DOE/EA-2115

DRAFT ENVIRONMENTAL ASSESSMENT FOR THE COMMERCIAL DISPOSAL OF DEFENSE WASTE PROCESSING FACILITY RECYCLE WASTEWATER FROM THE SAVANNAH RIVER SITE

December 2019

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Acronyms and Abbreviations

CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
DBA	design-basis accident
DSA	documented safety analysis
DOE	U.S. Department of Energy
DWPF	Defense Waste Processing Facility
SRS DWPF Recycle Wastewater EA	*Environmental Assessment for the Commercial Disposal of Defense Waste Processing Facility Recycle Wastewater from the Savannah River Site*
DWPF SEIS	*Final Supplemental Environmental Impact Statement—Defense Waste Processing Facility*
EA	environmental assessment
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ETF	Effluent Treatment Facility
FMCSA	Federal Motor Carrier Safety Administration
FR	*Federal Register*
FWF	WCS Federal Waste Facility
FY	fiscal year
HEU	highly enriched uranium
HLW	high-level radioactive waste
IP-2	Industrial Package-2
LCF	latent cancer fatality
LLW	low-level radioactive waste
LSA	low specific activity
MEI	maximally exposed individual
MFFF	Mixed-Oxide Fuel Fabrication Facility
MLLW	mixed low-level radioactive waste
mrem	millirem
NAAQS	National Ambient Air Quality Standards
NEPA	*National Environmental Policy Act of 1969*
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
PCB	Polychlorinated biphenyl
PM_n	particulate matter less than or equal to n microns in aerodynamic diameter
RCRA	*Resource Conservation and Recovery Act*
RCT	Recycle Collection Tank
ROD	Record of Decision
SEIS	Supplemental Environmental Impact Statement
SNF	spent nuclear fuel
SOF	sum of fractions
SPRU	Separations Process Research Unit
SRS	Savannah River Site

SRS HLW Tank Closure EIS	*High-Level Waste Tank Closure Final Environmental Impact Statement*
SRS Salt Processing Alternatives SEIS	*Savannah River Site Salt Processing Alternatives Final Supplemental Environmental Impact Statement*
SWM	solid waste management
SWPF	Salt Waste Processing Facility
Tank Farm DSA	*Concentration, Storage, and Transfer Facilities Documented Safety Analysis*
TRU	transuranic (waste)
U.S.C.	United States Code
USDOT	U.S. Department of Transportation
WAC	waste acceptance criteria
WCS	Waste Control Specialists, LLC
WIPP	Waste Isolation Pilot Plant
WM PEIS	*Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*

1 INTRODUCTION

1.1 Introduction

The Savannah River Site (SRS) occupies approximately 300 square miles primarily in Aiken and Barnwell counties in South Carolina (Figure 1-1). Over the years, a primary SRS mission has been the production of special radioactive isotopes to support national defense programs, including reprocessing of spent nuclear fuel (SNF) and target materials. More recently, the SRS mission has also emphasized waste management, environmental restoration, and the decontamination and decommissioning of facilities that are no longer needed for SRS's traditional defense activities. SRS generated large quantities of liquid radioactive waste as a result of reprocessing activities associated with its nuclear materials production mission. This liquid radioactive waste has historically been managed as high-level radioactive waste (HLW). The waste was placed into underground storage tanks at SRS and consists primarily of three physical forms: sludge, saltcake, and liquid supernatant.[1] The sludge portion in the underground tanks is being transferred on-site to the Defense Waste Processing Facility (DWPF) for vitrification in borosilicate glass to immobilize the radioactive constituents, as described in the *Final Supplemental Environmental Impact Statement—Defense Waste Processing Facility* (DOE/EIS-0082-S) (DWPF SEIS) (DOE 1994) and subsequent Record of Decision (ROD) (Volume 60 of the *Federal Register*, page 18589 [60 FR 18589]). The resulting vitrified waste form is poured as molten glass into production canisters where it cools into a solid glass-waste and is securely stored at SRS until the U.S. Department of Energy (DOE) establishes a final disposition path.

DWPF operations generate recycle wastewater. The DWPF recycle wastewater is a combination of several dilute liquid waste streams consisting primarily of condensates from the vitrification processes. Other components of the DWPF recycle wastewater include process samples, sample line flushes, sump flushes, and cleaning solutions from the decontamination and filter dissolution processes. Currently, the DWPF recycle wastewater is returned to the tank farm for volume reduction by evaporation or is beneficially reused in saltcake dissolution or sludge washing.

