed Oxide Fuel Fabrication Facility Environmental Report, Revision 1 & 2*. Docket Number 070-03098. Charlotte, NC.

DCS 2003. *Mixed Oxide Fuel Fabrication Facility Environmental Report, Revision 4*. Docket Number 070-03098. Charlotte, NC. Aug.

DOE (U.S. Department of Energy) 1999. *Surplus Plutonium Disposition Final Environmental Impact Statement*. DOE/EIS-0283. Office of Fissile Materials Disposition, Washington, DC. Nov.

DOE 2000. "Record of Decision for the Surplus Plutonium Disposition Final Environmental Impact Statement." *Federal Register* 65:1608, Jan. 11.

DOE 2002. "Amended Record of Decision for the Surplus Plutonium Disposition Program*."* *Federal Register* 67:19432, April 19.

DOE 2003. *Changes Needed to the Surplus Plutonium Disposition Program Supplement Analyses and Record of Decision*. DOE/EIS-0283-SA1. Office of Fissile Materials Disposition, Washington, DC, April.

Gould, A.B. 2002. Letter from Gould (Director, Environmental Quality Division, DOE, Savannah River Operations Office, Aiken, SC) to C.C. Long (South Carolina State Historic Preservation Office, Columbia, SC). October 24.

Long, C.C. 2002. Letter from Long (South Carolina State Historic Preservation Office, Columbia, SC) to A.B. Gould (Director, Environmental Quality Division, DOE, Savannah River Operations Office, Aiken, SC). October 24.

6 ENVIRONMENTAL REGULATIONS AND PERMITS

The proposed project would be subject to many federal, state, local, and other legal requirements, and a variety of permits, licenses, and approvals would have to be obtained. Many of these requirements are identified and their status summarized in Table 6.1. For items that are the responsibility of the facility owner or operator, Table 6.1 presents requirement status on the basis of information obtained from the environmental report (ER) (DCS 2002a; 2003a,b; 2004). No independent evaluation was made of the status of consents not discussed in the ER that are the responsibility of the facility owner or operator. For items that are the responsibility of the U.S. Nuclear Regulatory Commission (NRC), references are made to other sections of this environmental impact statement (EIS) that discuss their status.

Because of the early stage of project design, the information in Table 6.1 should not be considered comprehensive or binding. It may later be determined that the facility is subject to additional requirements that are not listed in Table 6.1 or qualifies for exemptions or exclusions from some requirements that are listed.

For ease of reference, the information in Table 6.1 has been divided into the following categories:

- Civilian Use of Nuclear Material,
- Air Quality Protection and Noise Control,
- Protection of Water Resources,
- Waste Management and Pollution Prevention,
- Biotic Resources,
- Cultural Resources,
- Transportation, and
- Other.

Table 6.1. Applicable environmental regulations and consents or activities

Responsible agency	Authority	Requirement	Status
Civilian Use of Nuclear Material			
NRC	Atomic Energy Act of 1954, as amended (AEA) (42 U.S.C. 2011 et seq.); 10 CFR Part 40	*Part 40 License* to receive, possess, use, and transfer depleted uranium	DCS has satisfied this requirement by specifying depleted uranium activities in the Construction Authorization Request for its Part 70 License (DCS 2001, Sections 1.2.2 and 1.2.3, and 2002b).
NRC	AEA; 10 CFR Part 70	*Part 70 License* to receive, possess, use, and transfer plutonium	DCS has applied for this consent by filing a Construction Authorization Request and an Environmental Report with the NRC (DCS 2002a; 2003a,b).
South Carolina Department of Health and Environmental Control (SCDHEC)	AEA; South Carolina (SC) Regulations R.61-63	*Radioactive Materials License* to receive, use, possess, transfer, and dispose of radioactive material, including depleted uranium	DCS has satisfied this requirement by applying for a Part 70 License from the NRC.
Air Quality Protection and Noise Control			
SCDHEC	Clean Air Act (CAA) Section 165 (42 U.S.C. 7475); SC Regulations R.61-62.5 Standard No. 7	*Prevention of Significant Deterioration (PSD) Permit* to construct and operate a new major stationary source of air pollution in an area that complies with National Ambient Air Quality Standards for carbon monoxide, lead, nitrogen dioxide, ozone, sulfur oxides, particulate matter with aerodynamic diameter less than or equal to 10 µm (PM_{10}), and $PM_{2.5}$	DCS has determined that gaseous emissions from the facility would not be enough to trigger the requirement for a PSD Permit (DCS 2002a, Section 7.2.1.1). Section 4.3.2.2 discusses impacts of facility operations on air quality.

Table 6.1. Continued

Responsible agency	Authority	Requirement	Status
SCDHEC	CAA, Title V, Sections 501 - 507 (42 U.S.C. 7661 - 7661f); SC Regulations R.61-62.70	*Title V Operating Permit* for a new or existing stationary source that is a major source; a source subject to National Emission Standards for Hazardous Air Pollutants (NESHAPs); a source subject to New Source Performance Standards (NSPS); or an affected source under the Acid Rain Program	DCS has determined that the quantity of criteria and hazardous air pollutants (other than radionuclides) expected to be emitted during facility operation would not be enough to trigger the requirement for a Title V Operating Permit (DCS 2002a, Section 7.2.1.1). Even so, DCS has initiated consultation with the SCDHEC and plans to submit any permit forms necessary to augment the existing Title V Operating Permit held by the DOE SRS (DCS 2002a, Section 7.2.1.1).
SCDHEC	CAA, Section 112 (42 U.S.C. 7412); 40 CFR Part 61; SC Regulations R.61-62.63	*Approval for Construction* of a new source or modification that is subject to NESHAPs	DCS has determined that the proposed facility would be subject to NESHAPs requirements in 40 CFR Part 61, Subpart H, which govern radionuclide emissions from all DOE-owned or DOE-operated facilities, whether or not they are licensed by the NRC. However, EPA Region IV and SCDHEC approved an alternate calculation methodology that exempted the facility from preparing an application for NESHAPs construction approval (DCS 2002a, Section 7.2.1.1). Section 4.3.2.2 discusses impacts on air quality during routine operation.
SCDHEC	CAA, Section 111 (42 U.S.C. 7411); 40 CFR Part 60; SC Regulations R.61-62.60	*Demonstration of Compliance* with applicable NSPS	DCS has determined that the facility would not trigger the requirement to comply with any NSPS (DCS 2002a, Section 7.2.1.1).

Table 6.1. Continued

Responsible agency	Authority	Requirement	Status
SCDHEC	CAA, Section 112(r) (42 U.S.C. 7412); 40 CFR Part 68, Subpart G; SC Regulations R.61-62.68	*Risk Management Plan* for any stationary source that has more than a threshold quantity of a regulated substance in a process	DCS has determined that a Risk Management Plan is not required because the projected quantities of regulated substances at the facility would not be greater than threshold levels (DCS 2002a, Section 7.1.2).
SCDHEC	SC Pollution Control Act (SC Code of Laws, 1976, as amended, Title 48, Chapter 1); SC Regulations R.61-62.1, Section II.A	*State Construction Permit* to construct, alter, or add to a source of air contaminants within South Carolina, if the emission limits imposed would be more restrictive than those imposed by other federal or state air permitting requirements	DCS plans to develop a Construction Emissions Control Plan and to submit standard permit application forms required by the SCDHEC in order to evaluate the applicability of all state air permitting requirements (DCS 2002a, Section 7.2.1.1).
NRC	CAA, Section 176 (42 U.S.C. 7506); 40 CFR Part 93, Subpart B	*Determination of Conformity* with applicable air quality implementation plans	No air quality implementation plans apply to the area where the facility is located.
Protection of Water Resources			
SCDHEC	Clean Water Act of 1977 (CWA) (33 U.S.C. 1251 et seq.); SC Regulations R.61-9	*National Pollutant Discharge Elimination System (NPDES) Permit for Storm Water Discharges during Construction* for discharges of storm water from any land disturbance activity affecting an area greater than 5 acres	DCS has determined that the facility construction activities would be covered by the South Carolina NPDES General Permit for storm-water discharges from construction activities within the state (Permit No. SCR100000), provided that a notice of intent, supported by a Storm Water Management Pollution Prevention Plan is filed before construction activities are initiated (DCS 2002a, Section 7.2.1.2). DCS plans to submit the notice of intent and required plans at the appropriate time.

Table 6.1. Continued

Responsible agency	Authority	Requirement	Status
SCDHEC	CWA (33 U.S.C. 1251 et seq.); SC Regulations R.61-9	*NPDES Permit for Storm Water Discharges from Industrial Activity Areas* for discharges of storm water from any facility or activity classified as "associated with industrial activity"	DCS has determined that the South Carolina NPDES General Permit for storm-water discharges from industrial activities within the state (Permit No. SCR000000) would cover runoff exposed to pollutants in an industrial activity area at the facility after construction is complete, provided that a notice of intent, supported by a Storm Water Management Pollution Prevention Plan, is filed (DCS 2002a, Section 7.2.1.2). DCS plans to submit the notice of intent and required plan at the appropriate time.
SCDHEC	CWA (33 U.S.C. 1251 et seq.); SC Regulations R.61-9	*NPDES Permit for Wastewater Discharges* for discharges to surface waters of wastewater from industrial facilities	DCS has determined that the facility would not discharge process wastewater. Accordingly, DCS has consulted with the SCDHEC regarding the need for an NPDES permit and plans, as appropriate, to file a notice of intent to discharge non-process wastewater covered by the South Carolina NPDES general permit for utility water discharges (Permit No. SCG 250000) (DCS 2004, Section 7.2.1.2).
SCDHEC	SC Pollution Control Act (SC Code of Laws, 1976, as amended, Title 48, Chapter 1); SC Regulations R.61-67	*State Construction Permit* to construct, alter, or add to wastewater treatment facilities within South Carolina	DCS has initiated consultation with the SCDHEC and at the appropriate time, plans to obtain a permit to construct the tie-in between the existing SRS Central Sanitary Waste Treatment Facility and the sanitary wastewater system from the facility (DCS 2004, Section 7.2.1.2).

Table 6.1. Continued

Responsible agency	Authority	Requirement	Status
SCDHEC	SC Safe Drinking Water Act (SC Code of Laws, 1976, as amended, Title 44, Chapter 55); SC Regulations R.61-58	*Public Water System Construction Permit* for construction, modification, or expansion of any public water system	DCS has initiated consultation with the SRS Environmental Protection Department, which is responsible for compliance with SCDHEC requirements applicable to the existing drinking water systems at the SRS. DCS plans to obtain the necessary permit before construction begins on a tie-in between the existing SRS drinking water system and the facility drinking water system (DCS 2002a, Section 7.2.1.3).
SCDHEC	SC Safe Drinking Water Act (SC Code of Laws, 1976, as amended, Title 44, Chapter 55); SC Regulations R.61-58	*Public Water System Operating Approval* for placing a new, modified, or expanded public water system into service	DCS has initiated consultation with the SRS Environmental Protection Department, which is responsible for compliance with SCDHEC requirements applicable to the existing drinking water systems at the SRS. DCS plans to obtain the necessary operating approval before beginning operation of the tie-in between the existing SRS drinking water system and the facility drinking water system (DCS 2002a, Section 7.2.1.3).
U.S. Environ-mental Protection Agency (EPA)	CWA (33 U.S.C. 1251 et seq.); 40 CFR Part 112	*Spill Prevention Control and Countermeasures (SPCC) Plan* for any facility that could discharge oil in harmful quantities into navigable waters	DCS plans to prepare the required SPCC Plan (DCS 2002a, Section 7.2.1.2).
SCDHEC	CWA (33 U.S.C. 1251 et seq.); SC Regulations R.61-101	*State Water Quality Certification* certifying that the applicable state water quality standards will not be violated as a result of discharges to navigable waters by an activity authorized by a federal license	The SCDHEC has notified DCS that a State Water Quality Certification in accordance with SC regulation R.61-101 is not required (SCDHEC 2003).