To analyze capabilities of a potential alternative treatment and disposal method at the end of the liquid waste mission life, DOE is proposing to dispose of up to 10,000 gallons of stabilized (grouted[2]) DWPF recycle wastewater from the SRS H-Area Tank Farm at a commercial low-

[1] Sludge components of radioactive liquid waste consist of the insoluble solids that have settled to the bottom of the waste storage tanks. Radionuclides present in the sludge include fission products (such as strontium-90) and long-lived actinides. Supernatant is the liquid portion of the waste stored with the sludge and saltcake. The combination of supernatant and saltcake is referred to as salt waste.

[2] Grout is a proven safe and effective technology that continues to be used by DOE and other national and international parties to stabilize radioactive wastes, including certain tank wastes, for disposal. Use of stabilization agents for this purpose is consistent with the NRC's *Concentration Averaging and Encapsulation Branch Technical Position, Revision 1* (https://www.nrc.gov/docs/ML1225/ML12254B065.pdf), which allows mixing of nonradioactive constituents with radioactive waste (e.g., solidification, encapsulation, or additives used in thermal processing), provided the mixing has a purpose other than reducing the waste classification, such as waste stabilization or process control. Furthermore, the addition of stabilization agents to the waste prior to disposal is often necessary to meet the NRC requirements in 10 CFR 61.56, "Waste Characteristics" (e.g., to ensure stability of the waste form).

level radioactive waste (LLW) facility outside of South Carolina, licensed by either the U.S. Nuclear Regulatory Commission (NRC) or an Agreement State[3] under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 61. If implemented, this proposal would provide alternative treatment and disposal options for certain reprocessing waste—namely, DWPF recycle wastewater—through the use of existing, licensed, off-site commercial treatment and disposal facilities.