Table 6.1. Continued

Responsible agency	Authority	Requirement	Status
NRC; U.S. Army Corps of Engineers	CWA (33 U.S.C. 1251 et seq.); Executive Order 11988 (42 FR 26951; May 24, 1977) as amended by Executive Order 12148 (44 FR 43239; July 20, 1979)	*Floodplain Assessment* to evaluate the effects of issuing a Part 70 License on any floodplain	DCS has completed a floodplain assessment and incorporated its results into the design of the facility (DCS 2002a, Section 7.1.3 and Table 7-1). Section 3.3.1 discusses the results of the floodplain assessment.
U.S. Department of the Interior (National Park Service); NRC	Wild and Scenic Rivers Act, as amended (16 U.S.C. 1271 et seq.)	*Wild and Scenic Rivers Assessment* to ensure that issuing a Part 70 License will not result in activities that would adversely affect the values for which a river is being studied or has been designated as a wild and scenic river	DCS has determined that no river that is being studied or has been designated as a national wild and scenic river occurs within the SRS (DCS 2002a, Section 4.4.2.1).
U.S. Army Corps of Engineers	CWA (33 U.S.C. 1251 et seq.)	*Section 404 Permit* to discharge dredged or fill material into waters of the United States, including wetlands	DCS has determined that no wetlands are present on the facility site and that no other discharge of dredged or fill material into water of the United States would occur at the facility site (DCS 2002a, Section 4.6.2.2). Therefore, DCS has concluded that no Section 404 permit is required from the U.S. Army Corps of Engineers (DCS 2002a, Section 7.1.3 and Table 7-1).

Table 6.1. Continued

Responsible agency	Authority	Requirement	Status
Waste Management and Pollution Prevention			
EPA; SCDHEC	Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA) (42 U.S.C. 6901 et seq.), Subtitle C; SC Regulations R.61-79.262	*EPA Identification Number* to identify a hazardous waste generator	DCS has determined that the facility would generate small quantities of hazardous wastes. Therefore, DCS plans to file a notice of hazardous waste activity with EPA and obtain an EPA identification number when hazardous waste activities commence at the site (DCS 2002a, Section 7.2.1.4). Hazardous waste generated during facility operations is discussed in Section 4.3.2.4.
SCDHEC	RCRA, as amended by HSWA (42 U.S.C. 6901 et seq.), Subtitle C; SC Regulations R.61-79.270	*Hazardous Waste Facility Permit* for a facility that will store hazardous wastes beyond the allowed accumulation periods, treat hazardous wastes, or dispose of hazardous wastes	DCS has determined that the facility will not store hazardous waste beyond the allowed accumulation time. Also, DCS does not plan to treat or dispose of hazardous waste at the facility. Therefore, DCS has concluded that the facility would not require a hazardous waste facility permit (DCS 2002a, Section 7.2.1.4).
SCDHEC	RCRA, as amended by HSWA (42 U.S.C. 6901 et seq.), Subtitle I; SC Regulations R.61-92	*Underground Storage Tank Installation and Operation Permits* to install and operate an underground storage tank that will contain regulated substances, including petroleum products and other substances defined in Section 101(14) of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA)	DCS has initiated consultation with the SCDHEC regarding underground storage tanks for managing regulated substances at the facility and plans to obtain the necessary permits at the appropriate time (DCS 2002a, Section 7.2.1.4).

Table 6.1. Continued

Responsible agency	Authority	Requirement	Status
Biotic Resources			
NRC; U.S. Fish and Wildlife Service; South Carolina Department of Natural Resources; Georgia Department of Natural Resources	Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.); Migratory Bird Treat Act of 1918 (MBTA), as amended (16 U.S.C. 703-712); Nongame and Endangered Species Conservation Act (SC Code of Laws, 1976, as amended, Title 50, Chapter 15); Endangered Wildlife Act of 1973 (Georgia Laws 1973, p. 932, et seq.); Wildflower Preservation Act of 1973 (Georgia Laws 1973, p. 333, et seq.)	*Consultation* between the NRC, the U.S. Fish and Wildlife Service, and affected states to ensure that activities resulting from issuance of a Part 70 License (1) are not likely to jeopardize the continued existence of any species listed at the federal or state level as endangered or threatened, or result in destruction of critical habitat of such species and (2) will include appropriate precautions to mitigate adverse effects on birds protected by the MBTA	DCS has obtained declarations from the U.S. Fish and Wildlife Service and the South Carolina Department of Natural Resources indicating that facility construction and operation would have no effect on threatened and endangered species under their jurisdictions (DCS 2002a, Sections 7.1.6 and 7.2.3).

Table 6.1. Continued

Responsible agency	Authority	Requirement	Status
Cultural Resources			
NRC; Advisory Council on Historic Preservation; South Carolina State Historic Preservation Officer	National Historic Preservation Act of 1966, as amended (16 U.S.C. 470 et seq.); Archaeological and Historical Preservation Act of 1974 (16 U.S.C. 469-469c-2); Antiquities Act of 1906 (16 U.S.C. 431 et seq.); Archaeological Resources Protection Act of 1979, as amended (16 U.S.C. 470aa-mm)	*Archaeological and Historical Resources Consultation* between the NRC and the State Historic Preservation Officer or Tribal Historic Preservation Officer before allowing federally licensed activities to proceed in an area where archaeological or historic resources might be located	DCS has determined that, while there are no historic sites located within the facility site, there are two prehistoric archaeological sites that are eligible for listing on the *National Register of Historical Places* (DCS 2002a, Section 4.8.2). Mitigation of these sites was completed during August 2002 (DCS 2002a, Table 7-1). Sections 3.7 and 4.3.7.8 describe the required consultations.
NRC	American Indian Religious Freedom Act of 1978 (42 U.S.C. 1996); Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. 3001, et seq.)	*Native American Resources Consultation* between the NRC and Native Americans to ensure that activities resulting from issuance of a Part 70 License have been designed to protect access to, physical integrity of, and confidentiality of Native American sites	DCS reports that consultation has been initiated with appropriate Native American groups to identify concerns about construction activities associated with a facility such as the MOX facility at the SRS (DCS 2002a, Section 4.8.4). Sections 3.7.3 and 4.2.6.3 discuss the status of this consultation.

Table 6.1. Continued

Responsible agency	Authority	Requirement	Status
Transportation			
U.S. Department of Transportation (DOT); NRC	Hazardous Materials Transportation Act, as amended by the Hazardous Materials Transportation Uniform Safety Act of 1990 and other acts (49 U.S.C. 1501, et seq.); Atomic Energy Act of 1954, as amended (42 U.S.C. 2011, et seq.); 49 CFR 172, 173, 174, 177, and 397; 10 CFR 71	*Packaging, Labeling, and Routing Requirements for Radioactive Materials*	At the appropriate time, DCS will comply with DOT and NRC requirements for packaging, labeling, and routing of radioactive materials. DCS has identified no specific permits, licenses, or approvals that will be required for transportation of materials to or from the facility.
Other			
NRC; U.S. Natural Resource Conservation Service	Farmland Protection Policy Act (7 U.S.C. 4201 et seq.); 7 CFR Part 658	*Prime Farmland Assessment* to consider alternatives to address the adverse effects on prime farmland of activities resulting from issuance of a Part 70 license	DCS has determined that none of the land on the facility site has been identified as prime farmland because the land is not available for agricultural production (DCS 2002a, Section 7.1.7 and Table 7-1).
NRC	National Environmental Policy Act of 1969, as amended (NEPA) (42 U.S.C. 4321 et seq.); 40 CFR 1500 - 1508; 10 CFR Part 51	*Environmental Impact Statement (EIS)* to evaluate the potential environmental impacts of a proposed major federal action that may significantly affect the quality of the human environment, and to consider alternatives to the proposed action	This EIS meets the requirements of the NEPA.

Table 6.1. Continued

Responsible agency	Authority	Requirement	Status
OSHA; South Carolina Department of Labor, Licensing, and Regulation	Occupational Safety and Health Act, as amended (29 U.S.C. 651, et seq.); 29 CFR 1910.119; SC Regulations, Chapter 71, Article 1, Subarticle 6, "South Carolina Occupational Safety and Health Standards for General Industry and Public Sector Marine Terminals"	*Process Hazard Analysis* to identify, evaluate, and control the hazards of a process involving a flammable liquid or gas, hydrocarbon fuel, or highly hazardous chemical at or above the specified threshold quantity	Before operating the proposed facility, DCS would be required to perform a process hazard analysis for nitrogen tetroxide, which would be present at the proposed MOX facility in a quantity greater than the specified threshold quantity.

6.1 References for Chapter 6

DCS (Duke Cogema Stone & Webster) 2001. *Construction Authorization Request for the Mixed Oxide Fuel Fabrication Facility.* Docket Number 070-03098. Charlotte, NC.

DCS 2002a. *Mixed Oxide Fuel Fabrication Facility Environmental Report*, *Revision 1 & 2*. Docket Number 070-03098. Charlotte, NC.

DCS 2002b. *Amended Construction Authorization Request for the Mixed Oxide Fuel Fabrication Facility*. Docket Number 070-03098. Charlotte, NC.

DCS 2003a. *Mixed Oxide Fuel Fabrication Facility Environmental Report, Revision 3*. Docket number 070-03098. Charlotte, NC. June.

DCS 2003b. *Mixed Oxide Fuel Fabrication Facility Environmental Report, Revision 4*. Docket Number 070-03098. Charlotte, NC. Aug.

DCS 2004. *Mixed Oxide Fuel Fabrication Facility Environmental Report, Revision 5.* Docket Number 070-03098. Charlotte, NC. June 10.

SCDHEC (South Carolina Department of Health and Environmental Control) 2003. "Duke Cogema Stone and Webster (DCS) Mixed Oxide Fuel Fabrication Facility 401 Water Quality Certification." Letter from Q. Epps (Section Manager, Water Quality Certification Standards, Navigable Waters, and Wetlands Programs, SCDHEC, Columbia, SC) to M.L. Birch (Manager, Environment, Safety and Health, DCS, Charlotte, NC) Mar. 3.

7 GLOSSARY

7Q10 flow: The 7-day low flow, 10-year recurrence flow for a river. This flow is the lowest recorded over any 7 consecutive days within any 10-year period.

absorbed dose (*dose*[1]): The amount of energy deposited in any material by ionizing radiation. The unit of absorbed dose, the rad, is a measure of energy absorbed per gram of material.

accident: An unplanned sequence of events resulting in undesirable consequences, such as the release of radioactive or hazardous material to the environment.

accident risk: Risk based on both the severity of an accident (consequence) and the probability that the accident will occur. High-consequence accidents that are unlikely to occur (low probability) may pose a low overall risk. For purposes of comparison, accident risk is typically calculated by multiplying the accident consequence (for example, dose or expected fatalities) by the probability of the accident's occurring.

accident severity categories: A method of characterizing all the possible types of accident scenarios that might occur according to their likely outcome and the probability of occurrence. The *Nuclear Regulatory Commission* method, which is used in this environmental impact statement, divides the spectrum of accidents into eight categories. Category I accidents are the least severe but the most frequent; Category VIII accidents are very severe but very infrequent.

accident source term: The amount of radioactive or hazardous material released to the environment following an accident.

acute: Resulting in immediate impacts.

acute health endpoint: A human health impact involving immediate injury or fatality.

administrative outfall: An authorized liquid waste *outfall* that discharges no pollutants.

Advisory Council on Historic Preservation: Under the National Historic Preservation Act of 1966, the Council reviews federal undertakings that may affect historic structures, sites, or archeological artifacts. Second contact in sequential review that begins with the State Historic Preservation Officer.

An independent federal agency that serves as the chief policy advisor to the President and Congress on matters concerning historic preservation. Included on the 20 member Council are the heads of several federal agencies, including the Secretaries of the Interior and Agriculture.

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[1] Italicized words and phrases are entries in this glossary.

aerosol: Particles of solid or liquid matter that can remain suspended in air from a few minutes to many months, depending on the particle size and weight.

aerosolize: The process of converting a solid or a liquid into an airborne suspension of fine particles (an *aerosol*).

affected environment: For an environmental impact statement (EIS), a description of the existing environment covering information necessary to assess or understand the impacts. It must contain enough detail to support the impact analyses and must highlight environmentally sensitive resources (for example, floodplains, wetlands, threatened and endangered species, archeological resources).

aggregate: The sum total.

air pollutant: Any substance in air which could, if in high enough concentration, harm humans, other animals, vegetation, or material. Pollutants may include almost any natural or artificial composition of matter capable of being airborne.

air quality: A measure of the quantity of pollutants, measured individually, in the air. These levels are often compared to regulatory standards.

Air Quality Control Region (AQCR): An interstate or intrastate area designated by the *U.S. Environmental Protection Agency* for the attainment and maintenance of *National Ambient Air Quality Standards*.

air quality standards: The legally prescribed level of constituents in the outside air that cannot be exceeded during a specific time in a specified area.

air toxics (hazardous air pollutants): Substances that have adverse impacts on human health when present in the *ambient air*.

ALARA (as low as reasonably achievable): An approach to keep radiation exposures (both to the workforce and the public) and releases of radioactive material to the environment at levels that are as low as social, technical, economic, practical, and public policy considerations allow. ALARA is not a dose limit; it is a practice whose objective is the attainment of dose levels as far below applicable limits as possible.

algorithm: A formula or set of steps used to solve a problem.