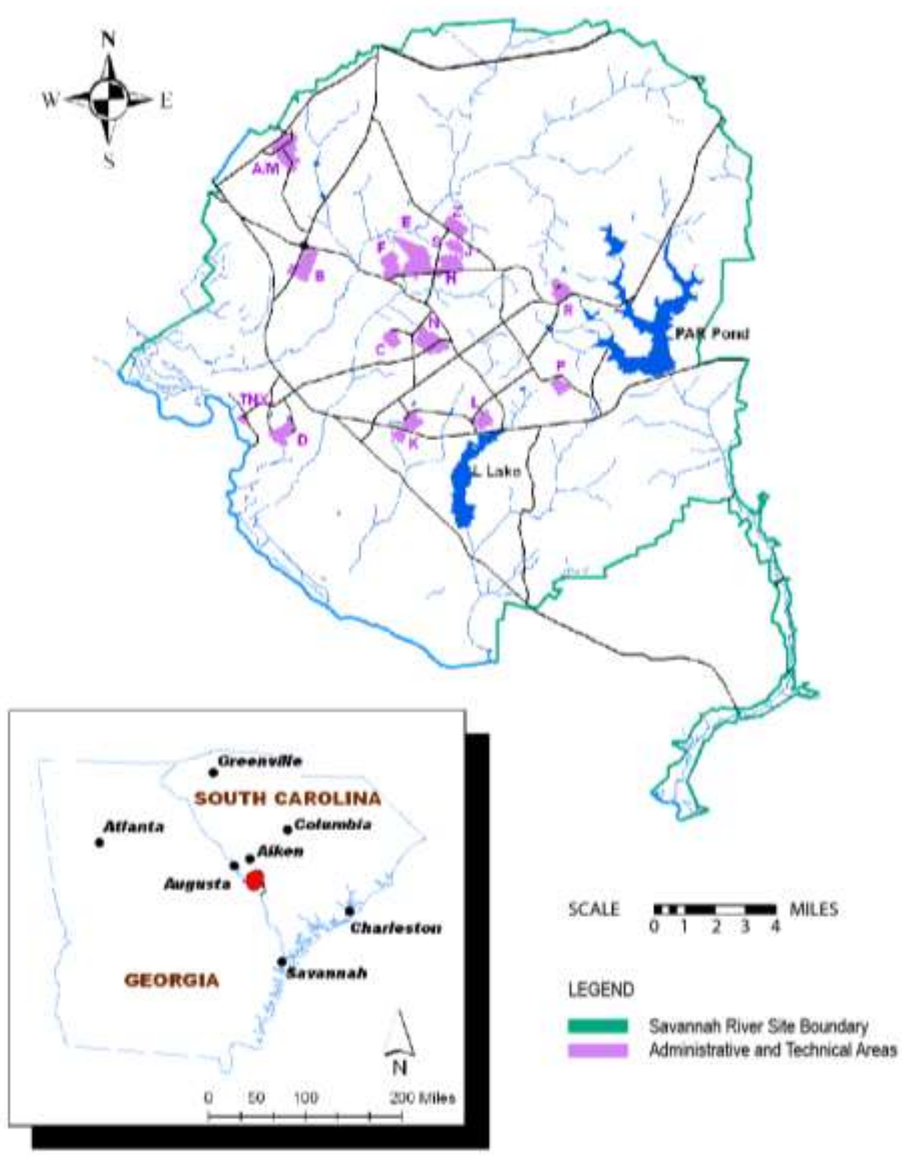

Figure 1-1. Location of Savannah River Site

[3] Congress authorized the NRC to enter into Agreements with states that allow the states to assume, and the NRC to discontinue, regulatory authority over source, byproduct, and small quantities of special nuclear material. The states, known as Agreement States, can then regulate byproduct, source, and small quantities of special nuclear materials that are covered in the Agreement, using its own legislation, regulations, or other legally binding provisions. (Section 274b of the *Atomic Energy Act of 1954*, as amended).

In accordance with the *National Environmental Policy Act* (Volume 42 of the United States Code, Section [U.S.C. §] 4321 et seq.) (NEPA) and DOE's implementing regulations at 10 CFR Part 1021, DOE is preparing this *Environmental Assessment for the Commercial Disposal of Defense Waste Processing Facility Recycle Wastewater from the Savannah River Site* (SRS DWPF Recycle Wastewater EA) to assess whether the potential environmental impacts of the Proposed Action and alternatives would be significant to human health and the environment and determine whether to prepare an environmental impact statement or a finding of no significant impact.

1.2 Background

On October 10, 2018, DOE published a notice in the *Federal Register* requesting public comment on its interpretation of the definition of the statutory term, "high-level radioactive waste," as set forth in the *Atomic Energy Act of 1954* and the *Nuclear Waste Policy Act of 1982* (83 FR 50909). In that notice, DOE explained the history and basis for its interpretation to classify the waste based on its radiological contents and not on the origin of the waste. Subsequently, on June 10, 2019, DOE published a supplemental notice in the *Federal Register* that provided additional explanation of DOE's interpretation as informed by public review and comment and further consideration by DOE (84 FR 26835). DOE revised its interpretation after consideration of public comments, which included comments from the NRC, affected states and Native American tribes, and other stakeholders, in order to clarify its meaning and import. This interpretation intends to facilitate the safe disposal of defense reprocessing waste if the waste meets either of the following two criteria:

1. Does not exceed concentration limits for Class C LLW as set out in 10 CFR 61.55 and meets the performance objectives of a disposal facility, or

2. Does not require disposal in a deep geologic repository and meets the performance objectives of a disposal facility as demonstrated through a performance assessment conducted in accordance with applicable requirements.

NRC's performance objectives for commercial LLW disposal facilities are specified in 10 CFR Part 61, Subpart C, "Performance Objectives." Performance objectives are the quantitative radiological standards set by the NRC or DOE to ensure protection of the health and safety of individuals and the environment during operation, and after permanent closure of the disposal facility. Performance assessments quantitatively evaluate a disposal facility's ability to protect human health and the environment by evaluating potential radiological human exposure after disposal facility closure. Performance assessments measure and evaluate risk by analyzing the long-term evolution of the waste forms and engineered features and the effect such changes could have on the performance of a waste disposal system.

As stated in the supplemental notice, DOE will continue its current practice of managing all its reprocessing wastes as if they were HLW unless and until a specific waste is determined to be another category of waste based on detailed assessments of its characteristics and an evaluation of potential disposal pathways.

1.3 Purpose and Need for Agency Action

DOE's purpose and need for action is to analyze capabilities for alternative treatment and disposal options for DWPF recycle wastewater through the use of existing, licensed, off-site commercial treatment and disposal facilities. When DOE prepared the 1994 DWPF SEIS (DOE 1994), the *Savannah River Site Salt Processing Alternatives Final Supplemental Environmental Impact Statement* (SRS Salt Processing Alternatives SEIS; DOE 2001), and the *High-Level Waste Tank Closure Final Environmental Impact Statement* (SRS HLW Tank Closure EIS; DOE 2002), DOE did not analyze the potential environmental impacts associated with potential commercial treatment and disposal options for DWPF recycle wastewater. DOE now proposes to use commercial LLW disposal facilities for up to 10,000 gallons of DWPF recycle wastewater to inform planning activities on treatment and disposal options for completion of the tank closure program.