ALOHA model: A computer model used to assess the impacts of potential chemical releases.

alpha particle (α): A positively charged particle made up of two protons and two neutrons that is emitted in the radioactive decay of certain atoms. An alpha particle is identical to the nucleus of the helium atom. It is easily stopped by a sheet of paper. Since they cannot penetrate human skin, alpha particles are not considered an external exposure hazard. Alpha particles within the body can cause harm, however.

ambient: Undisturbed, natural conditions, such as ambient temperature; surrounding conditions.

ambient air: The surrounding atmosphere, usually the outside air, as it exists around people, plants and structures. It is not the air in immediate proximity to emissions sources.

Ambient Air Quality Standards: Regulations prescribing the levels of airborne pollutants that may not be exceeded during a specified time in a defined area.

American Indian Religious Freedom Act: States that the policy of the United States is to protect and preserve for American Indians their inherent rights of freedom to believe, express, and exercise the traditional religions of the American Indian, Eskimo, Aleut, and Native Hawaiians. These rights include, but are not limited to, access to sites, use and possession of sacred objects, and the freedom to worship through ceremony and traditional rites.

anthropogenic: Produced by human activities.

aqueous process: An operation involving chemicals dissolved in water.

aquifer: A geologic formation that can yield significant quantities of groundwater to wells and springs.

aquitard: A geologic unit that is not permeable enough to transmit significant quantities of water. Aquitards transmit water at a very slow rate to or from an adjacent aquifer.

Archaeological and Historic Preservation Act: A federal law directed at the preservation of historic and archaeological data that would otherwise be lost as a result of federal construction. It authorized the U.S. Department of the Interior to undertake recovery, protection, and preservation of archaeological and historic data.

Archaeological Resources Protection Act of 1979: A federal act protecting cultural resources on federally owned lands. This act requires a permit for archaeological excavations or the removal of any archaeological resources on public or Native American lands.

archaeological site: Any location where humans have altered the terrain or discarded *artifacts* during prehistoric or historic times.

artifact: An object produced or shaped by human beings and of archaeological or historical interest.

as low as reasonably achievable: See *ALARA*.

atom: The smallest unit of an element that is capable of entering into a chemical reaction and displays the properties of the element.

Atomic Energy Act of 1954: A federal law that created the Atomic Energy Commission, which later split into the *Nuclear Regulatory Commission* and the Energy and Research and Development Administration (ERDA). ERDA became part of the *Department of Energy* in 1977. This act encouraged the development and use of nuclear energy and research for the general welfare and the security of the United States. This act authorized the Nuclear Regulatory Commission (NRC) to regulate and license fuel fabrication facilities that seek to receive, possess, use, or transfer special nuclear material.

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

attainment area: An area considered to have air quality as good as or better than the National Ambient Air Quality Standards for a given pollutant. An area may be in attainment for one pollutant and nonattaining for others.

attenuate: To lessen the magnitude or severity of an impact or effect.

background radiation: Radiation that is part of our natural world. It can originate from naturally occurring radioactive materials within the Earth and from outer space (cosmic sources). Background radiation also includes global fallout as it exists in the environment from the testing of nuclear explosive devices. Background radiation varies considerably with location.

becquerel (Bq): A unit used to measure radioactivity. One Becquerel is that quantity of a radioactive material that will have one transformation in one second. There are 3.7×10^{10} Bq in one *curie* (Ci).

beta particle (β): Beta particles are electrons except they are not bound to an atom. They cannot travel far from their radioactive source (about one half inch in human tissue and a few yards in air).

beyond design basis accident: An accident generally with more severe impacts to on-site personnel and the public than a *design basis accident*. This accident is used for estimating the impacts of a facility or process.

bioaccumulation: The net accumulation of a chemical by an organism as a result of uptake from all routes of exposure.

biomagnification: The tendency of some chemicals to accumulate to higher concentrations at higher levels in the food chain through dietary accumulation.

biota: The plant and animal life of a region.

blackwater stream: A freshwater stream that has a dark color because of organic debris and tannin-containing compounds.

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

borrow pits: An excavated area from which earthy material has been removed, typically for construction purposes.

bound: To estimate or describe a lower or upper limit on a potential environmental or health consequence when uncertainty exists.

bounding: In the case of accident analysis, that which represents the maximum reasonably foreseeable event or impact.

breach: A general term referring to a hole in a cylinder or container. A breach may be caused by corrosion or by mechanical forces.

bryozoa: Bryozoa are microscopic aquatic animals that live in large colonies of interconnected individuals. Bryozoa are abundant in modern marine environments and are also an important part of the fossil record. They are commonly referred to as sea mats, moss animals, or lace corals.

calcareous sand: Sand containing calcium carbonate, calcium, or limestone; it is usually white or tan.

cancer: A group of diseases characterized by uncontrolled cellular growth. Increased incidence of cancer can be caused by exposure to radiation and some chemicals.

candidate species: Species for which substantial information is available to support proposing that they be added to the federal threatened and endangered species list.

CANDU (Canadian deuterium-uranium reactor): A heavy-water reactor that uses natural uranium as a fuel and heavy water as a *moderator* and a coolant.

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

canopy: The upper forest layer of leaves consisting of the tops of individual trees whose branches sometimes cross each other.

canyon building: A term for a chemical separations plant, inspired by the building's long, high, narrow structure. Chemical separation is a process for extracting uranium and plutonium from dissolved spent nuclear fuel and irradiated targets.

capable fault: A *fault* is described as capable if it has had movement at or near the ground surface at least once within the past 35,000 years, or recurrent movement within the past 500,000 years.

capping: The process of installing a layer of clay or other impermeable material over the top of a closed landfill to prevent entry of rainwater and to minimize the escape of chemicals into the surrounding soil.

carbonate: Rocks and associated minerals that contain carbonate ion, as in calcium carbonate.

carbon monoxide (CO): A colorless, odorless gas that is toxic if breathed in high concentrations over an extended period. Carbon monoxide is a *criteria air pollutant*. One source of carbon monoxide is engine exhaust.

carcinogen: A substance that is capable of producing or inducing cancer.

cargo-related impacts: Transportation risks associated with the nature of the cargo itself.

Carolina bays: Closed, elliptical-shaped depressions capable of holding water. They are a type of *wetland*.

cask (for radioactive materials): A heavily shielded container that meets all applicable regulatory requirements for shipping *spent nuclear fuel* or *high-level waste*.

Category I Resources: Resources (for example, waters) defined by the U.S. Department of the Interior as unique and irreplaceable on a national or eco-regional basis.

Cenozoic: A geologic era dating from approximately 65 million years ago to the present. It is known as the age of mammals.

census blocks: Census blocks are defined by the U.S. Bureau of Census and are the smallest geographic unit for which the Census Bureau tabulates data. Blocks contain data from the 2000 Census of Population, including total population, population by race and ethnicity, age, marital status, population density and the number and composition of households, and information on housing unit types. Many blocks correspond to individual city blocks bounded by streets, but blocks – especially in rural areas – may include many square miles and may have some boundaries that are not streets. The Census Bureau established blocks covering the entire nation for the first time in 1990. Over 8 million blocks are identified for Census 2000.

census block groups: Census block groups are geographic entities consisting of groups of individual census blocks. Census blocks are grouped together so that they contain between 250 and 550 housing units.

census tract: An area usually containing between 2,500 and 8,000 persons that is used for organizing and monitoring census data. The geographic dimensions of census tracts vary widely, depending on population density. Census tracts do not cross county borders.

clay: A rock or mineral fragment of any composition that is smaller than very fine silt grains, having a diameter of less than 0.00016 in. (1/256 mm).

Class II water source: Current and potential drinking water, as classified by the EPA.

Clean Air Act: A federal law that mandates and provides for the enforcement of air pollution control standards from various sources. Its purpose is to protect the health and welfare of the public by controlling air pollution.

closed canopy: A forest *canopy* that is dense enough that the tree crowns fill or nearly fill the canopy layer so that light cannot reach the forest floor directly.

cloudshine: The exposure pathway of direct external exposure from radioactive material suspended in air.

Code of Federal Regulations (CFR): A publication in codified form of all federal regulations in force.

collective dose: The sum of individual doses received by all those exposed to a specified source of radiation in a given period of time. (Also referred to as population dose.)

collective population risk: A measure of possible loss or injury in a group of people that takes into account the probability that the hazard will cause harm and the consequences of that event. The collective population risk does not express the risk to specific individual members of the population.

committed effective dose equivalent (CEDE): The sum of the committed dose equivalents to various tissues of the body, each multiplied by its weighting factor. It does not include contributions from external doses. Committed effective dose equivalent is expressed in units of rem and provides an estimate of the lifetime radiation dose to an individual from radioactive material taken into the body through either inhalation or ingestion.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (Superfund): An act providing the regulatory framework for the *remediation* of past contamination from hazardous waste. If a site meets the act's requirements for designation, it is ranked along with other Superfund sites on the National Priorities List. This ranking is the U.S. Environmental Protection Agency's way of determining the priority of sites for cleanup.

conservative estimates: Conservative estimates lean on the side of pessimism and toward maximizing estimates of negative impacts.

consortium: A group (of companies) formed to undertake an enterprise beyond the resources of any one member.

contact-handled transuranic waste: Transuranic waste with a surface radiation dose rate not greater than 200 millirems per hour. It can be safely handled without any shielding other than that provided by the waste container itself.

conversion: An operation for changing material from one form, use, or purpose to another.

cooling water: Water circulated through a *nuclear reactor* or processing plant to remove heat.

cosmic radiation: Streams of highly penetrating, charged particles composed of protons, *alpha particles*, and a few heavier nuclei that bombard the earth from outer space. Cosmic radiation is part of the natural background radiation.

cost-benefit analysis: A formal quantitative procedure comparing costs and benefits of a proposed project or act under a set of preestablished rules.

Council on Environmental Quality: The President's Council on Environmental Quality (CEQ) was established by the enactment of *National Environmental Policy Act* (NEPA). The CEQ is responsible for developing regulations to be followed by all federal agencies in developing and implementing their own specific NEPA implementation policies and procedures.

criteria pollutants: Common air pollutants for which *National Ambient Air Quality Standards* have been established by the U.S. Environmental Protection Agency (EPA) under Title I of the *Clean Air Act*. Criteria *pollutants* include *sulfur dioxide*, *nitrogen oxides*, *carbon monoxide*, *ozone*, *particulate matter* (PM_{10} and $PM_{2.5}$), and *lead*. Standards for these pollutants were developed on the basis of scientific knowledge about their health effects.

critical habitat: Specific areas within the geographical range of an *endangered species* that is formally designated by the U.S. Fish and Wildlife Service under the Endangered Species Act as essential for conservation of the species.

criticality: A state in which a self-sustaining nuclear chain reaction is achieved.

cultural resources: *Archaeological sites*, architectural structures or features, traditional-use areas, and Native American scared sites or special use areas.

cumulative impacts: Potential impacts when the proposed action is added to other past, present, and reasonable foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

curie (Ci): The unit used to describe the intensity of radioactivity in a sample of material. A curie is equal to 37 billion disintegrations per second, which is approximately the activity of one gram of radium. It is also a quantity of any nuclide or mixture of nuclides having one curie of radioactivity.

D&D (deactivation and decommissioning): The removal of the facility safely from service and reduction of residual radioactivity to a level that permits release of the property to a specified end state.

deactivation: The process of removing a facility from operation and placing it in a safe and stable condition. Deactivation involves removal hazardous and radioactive materials.

decibel (dB): A standard unit for measuring sound-pressure levels based on a reference sound pressure of 0.0002 dyne per square centimeter. This is the smallest sound a human can hear. In general, a sound doubles in loudness with every increase of slightly more than 3 decibels.

decibel, A-weighted (dBA): A measurement of sound approximating the sensitivity of the human ear and used to characterize the intensity or loudness of sound.

decommissioning: The process of decontaminating and dismantling a facility following deactivation and returning the site to an end state that meets the prescribed regulatory criteria.

deep dose equivalent (DDE): The dose equivalent derived from external radiation at a depth of 1 cm in tissue.

deionized water: Water from which both negative and positive ions have been removed by an ion exchange process.