The 10,000-gallon amount is reasonable to enable a representative volume of DWPF recycle wastewater to be collected and stabilized to evaluate commercial disposal capabilities for this waste stream. Any proposal to dispose of more than 10,000 gallons of DWPF recycle wastewater would be evaluated in a separate NEPA review. Treatment or disposal of this waste at a commercial LLW facility would help to inform planning activities for the three years between the completion of the Salt Waste Processing Facility (SWPF) mission (estimated 2031) and DWPF mission completion (estimated 2034) (SRR 2019).[4] During this period, DOE will not have the option of returning DWPF recycle wastewater to SWPF for processing because SWPF will have completed its mission of treating salt waste from the tank farms and will undergo closure.

1.4 Proposed Action Evaluated in this Environmental Assessment

DOE's Proposed Action is the disposal of up to 10,000 gallons of stabilized (grouted) DWPF recycle wastewater from the SRS H-Area Tank Farm at a commercial LLW disposal facility located outside of South Carolina and licensed by either the NRC or an Agreement State under 10 CFR Part 61. If implemented, this proposal would provide alternative treatment and disposal options for certain reprocessing waste—namely, DWPF recycle wastewater[5]—through the use of existing, licensed, off-site commercial treatment and disposal facilities.

DOE has developed three alternatives for accomplishing this Proposed Action.

- **Alternative 1** would deploy a treatment capability at SRS to stabilize up to 10,000 gallons of DWPF recycle wastewater and then transport the grouted waste form to a licensed commercial disposal facility.

[4] As described in the *Liquid Waste System Plan, Revision 21* (System Plan) (SRR 2019), it is estimated that approximately 380,000 gallons of DWPF recycle wastewater could be generated during the three-year period following planned SWPF shutdown in 2031. Potential cumulative impacts associated with this volume of DWPF recycle wastewater are described in Section 4.2.6 of this EA.

[5] DOE's HLW interpretation would not impact practices for the management of other reprocessing waste at SRS, which include stabilization and disposal of treated liquid radioactive waste at the Saltstone Production Facility and F and H farm tank closures as non-HLW under Section 3116 of the *Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005* (Public Law 108-375).

- **Alternative 2** would transport up to 10,000 gallons of DWPF recycle wastewater to a licensed commercial disposal facility with the capability to stabilize and dispose of the final waste form.

- **Alternative 3** would transport up to 10,000 gallons of DWPF recycle wastewater to a licensed commercial treatment facility with the capability to stabilize the liquid into a grouted waste form, and then transport the final waste form to a licensed commercial disposal facility.

DOE on-site (i.e., E Area) and off-site (e.g., Nevada Nuclear Security Site) radioactive waste disposal facilities are not included in the alternatives analysis because the purpose of the proposed action is to evaluate the capability to dispose of DWPF recycle wastewater (up to 10,000 gallons) as LLW at a licensed commercial facility outside the state of South Carolina. DOE on-site and off-site disposal of LLW has been analyzed in previous NEPA documents (e.g., SRS Salt Processing Alternatives SEIS [DOE 2001] and the *Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* [WM PEIS; DOE 1997]). Any proposal to dispose of more than 10,000 gallons of DWPF recycle wastewater would be evaluated in a separate NEPA review, at which time DOE would determine the need to consider DOE on-site and off-site disposal.

The analyzed alternatives are discussed in more detail in Section 2.1 of this EA. DOE also evaluates a No-Action Alternative, as required by 10 CFR 1021.321(c).

1.5 National Environmental Policy Act Documents Related to the Proposed Action

This section identifies and discusses other NEPA documents that are potentially relevant to this EA. Decisions as a result of these other NEPA documents have affected (or will affect) operations/activities related to SRS tank waste management.

- **Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste** (WM PEIS) (DOE/EIS-0200; DOE 1997). In the 1990s, DOE anticipated a need for managing wastes at locations other than where the waste was generated. In order to address this need, DOE conducted analyses for management of radioactive and hazardous wastes, including LLW. The WM PEIS analyzed the transportation of large volumes of LLW across the country for treatment and disposal. This SRS DWPF Recycle Wastewater EA summarizes and incorporates by reference some of the analyses used to determine potential health and safety impacts resulting from transportation of LLW on the Nation's highways.