Department of Energy (DOE): A federal agency whose mission is to achieve efficiency in energy use, diversity in energy sources, a more productive and competitive economy, improved environmental quality, and a secure national defense. It was created in 1977.

depleted uranium: Uranium whose content of the isotope uranium-235 is less than 0.7%, which is the uranium-235 content of naturally occurring uranium.

depleted uranium hexafluoride (UF_6): A compound of *uranium* and fluorine from which most of the uranium-235 isotope has been removed.

dermal absorption: Entry of a substance into the body through the skin.

design basis accident: For nuclear facilities, an assumed abnormal event used to establish the performance requirements of structures, systems, and components that are necessary to keep the facility in a safe shutdown condition indefinitely, or to prevent or mitigate the consequences of such an event, so as to ensure that the public and operating staff are not exposed to radiation in excess of appropriate guideline values.

detention ponds: Engineered depressions in the land that contain storm-water runoff until it can slowly seep back into the ground or evaporate.

direct impact: An effect that results solely from the construction or operation of a proposed action without intermediate steps or processes. Examples include habitat destruction, soil disturbance, air emissions, and water use.

direct jobs: The number of workers required at a site to implement an alternative.

disposition: A process of use or disposal of materials that results in the remaining material being converted to a form that is substantially and inherently more *proliferation* resistant than the original form.

disproportionately high and adverse environmental impact: An adverse environmental impact determined to be unacceptable or above generally accepted norms. A disproportionately high impact refers to an environmental hazard with a risk or rate of exposure for a low-income or minority population that exceeds the risk or rate of exposure for the general population.

disproportionately high and adverse human health effect: Any effect on human health from exposure to environmental hazards that exceeds generally accepted levels of risk and affects low-income and minority populations at a rate that appreciably exceeds the rate for the general population.

dissolution: The chemical dispersal (dissolving) of a solid throughout a liquid medium.

dose (radiation dose): In a general sense, dose is a measure of the amount of energy from *ionizing radiation* deposited in a material. Dose is affected by the type of radiation, the amount of radiation, and the physical properties of the material itself. Radiation dose to humans is measured in units of *sieverts* (Sv) or *rem* (1 Sv = 100 rem).

drainage basin: An aboveground area of the Earth's surface that supplies the water to a particular stream.

ecology: The study of the interrelationships of organisms and their environment.

ecosystem: A group of organisms and their physical environment.

effective dose equivalent: The sum of the products of the dose equivalent to various organs or tissues and the weighting factors applicable to each of the body organs or tissues that are irradiated. This sum is a risk-equivalent value that can be used to estimate the risk of health effects to the exposed individual. The effective dose equivalent includes the *dose* from *radiation* sources internal and/or external to the body and is expressed in units of *rem* or *sievert*.

effluent: A gas or fluid discharged into the environment, treated or untreated. Most frequently, the term applies to wastes discharged to *surface waters*.

emissions: Substances that are discharged into the air.

endangered species: Any species (plant or animal) that is in danger of extinction throughout all or a significant part of its range. Requirements for declaring a species endangered are found in the *Endangered Species Act*.

Endangered Species Act of 1973: An act requiring federal agencies, with the consultation and assistance of the Secretaries of the Interior and Commerce, to ensure that their actions will not likely jeopardize the continued existence of any endangered or threatened species or adversely affect the habitat of such species.

environmental impact statement (EIS): A document required of federal agencies by the *National Environmental Policy Act* for major proposals or legislation that will or could significantly affect the environment. It describes the positive and negative effects of the proposed and alternative actions.

environmental justice: The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no population of people should be forced to bear a disproportionate share of the negative environmental impacts of pollution or environmental hazards due to a lack of political or economic strength.

Environmental Protection Agency (EPA): A federal agency that is responsible for setting, or working with state and local governments, to set standards that help control and prevent pollution and minimize the potential health effects in areas of solid and hazardous waste, pesticides, water, air, drinking water, and toxic and radioactive substances. It was created in 1970.

Eocene: A geologic epoch early in the Cenozoic era, dating from approximately 56 to 34 million years ago.

epicenter: The point on the Earth's surface directly above the focus of an earthquake.

equivalent dose: The equivalent dose is a measure of the effect that radiation has on humans. It takes into account the type of radiation and the *absorbed dose*. Not all types of radiation produce the same effects. For example, when considering beta, x-ray, and gamma ray radiation, the equivalent dose (in rem) is equal to the absorbed dose (in rads). For alpha radiation, the equivalent dose is assumed to be 20 times the absorbed dose.

erosion: The removal and transport of materials by wind, ice, or water on the Earth's surface.

exposure: Contact of an organism with a chemical, radiological, or physical agent.

exposure pathways: A route or sequence of processes by which a radioactive or hazardous material may move through the environment to humans or other organisms. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route.

external exposure: Exposure to radiation or hazardous substance that originates from sources outside of the body.

facility: Any building, structure, system, process, equipment, or activity that fulfills a specific purpose on a site.

facility workers: Persons working at the *Mixed Oxide* Fuel Fabrication Facility who are directly involved with the handling of radioactive or hazardous materials.

fault (geologic): A fracture in rock along which movement of one side relative to the other has occurred.

fauna: Animals, especially those of a specific region, considered as a group.

Federal Facilities Compliance Act of 1992: A federal law that amended the *Resource Conservation Recovery Act* with the objectives of bringing all federal facilities into compliance with applicable federal and state hazardous waste laws, waiving federal sovereign immunity under those laws, and allowing the imposition of fines and penalties. The law requires the U.S. Department of Energy to submit an inventory of all its mixed waste and to develop a treatment plan for mixed waste.

FIREPLUME: A computer code used to evaluate atmospheric dispersion of contaminants in an airborne release plume.

fissile nuclear material: Nuclear materials that are fissionable by slow (thermal) neutrons. Fissile materials include uranium-233, uranium-235, and plutonium-239.

fission: The splitting of a heavy atomic nucleus into at least two nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or be induced by neutron bombardment.

floodplain: The lowlands adjoining inland and coastal waters and relatively flat areas, including, at a minimum, that area inundated by a 1% or greater-chance flood in any given year. The level area adjoining a river or stream that is sometimes covered by flood water. The base floodplain is defined as the 100-year (1%) floodplain.

flora: Plants, especially those of a specific region, considered as a group.

fly-ash: Small solid ash particles from the noncombustible portion of fuel that are small enough to escape with the exhaust gases.

forb: An herb other than grass.

fossil: An impression or trace of an animal or plant of past geologic ages that has been preserved in the Earth's crust.

fossil fuel: Natural gas, petroleum, coal, and any form of solid, liquid, or gaseous fuel derived from such materials for the purpose of creating useful heat.

Fujita Scale: The official classification system for tornado damage. The scale ranges from F0 (gale tornado, minor damage, winds up to 72 mph) to F6 (inconceivable tornado, winds 319-379 mph). F2 on the Fujita scale indicates a significant tornado causing significant damage.

fugitive dust: The dust released into the air from activities associated with construction, manufacturing, or vehicles operating on open fields or dirt roads. It is a subset of *fugitive emissions*.

fugitive emissions: Emissions that are not caught by a capture system. They are often caused by equipment leaks, evaporative processes, and windblown disturbances.

full-time equivalent (FTE): Equivalent to a full-time worker. For example, two people, each working half time, constitute one FTE.

gamma radiation (γ): High-energy, short-wavelength electromagnetic radiation emitted from a radioactive nucleus during decay. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded by dense materials such as lead or uranium. Gamma rays are similar to X-rays but are more energetic.

Gaussian model: An air dispersion model based on the assumption that the time-averaged concentration of a substance emitted from a point source has a Gaussian distribution about the mean centerline. A Gaussian distribution is represented by a symmetrical bell-shaped curve.

glauconitic sand: Sand that contains the mineral glauconite, which consists of a dull green earthy iron potassium silicate.

GENII: A computer software code used to evaluate dose from the migration of radionuclides introduced into the environment that may eventually affect humans through *ingestion*, *inhalation*, or direct radiation.

geologic repository: An underground facility intended for the disposal of nuclear waste. The waste is isolated by placing it in mined cavities in a continuous, stable geologic formation at depths typically greater than 300 m (984 ft).

geology: The science that deals with the study of the materials, processes, environments, and history of the Earth, including the rocks and their formation and structure.

glovebox: An airtight box used to work with hazardous material. It is vented to a closed filtering system, and has gloves attached inside to protect the worker.

gravitational acceleration (g): An acceleration equal to the Earth's gravitational acceleration at sea level (32 feet /second/second).

gross alpha: The total (or gross) radioactivity in a sample due to emission amount of *alpha particles.* It includes both naturally occurring and man-made radiation.

groundshine: Radiation from ground-deposited *radionuclides*.

groundwater: The supply of water found beneath the Earth's surface, usually in *aquifers*, which may supply wells and springs. Generally, all water contained in the ground.

grout: A cementing or sealing mixture of cement and water to which sand, sawdust, or other additives (sometimes waste) may be added. In terms of waste management practices, grouting is used to reduce the mobility of a waste material. In-situ grout is used to stabilize contaminated soil without having to remove it.

habitat: Area where a plant or animal lives.

half-life (radiological): The time in which half the atoms of a radioactive substance decay to another nuclear form. It varies for different radioisotopes from millionths of a second to billions of years.

hazard Index (HI): A measure of the noncancer risk involved in human exposure to a chemical substance. It is the sum of the *hazard quotients* for all chemicals to which an individual is exposed. A Hazard Index value of 1.0 or less means that no adverse human health effects (noncancer) are expected to occur.

hazard quotient (HQ): A comparison of the estimated intake level or dose of a chemical in air, water, or soil with its reference dose; expressed as a ratio.

hazardous waste: According to the *Resource Conservation and Recovery Act*, a waste that because of its characteristics may (1) cause or significantly contribute to an increase in mortality or an increase in serious irreversible illness, or (2) pose a substantial hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Hazardous wastes possess at least one of the following characteristics: ignitability, corrosivity, reactivity, or toxicity. Hazardous waste is nonradioactive.

headwaters: The source of a flowing body of water.

health risk conversion factors: Estimates of the expected number of health effects cause by exposure to a given amount of radiation. Health risk conversion factors are multiplied by the estimated radiation dose received by a given population in order to estimate the number of health effects expected to occur as a result of an exposure.

heavy combination trucks: Rigs composed of a separable tractor unit containing the engine and one to three freight trailers connected to each other and the tractor. They are typically used for shipping radioactive wastes.

herpetofauna: Reptiles and amphibians.

HGSYSTEM: A computer code used to assess hazardous chemical impacts.

high-efficiency particulate air (HEPA) filters: A filter designed to remove 99.97% of particles as small as 0.3 micrometers in diameter from a flowing air stream.

high-level (radioactive) waste (HLW): The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid. High-level waste contains a combination of *transuranic waste* and *fissio*n products in concentrations requiring permanent isolation. High-level waste may include other highly radioactive material that the U.S. Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation.

highly enriched uranium: Uranium enriched in the isotope uranium-235 to 20% or above, which thus becomes suitable for nuclear weapons use.

HIGHWAY: A transportation routing model.

historic structures: A standing structure that has historic significance.

human health risk: The likelihood that a given exposure or series of exposures will damage the health of individuals.

hydrazine: A highly reactive and corrosive chemical that is a *carcinogen* and a reproductive hazard. It is the only chemical that would be used in the MOX process that is listed as a hazardous air pollutant under the *Clean Air Act.*

hydrogen fluoride: A colorless, toxic, fuming, corrosive liquid or gas. It is produced when uranium hexafluoride (UF_6) comes in contact with water, such as humidity in the air. It is often a by-product when UF_6 is converted to another chemical form.

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

ICRP (International Commission on Radiological Protection): An international body tasked with providing an overview of radiation standards and regulations and information to help standardize these regulations.

immobilization: A process used to stabilize waste, thus inhibiting its release into the environment.

impoundment: A natural or artificial body of water confined by a dam, dike, floodgate, or other barrier.

in attainment: In compliance with air quality standards. Areas that are in attainment have air quality that is as good as or better than specified in the *National Ambient Air Quality Standards* for a given pollutant. An area may be in attainment for one pollutant and nonattaining for others.

incremental impact: The impact due to an emission source (or group of sources) in isolation, without including background levels.

indirect impact: An effect that is related to, but removed from a proposed action by an intermediate step or process. An example would be surface-water quality changes resulting from soil erosion at construction sites.

indirect jobs: Jobs generated or lost in related industries within a *regional economic area* as a result of a change in direct employment.

infrastructure: The basic facilities, services, and utilities needed for the functions of an industrial facility or site. Transportation and electrical systems are part of the infrastructure.

ingestion: To take in by mouth. Material that is ingested enters the digestive system.

inhalation: To take in by breathing. Material that is inhaled enters the lungs.

in-migration: People moving into an area, in this case, the region of influence.

in situ: In its natural position or place.

internal exposure: The radiation dose to internal organs and tissues of the body from the ingestion or inhalation of radioactive contaminants in air, water, food, or soil.

invertebrates: Animals without a backbone (insects, for example).

ion: An atom that has too many or too few electrons, causing it to have an electrical charge, and therefore to be chemically active.

ion exchange: A process that removes specific chemicals and radionuclides from a liquid stream (usually water) for the purposes of purification or decontamination. In this process, salts present as charged ions in water are attached to active groups on and in an ion exchange resin, and other ions are discharged into water allowing separation of the two groups of ions.

ionizing radiation: Radiation that has enough energy to remove electrons from atoms, causing them to become charged or ionized.

irradiate: Expose to some form of radiation, usually a nuclear reactor. Irradiated reactor components and fuel are subjected to neutron radiation and become radioactive themselves or produce *isotopes*.

ISCST3: Version 3 of the Short-Term Industrial Source Complex model. It was used to estimate potential air quality impacts from MOX facility construction and operation activities.

isotope: An atom of an element with a specific atomic number and atomic mass. Isotopes of the same element have the same number of protons (atomic number) but different numbers of neutrons (atomic mass). For example, uranium-235 is an isotope of uranium with 93 protons and 143 neutrons; uranium-238 is an isotope of uranium with 92 protons and 146 neutrons.

kaolinitic clay: A fine, usually white *clay* that contains the mineral kaolinite, a hydrous silicate of aluminum.

L_{dn}: A 24-hour average sound level that gives additional weight to noise that occurs during the night (10:00 p.m. to 7:00 a.m.).

L_{eq}: For sounds that vary with time, L_{eq} is the steady sound level that would contain the same total sound energy as the time-varying sound over a given period.

L_{eq}(24): L_{eq} averaged over 24 hours.

Land Disposal Restrictions: Part of the Hazardous and Solid Waste Amendments to RCRA. They restrict land disposal of certain hazardous wastes; these wastes may be land disposed only if they meet specified treatment standards.

land use: A characterization of land surface in terms of its potential utility for various activities.

latent: Occurring some time (usually several years) after exposure.

latent cancer fatalities (LCFs): Deaths resulting from cancer that has become active after a latent period following exposure to a cancer-causing agent. Latent cancer fatalities are similar to naturally occurring cancer and may be expressed at any time after the initial exposure.

latent cancers: Cancers that occur after a latency period of about 10 or more years from the time of exposure.

latency period: The average period of time between exposure to an agent and the onset of a health effect.

latent fatalities (latent mortality): Fatalities that result from acute or chronic environmental exposures to hazardous substances or radiation but that do not occur immediately after exposure.

lead: A gray-white metal that is listed as a criteria air pollutant. Health effects from exposure to lead include brain and kidney damage and learning disabilities.

linear/no threshold hypothesis: A hypothesis that implies, in part, that even small doses of radiation cause some risk of inducing cancer, and doubling of the radiation dose would mean doubling of the expected number of cancers.

listed species: Species that are considered threatened or endangered.

loam: A soil consisting of an easily crumbled mixture of *clay*, *silt*, and sand.

low-enriched uranium (LEU): Uranium enriched in the isotope uranium-235, greater than 0.7% but less than 20% of the total mass. Naturally occurring uranium contains about 0.7% uranium-235, almost all the rest is uranium-238.

low-level (radioactive) waste: Waste that contains radioactivity and is not classified as *high-level waste*, *transuranic waste*, or *spent nuclear fuel*.

low-specific-activity (LSA) drum: A container, such as a 55-gallon drum, that is used to package low-*specific-activity* material. The depleted uranium considered in this EIS is low-specific-activity material.

macroinvertebrates: Small animals, such as larval aquatic insects, that are visible to the naked eye and have no vertebral column.

magnitude: A measure of the total energy released by an earthquake. It is commonly measured in numerical units on the *Richter scale*. Each unit is different from an adjacent unit by a factor of 30.

marsh: An area of low-lying wetlands dominated by grasslike plants.

maximally exposed individual: A hypothetical person who — because of proximity, activities, or living habits — could receive the highest possible dose of radiation or of a hazardous chemical from a given event or process.

meteorology: The science dealing with the atmosphere and its phenomena, especially as relating to weather.

metric ton: A unit of mass equal to approximately 1.1 short (U.S.) tons, or 2,200 pounds.

millirem (mrem): A unit of radiation exposure equal to one-thousandths of a *rem*.

Miocene: A geologic epoch of the *Cenozoic era* dating from approximately 24 to 5 million years ago.

mitigation: A series of actions implemented to ensure that projected impacts will result in no net loss of habitat value or wildlife populations. The purpose of mitigative actions is to avoid, minimize, rectify, or compensate for any adverse environmental impact.

mixed low-level (radioactive) waste: Low-level waste that also contains hazardous chemical components regulated under the *Resource Conservation Recover Act*.

mixed oxide: For the purposes of this EIS, a physical blend of uranium oxide and plutonium oxide.

mixed transuranic waste: Transuranic waste that also contains hazardous chemical components regulated under the *Resource Conservation and Recovery Act.*

mixed waste: Waste that contains both hazardous and radioactive components.

model: A conceptual, mathematical, or physical system obeying certain specified conditions, whose behavior is used to understand the physical system it is attempting to mimic. Models are often used to predict the behavior or outcome of future events.

moderator: A material (usually water, heavy water, or graphite) used in some nuclear reactors to slow down high-velocity neutrons, thereby increasing the likelihood of *fission*. Moderation controls are a factor in mitigating *criticality* accidents.

Modified Mercalli Intensity Scale: A measure of the perceived intensity of earthquake ground shaking, originally developed in Italy nearly a century ago. It includes 12 degrees of shaking from I (not felt by people) to XII (nearly total damage).

molar concentration: The amount of a substance dissolved per unit volume of solution.

National Ambient Air Quality Standards (NAAQS): Air quality standards established by the *Clean Air Act*, as amended. The primary NAAQS are intended to protect the public health with an adequate margin of safety; and the secondary NAAQS are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Emission Standards for Hazardous Air Pollutants (NESHAPs): A set of national emission standards for listed hazardous pollutants emitted from specific classes or categories of new and existing sources. These standards were implemented in the *Clean Air Act* Amendments of 1977.

National Environmental Policy Act (NEPA) of 1969: A federal law constituting the basic national charter for protection of the environment. The act calls for the preparation of an environmental impact statement (EIS) for every major federal action that may significantly affect the quality of the human or natural environment. The main purpose is to ensure that environmental information is provided to decision makers so that their actions are based on an understanding of the potential environmental and socioeconomic consequences of a proposed action and the reasonable alternatives.

National Historic Preservation Act: A federal law providing that property resources with significant national historic value be placed on the *National Register of Historic Places*. It does not require permits; rather, it mandates consultation with the proper agencies whenever it is determined that a proposed action might impact a historic property.

National Pollutant Discharge Elimination System (NPDES): A federal permitting system controlling the discharge of effluents to surface waters of the United States and regulated through the *Clean Water Act*, as amended.

National Register of Historic Places (NRHP): A list of districts, sites, buildings, structures, and objects of prehistoric or historic local, state, or national significance. The list is maintained by the Secretary of the Interior.

nitrogen oxides (NO_x): The oxides of nitrogen, primarily nitrogen oxide (NO) and nitrogen dioxide (NO_2), that are produced in the combustion of fossil fuels. Nitrogen dioxide emissions constitute an air pollution problem, because they contribute to acid deposition and the formation of atmospheric ozone. Nitrogen oxides are *criteria air pollutants*.

noise: Any sound that is undesirable because it interferes with speech and hearing, is intense enough to damage hearing, or is otherwise annoying (unwanted sound).

Noise Control Act of 1972: A federal law directing all federal agencies to carry out programs in a manner that furthers the national policy of promoting an environment free from noise that jeopardizes health or welfare.

nonattainment area: The U.S. Environmental Protection Agency's designation for an air quality control region (or portion thereof) in which ambient air concentrations of one or more criteria pollutants exceed *National Ambient Air Quality Standards*.

normal operations: Conditions during which facilities and processes operate as expected or designed. In general, normal operations include the occurrence of some infrequent events that, although not considered routine, are not classified as accidents.

Notice of Intent: A notice that an environmental impact statement will be prepared and considered. It describes the proposed action and provides information on issues and potential impacts and invites comments and suggestions on the scope of the environmental impact statement.

nuclear power plant: A facility that converts nuclear energy into electric power. Heat produced in a *nuclear reactor* is used to make steam, which drives a turbine connected to an electric generator.

nuclear reactor: A machine in which a fission chain reaction is maintained for the purpose of irradiating materials or producing heat for the generation of electricity.

Nuclear Regulatory Commission (NRC): The NRC is an independent regulatory agency created out of the Atomic Energy Commission in 1975 to regulate civilian uses of nuclear material. It is responsible for ensuring that activities associated with the operation of nuclear power and fuel cycle plants and the use of radioactive materials in medical, industrial, and research applications are carried out with adequate protection of public health and safety, the environment, and national security.

Nuclear Waste Policy Act of 1982: The act that authorized federal agencies to develop a geologic repository for the permanent storage of *spent nuclear fuel* and *high-level radioactive waste.*

off-link population: Persons living or working within 0.8 km (0.5 mi) of each side of a transportation route.

Oligocene: A geologic epoch of the *Cenozoic era* dating from approximately 34 to 24 million years ago.

on-link population: Persons sharing a transportation route.

order of magnitude: A range of numbers extending from some value to 10 times that value. If, for example, a number is two orders of magnitude greater than another, it is 100 times greater.

organic compounds: A large group of chemical compounds containing mainly carbon, hydrogen, nitrogen, and oxygen. All living organisms are made up of organic compounds.

outfall: The discharge point of a drain, sewer, or pipe into a body of water.

oxide: A compound formed when an element (for example, plutonium) is bonded to oxygen.

ozone: A strong-smelling, reactive toxic chemical gas consisting of three oxygen atoms chemically attached to each other. It is the product of the photochemical process involving the sun's energy and ozone precursors, such as hydrocarbons and oxides of nitrogen. In the stratosphere, ozone protects the Earth from the sun's ultraviolet rays, but in lower levels of the atmosphere, ozone is considered an air pollutant and can cause irritation of the eyes and respiratory tract. Ozone is one of the criteria air pollutants specified under Title I of the *Clean Air Act* and is a major constituent of smog.

PM_{10}: Particulate matter with a diameter less than 10 μm (0.0004 in.). Particles less than this diameter are small enough to be breathed and could be deposited in the lungs. PM_{10} is one of the six criteria air pollutants specified under Title I of the *Clean Air Act.*

$PM_{2.5}$: Particulate matter with a diameter less than 2.5 μm (0.0001 in.). A standard for this material as a *criteria pollutant* has been defined but not yet implemented.

Paleocene: The earliest epoch in the *Cenozoic era*, dating from approximately 65 to 56 million years ago.

paleontology: The study of plant and animal life that existed in former geologic times, particularly through the analysis of *fossils*.

Paleozoic: The longest era of geologic time, dating from approximately 544 to 248 million years ago. Seed-bearing plants, amphibians, and reptiles first appeared in the Paleozoic era.

parameters: Data or values that are input to computer codes or equations. They are quantifiable or measurable characteristics like wind speed, temperature, pH, vehicular speed, duration of exposure, etc.

particulate matter (PM): Fine liquid or solid particles such as dust, smoke, mist, fumes, or smog, found in air or emissions. The size of the *particulates* is measured in micrometers (μ); a micrometer is 1 millionth of a meter (0.000039 in.). Particle size is important because the *Environmental Protection Agency* has set standards for PM_{10} and $PM_{2.5}$ designed to protect human health and welfare. Particulate matter is a *criteria pollutant*.

particulates: Solid particles and liquid droplets small enough to become airborne.

Pascal (Pa): A unit of measurement for pressure in the International System of Units (SI). 1 pascal = 0.0001450 pounds per square inch.

Pasquill atmosphere stability class: A classification scheme that describes the degree of atmospheric turbulence. Categories range from extremely unstable (A) to extremely stable (F). Unstable conditions promote the rapid dispersion of atmospheric contaminants and result in lower contaminant air concentrations compared with stable conditions.

permitted outfalls: *Outfalls* that are regulated by permits.

person-rem: A unit used to measure the radiation exposure to an entire group and to compare the effects of different amounts of radiation on groups of people; it is the product of the average dose equivalent (in *rem*) to a given organ or tissue multiplied by the number of persons in the population of interest.

person-sievert: A unit of radiation exposure. One person-*sievert* is equivalent to 100 *person-rem*.

person-year: The sum of the number of years each person in a study population is at risk; a metric used to aggregate the total population at risk, assuming that 10 people at risk for 1 year is equivalent to 1 person at risk for 10 years.

physiographic province: A region in which the landforms are similar in geologic structure and differ significantly from the landform patterns in adjacent regions.

physiographic regions: Geographic regions based on geologic setting.

pit: The core element of a nuclear weapon's fission component.

plasma arc cutting: Plasma arc cutting uses a high-velocity jet of electrically charged gas to cut metal at temperatures up to 50,000°F.

plume: The elongated pattern of contaminated air or water originating at a point source such as a smoke stack or a hazardous waste disposal area.

plutonium: A heavy, radioactive, metallic element with the atomic number 94. It is produced artificially in a reactor by the bombardment of uranium with neutrons and is used in the production of nuclear weapons. Weapons-usable plutonium consists mainly of plutonium-239.

point source: A source of effluents that is small enough in dimensions that it can be treated as if it were a point. A point source can be either a continuous source or a source that emits effluents only in puffs for a short time.

pollutant: Any material entering the environment that has undesired effects.

pollution: The addition of an undesirable agent to the environment in excess of the rate at which natural processes can degrade, assimilate, or disperse it.

pollution prevention: The use of any process, practice, or product that reduces or eliminates the generation and release of pollutants, hazardous substances, contaminants, and wastes, including those that protect natural resources through conservation or more efficient utilization.

polycyclic aromatic hydrocarbons (PAHs): Organic compounds that include only carbon and hydrogen with a fused ring structure containing at least two benzene (six-sided) rings. Some PAHs are potent human carcinogens. The combustion of organic substances is a common source of atmospheric PAHs.

Prevention of Significant Deterioration (PSD): A program used in development of permits for new or modified industrial facilities in an area that is already in attainment. The intent is to prevent an attainment area from becoming a *non-attainment area*. Allowable increases are lowest in Class I areas (national parks and wilderness areas); the rest of the country is subject to PSD II increments.

Price Anderson Act: First enacted into law in 1957, it limits the liability of the nuclear power industry in the event of an accident.

primary contact recreations: Activities such as swimming and diving where there is direct contact with the water.

prime farmland: Land with the best combination of physical and chemical characteristics for economically producing high yields of food, feed, forage, fiber, and oilseed crops with minimum inputs of fuel, fertilizer, pesticides, and labor. Prime farmland includes cropland, pastureland, rangeland, and forestland.

probable maximum flood: Flood levels predicted for hydrological conditions that maximize the flow of surface waters.

proliferation: The spread of nuclear, biological, and chemical capabilities and the weapons (e.g., missiles) capable of delivering them.

proprietary income: Income from self-employment.

protected species: Species that are protected by federal legislation, such as the Endangered Species Act or the Migratory Bird Treaty Act.

radiation: Energy radiated in the form of waves or particles through matter and space. Radiation comes from radioactive material or from equipment such as X-ray machines. Radiation may be either *ionizing radiation* or non-ionizing radiation.

radiation dose: See *dose*.

radioactive waste: Materials that are radioactive or are contaminated with radioactive materials and for which use, reuse, or recovery are impractical.

radioactivity: The spontaneous decay or disintegration of unstable atomic nuclei, accompanied by the emission of *radiation*. Eventually the unstable nuclei reach a stable state.

radionuclide: An atom that exhibits radioactive properties. Standard practice for naming a radionuclide is to use the name or atomic symbol of the element, followed by its atomic weight. (For example, cobalt-60 [Co-60], a radionuclide of cobalt with an atomic weight of 60.) Radionuclides can be man-made or naturally occurring, can have a long life, and can have potentially mutagenic or carcinogenic effects on the human body.

RADTRAN 4: A computer code that calculates population risks associated with the transport of radioactive materials by truck, rail, air, ship, or barge.

raffinate: The decontaminated salt solution produced by removal of radionuclides from a high-level waste solution.

raptors: Birds of prey (for example, hawks, owls, eagles).

reference dose: The chemical intake level below which noncancer adverse effects are very unlikely. It is measured in units of milligrams per kilogram of body weight per day (mg/kg/d).

regional economic area (REA): A geographic area consisting of an economic node and the surrounding, economically related counties, including the places of work and residences of the labor force. The REA for this EIS is made up of the 15 counties surrounding the Savannah River Site.

region of influence (ROI): The physical area that bounds the environmental, sociological, economic, or cultural features of interest for the purpose of analysis. A site-specific geographic area that includes the counties where approximately 90% of the site's current employees reside. The ROI for this EIS consists of Columbia and Richmond Counties in Georgia and Aiken and Barnwell Counties in South Carolina.

release fraction: The portion, or fraction, of a material that could be released or spilled to the environment during an accident.

rem (roentgen equivalent man): A unit used to derive a quantity called absorbed dose. The dosage of an ionizing radiation that will cause the same biological effect as one *roentgen* of X-ray or gamma-ray exposure; 100 rem is equivalent to one *sievert*.

remediation: Action taken to permanently remedy a release, or threatened release, of a hazardous or radioactive substance to the environment, instead of or in addition to removal.

Resource Conservation and Recovery Act (RCRA): A federal law that provides for a "cradle-to-grave" regulatory program for hazardous waste, including a system for managing hazardous waste from its generation to its ultimate disposal.

Resource Management Class: Four classifications of use to describe different degrees of modification of the landscape. Class I are areas where the natural landscape is preserved, including national wilderness area and wild sections of national wild and scenic rivers; Class II are areas with very limited land development activity, resulting in visual contrasts that are seen but do not attract attention; Class III are areas in which development may attract attention, but the natural landscape still dominates; Class IV are areas in which development activities lead to major modification of the existing character of the landscape.

respirable: Able to be inhaled into the lungs.

Richter Scale: A logarithmic scale used to express the total amount of energy released by an earthquake. The scale has 10 divisions, from 1 (not felt by humans) to 10 (nearly total destruction).

risk: The likelihood of suffering a detrimental effect as a result of exposure to a hazard. In accident analysis, a quantitative or qualitative expression of possible loss that takes into account both the probability that an event will cause harm and the consequences of that event.

Record of Decision (ROD): A document separate from but associated with an environmental impact statement that publicly and officially discloses the responsible agency's decision on the EIS alternative to be implemented.

roentgen: A unit of exposure to ionizing X- or gamma radiation equal to or producing one electrostatic unit of charge per cubic centimeter of air. It is approximately equal to one rad.

runoff: The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and eventually enters streams.

Safe Drinking Water Act: A federal law protecting the quality of public water supplies, water supply and distribution systems, and all sources of drinking water.

Safety Evaluation Report (SER): The SER is an NRC document, associated with a proposed action, that focuses on health and safety issues and compliance with NRC regulations. There are two SERs associated with the MOX facility: one for the construction authorization and another for the operating license application.

sanitary waste: Nonhazardous, nonradioactive liquid and solid waste generated by normal housekeeping activities.

saltstone: A cement-like solid waste form that is a blend of cement, *fly-ash*, and *slag* used to immobilize low-radioactivity salt solutions.

savanna: A grassland with widely scattered trees and shrubs.

scoping: The process of inviting public comment on what should be considered prior to preparation of an environmental impact statement. Scoping assists the preparers of an EIS in defining the proposed action, identifying alternatives, and developing preliminary issues to be addressed in an EIS.

scrub-shrub: Woody vegetation that is less than 20 feet tall, including true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions.

secondary contact recreations: Activities having some direct contact with water, but where swallowing of the water is not likely to occur. An example is fishing.

sedges: Perennial nonwoody plants common to most fresh water *wetlands*. They resemble grasses.

sediment: Eroded soil particles that are deposited downhill or downstream by surface runoff.

seismic: Pertaining to any earth vibration, especially that of an earthquake.

seismic zone: An area defined by the Uniform Building Code (1991) on the basis of its susceptibility to damage as the result of earthquakes. The United States is divided into six zones: Zone 0, no damage; Zone 1, minor damage; Zone 2A (Eastern United States), moderate damage; Zone 2B (Western United States), slightly more damage that 2A; Zone 3, major damage; and Zone 4, areas within Zone 3 nearer certain major fault systems.

seismology: The study of earthquakes.

shielding: Any material that is placed between a source of radiation and people, equipment, or other objects in order to absorb the radiation and reduce radiation exposure.

sievert (Sv): A unit of radiation dose used to express a quantity called *equivalent dose*. This relates the absorbed dose in human tissue to the effective biological damage of the radiation by taking into account the kind of radiation received, the total amount absorbed by the body, and the tissues involved. Not all radiation has the same biological effect, even for the same amount of absorbed dose. One sievert is equivalent to 100 *rem*.

silt: A sedimentary material consisting of fine mineral particles intermediate in size between sand and clay.

siltation: The process by which a river, lake, or other water body becomes clogged with sediment. The process of covering or obstructing with silt.

sinter: To form a homogenous mass by heating without melting.

slag: A glass-like material left as a residue by the smelting of metallic ore.

slope factor: An upper bound estimate of a chemical's probability of causing cancer, based on extent of intake and given in units of inverse intake (1/mg/Kg-d).

source term: The estimated quantities of radionuclides or chemical pollutants released to the environment from a source or group of sources.

special nuclear material: As defined in Section 11 of the *Atomic Energy Act*, " (1) plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the NRC determines to be special nuclear material, or (2) any material artificially enriched by any of the foregoing."

species of concern: A native species that is not listed as endangered or threatened but that has experienced a long-term decline in population or is vulnerable to a significant decline due to low numbers, restricted distribution, dependence on limited habitat resources, or sensitivity to environmental disturbance.

specific activity: The radioactivity of the radionuclide per unit mass of the nuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the radioactivity per unit mass of the material.

specific conductance: Specific conductance is the electrical conductivity of water normalized to a temperature of 25°C. It is a good measure of the concentration of total dissolved solids and salinity in water.

spent (nuclear) fuel: Fuel that has been withdrawn from a nuclear reactor following irradiation and whose constituents have not been separated. Spent fuel has been burned (irradiated) in a reactor to the extent that it no longer makes an efficient contribution to a nuclear chain reaction. This fuel is more radioactive than it was before *irradiation*.

SRS employees: Persons working at the Savannah River Site but not directly involved with the handling of radioactive or hazardous materials at the MOX facility.

stability class: Stability class describes the potential of atmospheric conditions to disperse pollutants. A relatively stable atmosphere contains very little turbulence so that pollutant concentrations remain high. Unstable atmospheric conditions promote vertical mixing and, thus, lower pollutant concentrations. The original Pasquill Stability Classifications consisted of six classes; A, the most unstable, through F, the most stable.

State Historic Preservation Officer (SHPO): The state officer charged with the identification and protection of prehistoric and historic resources in accordance with the *National Historic Preservation Act*.

subsidence: The process of sinking or settling of a land surface due to natural or artificial causes.

sulfur dioxide (SO_2): A compound of sulfur produced by the burning of sulfur-containing compounds and considered to be a major air pollutant. Sulfur dioxide is a *criteria pollutant.*

surface water: Water on the Earth's surface that is directly exposed to the atmosphere, as distinguished from water in the ground (*groundwater*).

temporary emergency exposure limits (TEELs): The TEEL-1 concentration for a chemical is the maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor. The TEEL-2 value is the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action. The TEEL-3 value is the maximum concentration in air below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

terrestrial: Pertaining to plants or animals living on land rather than in the water.

threatened species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Requirements for declaring a species threatened are contained in the *Endangered Species Act*.

threshold non-linear relationship: In a threshold nonlinear relationship, some low level of exposure to a harmful substance can be tolerated without causing a health effect. (See also linear/no threshold hypothesis.)

throughput: A general term that refers to the amount of material handled or processed by a facility in a specified time period.

topography: The shape of the earth's surface. The relative position and elevations of natural and man-made features of an area.

total effective dose equivalent (TEDE): The sum of the effective dose equivalent (EDE) from exposure to external radiation and the 50-year committed effective dose equivalent (CEDE) from exposure to internal radiation.

total suspended particulates (TSP): Particles of solid or liquid matter — such as soot, dust, aerosols, fumes, and mist — up to approximately 30 μm in size, that can be suspended in the air. National, South Carolina, and Georgia Ambient Air Quality Standards all set the annual primary (health-based) TSP level at 75 $\mu g/m^3$.

toxicity: The ability of a substance to cause damage to cells or tissues of living organisms when the substance is inhaled, ingested, or absorbed by the skin.

Toxic Substances Control Act (TSCA): A federal law authorizing the U.S. Environmental Protection Agency to secure information on all new and existing chemical substances and to control any of these substances determined to cause unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by the EPA before such chemicals are manufactured for commercial purposes.

traditional cultural properties: Places and resources important to traditional American cultures, which include, but are not restricted to, Native American cultures.

TRAGIS (Transportation Routing Analysis Geographic Information System): A GIS-based transportation and analysis computer model for rail, highway, and waterway transportation modes.

transport index: The radiation dose rate at 1 meter (approximately 3 feet) from the lateral sides of a vehicle transporting radioactive material.

transuranic: Of, relating to, or being any element whose atomic number is higher than that of uranium (that is, 92). All transuranic elements are radioactive.

transuranic (TRU) waste: Radioactive waste that contains more than 100 nanocuries per gram of alpha-emitting isotopes with atomic numbers greater than 92 and half-lives greater than 20 years. Such wastes result primarily from fuel reprocessing and from the fabrication of plutonium weapons and plutonium-bearing reactor fuel.

Triassic: The first period of the Mesozoic era, dating from approximately 246 to 213 million years ago.

trichloroethylene (TCE): An organic solvent and degreaser.

tritium: A radioactive isotope of the element hydrogen, having two neutrons and one proton. It can be taken into the body easily because it is chemically identical to natural hydrogen. Tritium decays by beta emission with a half-life of about 12.5 years.

Type A package: A type of packaging for radioactive materials. The package must withstand the conditions of normal transportation without loss or dispersal of the radioactive contents. It does not usually require special handling or transportation equipment.

Type B package: A more durable type of packaging for radioactive materials than Type A. In addition to meeting all the Type A standards, Type B packaging must also provide a high degree of assurance that the package integrity will be maintained, even during severe accidents, with essentially no loss of the radioactive contents.

unscarified seed: Seed that has not had the hard outer coat scuffed or otherwise treated to improve germination.

Upper Cretaceous: A geologic time period from about 90 to 66 million years ago. The entire Cretaceous period dates from approximately 144 million to 66 million years ago; it is known as the age of dinosaurs.

uranium: A heavy, silvery-white metallic element (atomic number 92) with many radioactive isotopes. One isotope, uranium-235, is most commonly used as a fuel for nuclear fission. Another, uranium-238, is transformed into fissionable plutonium-239 following its capture of a neutron in a nuclear reactor.

uranium dioxide (UO_2): A black crystalline powder that is widely used in the manufacture of fuel pellets for nuclear reactors.

valence: The number of electrons with which a given atom generally bonds, or the number of bonds an atom forms.

vehicle-related impacts: Transportation risks (physical trauma or emissions) that are related to the transportation vehicle itself, not the cargo it is carrying.

viewshed: The extent of the area that may be viewed from a particular location. Viewsheds are generally bounded by topographic features such as hills or mountains.

Visual Resource Management (VRM): A process devised by the Bureau of Land Management to assess the aesthetic quality of a landscape and to design proposed activities in a way that would minimize their visual impact on that landscape. The process consists of a rating of site visual quality followed by a measurement of the degree of contrast between the proposed development activities and the existing landscape.

vitrification: A process by which glass is used to encapsulate or immobilize radioactive wastes.

volatile organic compounds (VOCs): A broad range of *organic compounds*, that readily evaporate and vaporize at normal temperatures and pressures. Examples include certain solvents, paint thinners, degreasers (benzene), chloroform, and methyl alcohol. VOCs can react with other substances, principally nitrogen oxides, to form ozone. The reactions are energized by sunlight.

Waste Isolation Pilot Plant (WIPP): A national disposal site for transuranic and mixed transuranic waste, located in southeastern New Mexico.

waste management: The planning, coordination, and direction of functions related to generation, handling, treatment, storage, transportation, and disposal of waste. It also includes associated pollution prevention and surveillance and maintenance activities.

waste minimization: An action that economically avoids or reduces the generation of waste by source reduction and recycling; or reduces the toxicity of hazardous waste, improving energy usage.

waste stream: A waste or group of wastes with similar physical form, radiological properties, EPA waste codes, or associated *Land Disposal Restriction* treatment standards. A waste stream may result from one or more processes or operations. Also, a waste or group of wastes from a process or a facility with similar physical, chemical, or radiological properties.

wastewater: Water originating from human sanitary water use (domestic wastewater) and from a variety of industrial processes (industrial wastewater).

watershed area: All land and water within the confines of a *drainage basin*.

weapons-grade: Plutonium or *highly enriched uranium*, in metallic form, that was manufactured for weapons application. Weapons-grade plutonium contains less that 7% plutonium 240.

wetland: Land areas exhibiting hydric (moist) soil conditions, saturated or inundated soil during some portion of the year, and plant species tolerant of such conditions. Wetlands include swamps, marshes, and bogs.

Wild and Scenic Rivers Act: The federal law that established the National Wild and Scenic Rivers System. It was designed to preserve and protect the free-flowing condition of selected rivers having outstanding natural, cultural, or recreational features. For federally owned land within the boundaries of rivers in the system, certain activities that would have a direct and adverse effect on the river values may be controlled.

wind rose: A circular diagram showing, for a specific location, the percentage of time the wind blows from each compass direction over a specified period of record. A wind rose for use in assessing consequences of airborne releases also shows the frequency of different wind speeds for each compass direction.

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APPENDIX A:

PROTECTED SPECIES

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APPENDIX A:

PROTECTED SPECIES

Sixty-one threatened, endangered, and other special status species listed by the federal government or the State of South Carolina may be found in the vicinity of the Savannah River Site (SRS). Protected species listed by the state for Aiken and Barnwell Counties (within which most of the SRS is located) and by Georgia for the reach of the Savannah River bordering the SRS and for Burke County across the river from the SRS are listed in Table A.1. Table A.1 also lists the status and habitat preferences for the protected species. Species from Allendale County, South Carolina, and Screven County, Georgia, are not considered because of the distance of these counties from the F-Area. No designated critical habitat for threatened or endangered species exists on the SRS (DOE 1996).

The SRS has established a proactive threatened and endangered species program that includes habitat restoration. In particular, special efforts have been enacted since 1986 to reestablish and expand the population of the federally and state-endangered red-cockaded woodpecker (*Picoides borealis*) at the SRS. The SRS has been divided into three natural resource habitat management areas: (1) a 34,858-ha (86,069-acre) red-cockaded woodpecker habitat management area, (2) a 19,508-ha (48,167-acre) supplemental red-cockaded woodpecker habitat management area, and (3) other-use areas totaling 25,965 ha (64,111 acres) (DOE 2000). Within the red-cockaded woodpecker habitat management area, harvest rotation for loblolly and longleaf pine is set at 100 and 200 years, respectively. These long rotation periods are designed to increase the number of potential cavity nesting trees. Rotation for pines within the supplemental red-cockaded woodpecker habitat management and other-use areas is set at 50 years to encourage woodpecker recovery within the designated red-cockaded woodpecker habitat management area. The bottomland hardwood, upland hardwood, and mixed pine/hardwood timber management areas that do not provide red-cockaded woodpecker habitat are managed on 100-year rotations (DOE 2000). No red-cockaded woodpecker management is practiced within the other-use area (Edwards et al. 1999).

A combination of methods has been used to improve the red-cockaded woodpecker population at the SRS. These methods have included removing southern flying squirrels from red-cockaded woodpecker nesting cavities, excavating new nesting cavities, thinning hardwood midstory trees, and augmenting the number of female red-cockaded woodpeckers at the SRS. The excavation of cavities has allowed nesting use in younger tree stands several decades before the birds would be able to do this on their own (Allen 1990a,b). The annual conversion of slash and loblolly pine areas to longleaf pine also provides a long-term benefit to red-cockaded woodpeckers and other wildlife species associated with the longleaf pine savanna ecosystem (DOE 2000).

The endangered status of the red-cockaded woodpecker is primarily related to the loss of mature pine forests in the southeastern states from logging and fire suppression; only about 1%

of the species' historical habitat remains (WSRC 1994; FWS 2001a). They prefer longleaf and loblolly pines that are more than 70 years old, often selecting those trees with red-heart disease, which softens the core of the tree. They forage in pine trees over 30 years old (WSRC 1994; USAF 1996). The woodpeckers also prefer areas with minimal midstory trees, so as to lessen potential competition (e.g., from other woodpecker species) and predation (e.g., black rat snakes) (FWS 2001a). Other species either compete for or use abandoned red-cockaded woodpecker cavity holes, including southern flying squirrels, chickadees, bluebirds, titmice, herpetofauna (amphibians and reptiles) and insects (particularly bees and wasps) (FWS 2001b).

The red-cockaded woodpecker is a social species, living in a family group that inhabits a collection of cavity trees called a cluster. Each bird in the group maintains its own cavity tree, but only one pair in the group actually nests. A cluster may include from 1 up to 20 or more cavity trees on 1.2 to 24.3 ha (3 to 60 acres), averaging about 4.0 ha (10 acres). Territory size is related to both habitat suitability and population density. The typical territory for a family group ranges from about 50.6 to 81.0 ha (125 to 200 acres), but reported extremes are as low as 24.3 ha (60 acres) and as high as 243 ha (600 acres) (FWS 2001a,b).

The SRS contains two subpopulations of the red-cockaded woodpecker. Currently 26 active clusters with almost 150 individual birds occur on the SRS. In 1985, only four birds were reported from the SRS (DOE 2000). The closest nesting area to the proposed facility site is about 5 km (3.1 mi) away (DOE 1999). The proposed area for the facility does not occur within either the red-cockaded woodpecker habitat management area or the supplemental management area. However, all areas containing pines, including those at the proposed site, provide suitable forage areas for this species.

Table A.1. Rare, threatened, and endangered species from Aiken and Barnwell Counties, South Carolina, and Burke County, Georgia

Species common name (scientific name)	Status, federal/state[a,b]	County locations[c]	Habitat
Plants			
Aethusa-like trepocarpus (*Trepocarpus aethusae*)	–/SC	A	Bottomland hardwoods
American eelgrass (*Vallisneria americana*)	–/SC	Ba	Ponds and streams, mostly in the sandhills
American nailwort (*Paronychia americana*)	–/SC	A, Ba	Sandhills, dry pinelands
Awnpetal meadowbeauty (*Rhexia aristosa*)	–/SC	Ba	Wet depressions, Carolina bays, savannas, pinelands
Bearded milkvetch (*Astragalus villosus*)	–/SC	A, Ba	Pinelands, disturbed sites

Table A.1. Continued

Species common name (scientific name)	Status, federal/state[a,b]	County locations[c]	Habitat
Biennial beeblossum (*Gaura biennis*)	–/SC	A, Ba	Streambanks, meadows, roadsides
Bog spicebush (*Lindera subcoriacea*)	–/RC	A, Ba	Evergreen-shrub bogs, acidic swamp forests, and seepage bogs
Boykin's lobelia (*Lobelia boykinii*)	–/SC	Ba	Cypress ponds, wet pinelands, Carolina bays
Canada moonseed (*Menispermum canadense*)	–/SC	Ba	Moist woods and thickets
Candby's cowbane (*Oxypolis canbyi*)	E/E, E	Ba, Bu	Peaty muck of shallow cypress ponds, wet pine savannas, and adjacent sloughs and drainage ditches
Candy's bulrush (*Scirpus etuberculatus*)	–/SC	A	Swamps and quiet or flowing shallow water
Carolina birds-in-a-nest (*Macbridea caroliniana*)	–/SC	A, Ba	Freshwater margins
Carolina bugbane (*Trautvetteria caroliniensis*)	–/SC	Ba	Woods, especially in damp or wet soils
Carolina larkspur (*Delphinium carolinianum*)	–/SC	A	Dry woods, prairies, and sandhills
Carolina wild petunia (*Ruellia caroliniensis* spp. *ciliosa*)	–/SC	A	Moist or dry woods
Collins' sedge (*Carex collinsii*)	–/SC	A	Bogs, especially white cedar swamps
Creeping St. johnswort (*Hypericum adpressum*)	–/RC	Ba	Marshes, shores, and wet meadows
Cypressknee sedge (*Carex decomposita*)	–/SC	Ba	Wooded swamps
Drowned hornedrush (*Rhynchospora inundata*)	–/SC	A, Ba	Inundated pond margins and wet peat
Durand's white oak (*Quercus sinuata*)	–/SC	Ba	Wooded slopes, edges of streams
Dwarf burhead (*Echinodorus parvulus*)	–/SC	A, Ba	Carolina bays
Eared goldenrod (*Solidago auriculata*)	–/SC	A	Fields, roadsides, open woods

Table A.1. Continued

Species common name (scientific name)	Status, federal/state[a,b]	County locations[c]	Habitat
Eastern leatherwood (*Dirca palustris*)	–/SC	A	Rich, moist woods
Eastern wahoo (*Euonymus atropurpurea*)	–/SC	A	Woodlands and thickets, usually on moist, rich soils
Elliott's croton (*Croton elliottii*)	–/SC	A, Ba	Carolina bays
Faded trillium (*Trillium discolor*)	–/SC	A	Moist woods
False rue anemone (*Enemion biternatum*)	–/RC	A	Moist woods
Flax leaf false-foxglove (*Agalinis linifolia*)	–/RC	A	Wet, sandy soils
Florida bladderwort (*Utricularia floridana*)	–/SC	Ba	Shallow ponds, often within Carolina bays
Georgia beargrass (*Nolina georgiana*)	–/SC	A, Ba	Sandhills
Georgia plume (*Elliottia racemosa*)	–/T	Bu	Sand ridges, dry oak ridges, evergreen hammocks, sandstone outcrops
Green fringed orchid (*Platanthera lacera*)	–/SC	A, Ba	Carolina bays, bottomland hardwoods
Ground juniper (*Juniperus communis*)	–/SC	A	Dry, rocky, or otherwise poor soils
Hooded pitcher plant (*Sarracenia minor*)	–/U	Bu	Acidic soils of open bog, wet savannas, pond margins, low areas in pine flatwoods, sphagnum seeps of bottomland forests, sloughs and ditches
Lance-leaf wild-indigo (*Baptisia lanceolata*)	–/SC	Ba	Pine forests, open woods
Least trillium (*Trillium pusillum* var *pusillum*)	–/NC	A	Alluvial or low woods, savannas
Leechbrush (*Nestronia umbellula*)	–/SC, T	A, Ba, Bu	Dry, open, upland forests of mixed hardwood and pines
Long sedge (*Carex folliculata*)	–/SC	A	Wet or swampy woods

Table A.1. Continued

Species common name (scientific name)	Status, federal/state[a,b]	County locations[c]	Habitat
Loose watermilfoil (*Myriophyllum laxum*)	–/RC	A, Ba	Sinkhole ponds and other shallow, freshwater ponds; and sandy, clear streams draining spring-fed swamps
Lowland brittle fern (*Cystopteris protrusa*)	–/SC	A	Moist woods
Muhlenberg maidencane (*Amphicarpum muehlenbergianum*)	–/SC	Ba	Pastures, pinelands, moist margins of woods, disturbed sites
Narrow-leaved trillium (*Trillium lancifolium*)	–/NC	A	Moist woods
Nutmeg hickory (*Carya myristiciformis*)	–/RC	Ba	Bottomland hardwoods
Pickering's morning-glory (*Stylisma pickeringii* var *pickeringii*)	–/SC	A	Scrub habitats with scant litter accumulation, sparse ground cover, and little canopy cover (scrubby oaks and pines)
Piedmont azalea (*Rhododendron flammeum*)	–/SC	A, Ba	Upland hardwood bluffs
Piedmont bladderwort (*Utricularia olivacea*)	–/SC	Ba	Shallow, acidic ponds
Piedmont cucumber tree (*Magnolia cordata*)	–/SC	A	Rich woods
Piedmont mock bishopweed (*Ptilimnium nodosum*)	E/E	A, Ba	Wet savannas and peaty fringes of pineland pools and cypress ponds
Piedmont three-awned grass (*Aristida condensata*)	–/SC	A	Sand pine scrub, sandhills, disturbed sites
Pine-leaved golden aster (*Pityopsis pinifolia*)	–/SC	A	Barrens, sandy soils
Pink ladyslipper (*Cypripedium acaule*)	–/U	Bu	Acid soils of pine woodlands, upland hardwoods with pines
Pyramid magnolia (*Magnolia pyramidata*)	–/RC	A	Low, moist situations
Red standing-cypress (*Ipomopsis rubra*)	–/SC	A, Ba	Pastures, roadsides
Relict trillium (*Trillium reliquum*)	E/E	A	Rich moist woods on bluffs and ravine slopes

Table A.1. Continued

Species common name (scientific name)	Status, federal/state[a,b]	County locations[c]	Habitat
Reticulated nutrush (*Scleria reticularis*)	–/SC	Ba	Damp, sandy soils and pine barrens
Robbins' spikerush (*Eleocharis robbinsii*)	–/SC	A, Ba	Mud or shallow water
Rose coreopsis (*Coreopsis rosea*)	–/RC	A	Wet, often sandy or acid soils, or in shallow water
Sandhill rosemary (*Ceratiola ericoides*)	–/T	Bu	Very dry, openly vegetated, scrub-oak sandhills
Sandhills milkvetch (*Astragalus michauxii*)	–/SC	Ba	Sandhills, open sandy woods
Sarvis holly (*Ilex amelanchier*)	–/SC	A	Woody streambanks in sandhills, wet depressions, Carolina bays
Scarlet beebalm (*Monarda didyma*)	–/SC	Ba	Moist woods and thickets
Shoals spiderlily (*Hymenocallis coronaria*)	–/NC	A	Major streams and rivers in rocky shoals and in cracks of exposed bedrock
Shortleaf sneezeweed (*Helenium brevifolium*)	–/RC	Ba	Swampy or boggy places and moist pine woods
Shortleaf yelloweyed grass (*Xyris brevifolia*)	–/SC	A	Pine flatwoods, pond margins
Silky camellia (*Stewartia malacodendron*)	–/R	Bu	Rich, wooded bluffs and ravine slopes, transitional areas between sandhills and creek swamps
Slender arrowhead (*Sagittaria isoetiformis*)	–/SC	A, Ba	Carolina bays
Small-flowered buckeye (*Aesculus parviflora*)	–/RC	A	Upland hardwood bluffs
Small-flowered silverbell-tree (*Halesia parviflora*)	–/SC	A, Ba	Dry, sandy, upland sites
Smooth coneflower (*Echinacea laevigata*)	E/E	A, Ba	Meadows and open woodlands on basic or near neutral soils
Southeastern sneezeweed (*Helenium pinnatifidium*)	–/SC	Ba	Wet pinelands
Spatulate seedbox (*Ludwigia spathulata*)	–/SC	A, Ba	Wet depressions, pond margins, Carolina bays
Stalkless yellowcress (*Rorippa sessiliflora*)	–/SC	A	Bottomland hardwoods

Table A.1. Continued

Species common name (scientific name)	Status, federal/state[a,b]	County locations[c]	Habitat
Striped garlic (*Allium cuthbertii*)	–/SC	A, Ba	Sandhills, marshes
Sweet pitcher plant (*Sarracenia rubra*)	–/SC, E	A, Bu	Acidic soils in open bogs, sandhill seeps, wet savannas, low areas in pine flatwoods, along sloughs and ditches
Three-angle spikerush (*Eleocharis tricostata*)	–/SC	Ba	Pine barren ponds
Tracy beakrush (*Rhynchospora tracyi*)	–/SC	Ba	Carolina bays
Upland swamp-privet (*Forestiera ligustrina*)	–/SC	A	Sandy or rocky soils
Water toothleaf (*Stillingia aquatica*)	–/SC	Ba	Grass-sedge wet depressions, bogs
White wicky (*Kalmia cuneata*)	–/NC	A	Borders of Carolina bays and bogs; between sandhills and upland swamps
Winter grape fern (*Botrychium lunarioides*)	–/SC	A	Open fields, meadows, sandy or gravelly streambanks
Yellow pipewort (*Syngonanthus flavidulus*)	–/RC	A	Wet pinelands, pond margins
Invertebrates			
Arogos skipper (*Atrytone arogos*)	–/SC	A	Open fields, meadows, prairies
Barrel floater (*Anodonta couperiana*)	–/SC	Ba	Streams, rivers
Carolina slabshell (*Elliptio congaraea*)	T/E	Ba	Streams, rivers
Eastern creekshell (*Villosa delumbis*)	–/SC	Ba	Streams, rivers
Eastern floater (*Pyganodon cataracta*)	–/SC	Ba	Streams, rivers
Paper pondshell (*Utterbackia imbecillis*)	–/SC	Ba	Streams, rivers
Rayed pink fatmucket (*Lampsilis splendida*)	–/SC	Ba	Streams, rivers

Table A.1. Continued

Species common name (scientific name)	Status, federal/state[a,b]	County locations[c]	Habitat
Southern rainbow (*Villosa vibex*)	–/SC	Ba	Streams, rivers
Yellow lampmussel (*Lampsilis cariosa*)	–/SC	Ba	Streams, rivers
Fish			
Robust redhorse (*Moxostoma robustum*)	–/E	Bu	Mainstream river habitats (e.g., Augusta Shoals of Savannah River)
Shortnose sturgeon (*Acipenser brevirostrum*)	E/E, E	A, Bu	Spawns in large coastal rivers; remainder of year spent in lower reaches or river estuary
Amphibians and Reptiles			
American alligator (*Alligator mississippiensis*)	T(S/A)/–	A, Ba	Savannah River Swamp, Par Pond, Beaver Dam Creek, and other streams
Bird-voiced treefrog (*Hyla avivoca*)	–/SC	A, Ba	Wooded swamps along creeks and larger waterways
Black swamp snake (*Seminatrix pygaea*)	–/SC	A	Cypress ponds
Eastern coral snake (*Micrurus fulvius*)	–/SC	A	Well-drained pine woods; open, dry, or sandy areas; pond and lake borders; and hammocks
Eastern tiger salamander (*Ambystoma tigrinum tigrinum*)	–/SC	A	Savannah River Swamp and Carolina bays
Florida green water snake (*Nerodia floridana*)	–/SC	A	Swamps, marshes, and quiet bodies of water
Gopher frog (*Rana capito*)	–/SC	A, Ba	Gopher tortoise burrows during daylight hours
Gopher tortoise (*Gopherus polyphemus*)	–/E, T	A, Bu	Sandy soil and abundant herbaceous vegetation (e.g., longleaf pine savannas); often forced to inhabit roadsides and old fields
Pine (or gopher) snake (*Pituophis melanoleucus*)	–/SC	A	Flat, sandy pine barrens, sandhills, and dry mountain ridges, usually in or near pine woods

Table A.1. Continued

Species common name (scientific name)	Status, federal/state[a,b]	County locations[c]	Habitat
Southern hognose snake (*Heterodon simus*)	–/SC	A	Sandy woods, fields, and groves, dry river floodplains, and hardwood hammocks
Spotted turtle (*Clemmys guttata*)	–/SC, U	A, Ba, Bu	Heavily vegetated, shallow wetlands with standing or slowly flowing water
Birds			
Bachman's sparrow (*Aimophila aestivalis*)	–/R	Bu	Mature open pine woods, regenerating clearcuts, old pastures with dense ground cover of grasses and forbs, palmetto scrub
Bald eagle (*Haliaeetus leucocephalus*)	T/E	A	Active nests in Pen Branch area and area south of Par Pond
Little blue heron (*Egretta caerulea*)	–/SC	A	Freshwater ponds, lakes, and marshes; coastal saltwater wetlands
Red-cockaded woodpecker (*Picoides borealis*)	E/E, E	A, Ba, Bu	Nests in mature pine forests (particularly longleaf); forages in pine forests
Wood stork (*Mycteria americana*)	E/E, E	Ba, Bu	Variety of freshwater and estuarine wetlands for breeding, feeding, and nesting; nests in trees in standing water or on islands
Mammals			
Black bear (*Ursus americanus*)	–/SC	A	Forests and swamps
Eastern fox squirrel (*Sciurus niger*)	–/SC	A, Ba	Pine forests with interspersed clearings
Eastern woodrat (*Neotoma floridana*)	–/SC	A, Ba	Hummocks, swamps, and cabbage palmetto
Hoary bat (*Lasiurus cinereus*)	–/SC	A	Wooded areas
Rafinesque's big-eared bat (*Corynorhinus rafinesquii*)	–/E	A	Roosts in or near mature forests with water nearby; forage among canopies of large trees

Table A.1. Continued

Species common name (scientific name)	Status, federal/state[a,b]	County locations[c]	Habitat
Spotted skunk (*Spilogale putorius*)	–/SC	A	Brushy or sparsely wooded areas, along streams, among boulders, prairies
Star-nosed mole (*Condylura cristata*)	–/SC	A, Ba	Low, wet ground near lakes and streams

[a]E = endangered; T = threatened; T(S/A) = threatened (similarity of appearance); NC = of concern, national (unofficial, plants only); R = rare; RC = of concern, regional (unofficial, plants only); SC = species of concern; U = unusual; – = not listed.

[b]For species listed from both South Carolina and Georgia counties, the status for South Carolina is provided first.

[c]A = Aiken County, South Carolina; Ba = Barnwell County, South Carolina; Bu = Burke County, Georgia.

Sources: Burt and Grossenheider (1976); Conant (1958); DCS (2002); DOE (1991); Fernald (1989); Flora of North America Editorial Committee (1997); Gleason and Cronquist (1991); Harrar and Harrar (1962); Knox and Sharitz (1990); National Geographic Society (1999); Ozier et al. (1999); Patrick et al. (1995); Petrides (1988); SCDNR (2001a,b); USDA (2001); Workman and McLeod (1990); Wunderlin (1982).

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