- **Final Environmental Impact Statement for the Defense Waste Processing Facility, Savannah River Plant, Aiken, South Carolina** (DOE/EIS-0082; DOE 1982). This EIS provided environmental input into both the selection of an appropriate strategy for the permanent disposal of HLW stored at SRS and the subsequent decision to construct and operate the DWPF. Following the ROD (47 FR 23801, June 1, 1982), construction of

DWPF began in late 1983, and radioactive operations began in March 1996. One of the dilute secondary aqueous radioactive waste streams associated with DWPF is referred to as DWPF recycle wastewater. This waste stream is the subject of the Proposed Action in this SRS DWPF Recycle Wastewater EA.

- **Final Supplemental Environmental Impact Statement for the Defense Waste Processing Facility, Savannah River Site, Aiken, South Carolina** (DOE/EIS-0082-S1; DOE 1994). This SEIS evaluated the ongoing construction of DWPF and changes that had occurred in the design since issuance of the Final EIS in 1982. This SEIS analyzed the current practice of returning the DWPF recycle wastewater to the tank farm for reduction by evaporation or reuse in saltcake dissolution or sludge washing. That process constitutes the No-Action Alternative evaluated in this SRS DWPF Recycle Wastewater EA. As described in Section 2.1.1, the Proposed Action in this EA would change that process for up to 10,000 gallons of DWPF recycle wastewater to provide alternative treatment and disposal options for DWPF recycle wastewater following closure of the SWPF through the use of existing, licensed, off-site commercial treatment and/or disposal facilities.

- **Savannah River Site Salt Processing Alternatives Final Supplemental Environmental Impact Statement, Aiken, South Carolina** (DOE/EIS-0082-S2; DOE 2001). DOE prepared this SEIS to evaluate alternatives for separating the high-activity fraction from the low-activity fraction of the salt solutions stored in underground tanks at SRS with the high-activity fraction vitrified in the DWPF and currently stored as HLW and the lower-activity fraction disposed of as grouted LLW (saltstone) at SRS. This SEIS also analyzed the current practice of returning the DWPF recycle wastewater to the tank farm for reduction by evaporation or reuse in saltcake dissolution or sludge washing. That process constitutes the No-Action Alternative evaluated in this SRS DWPF Recycle Wastewater EA. As described in Section 2.1.1, the Proposed Action in this EA would change that process for up to 10,000 gallons of DWPF recycle wastewater.

- **High-Level Waste Tank Closure Final Environmental Impact Statement, Aiken South Carolina** (DOE/EIS-0303; DOE 2002). DOE prepared this EIS to evaluate the proposed action to close the tanks at SRS in accordance with applicable laws and regulations, DOE orders, and the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems* (SRR 2011) (approved by the South Carolina Department of Health and Environmental Control), which specifies the management of residuals as waste incidental to reprocessing. The EIS evaluated three alternatives regarding the tanks at SRS: the Stabilize Tanks Alternative, the Clean and Remove Tanks Alternative, and the No-Action Alternative. Under the Stabilize Tanks Alternative, the EIS considered three options for tank stabilization: Fill with Grout (Preferred Alternative), Fill with Sand, and Fill with Saltstone. The HLW Tank Closure EIS included evaluation of accident scenarios associated with waste retrieval that are applicable to the Proposed Action in this EA.

1.6 Scope of this Environmental Assessment and Organization

In accordance with the Council on Environmental Quality (CEQ) regulations at 40 CFR Parts 1500−1508 and DOE NEPA implementing procedures at 10 CFR Part 1021, DOE has prepared this EA to assess the potential impacts of implementing the Proposed Action and alternatives for the disposal of up to 10,000 gallons of stabilized (grouted) DWPF recycle wastewater from SRS at a commercial LLW disposal facility. As such, this EA:

- Provides an introduction and background discussion of the Proposed Action and the purpose and need for the DOE action (Chapter 1);
- Describes the Proposed Action and the alternatives analyzed (Chapter 2);
- Describes the existing environment relevant to potential impacts of the alternatives and analyzes the potential direct and indirect environmental impacts that could result from the alternatives (Chapter 3);
- Identifies and characterizes cumulative impacts that could result in relation to past, present, and other reasonably foreseeable actions within the surrounding area of the alternatives (Chapter 4);
- Identifies federal and state agencies consulted during the preparation of this EA (Chapter 5);
- Presents a bibliographic listing of the references cited in this EA (Chapter 6);
- Provides radionuclide concentrations from a recent sample of DWPF recycle wastewater (Appendix A); and
- Presents a transportation accident consequence assessment involving DWPF recycle wastewater (Appendix B).

Certain aspects of the Proposed Action and alternatives have a greater potential for creating adverse environmental impacts than others. For this reason, CEQ regulations (40 CFR 1502.1 and 1502.2) recommend that agencies "focus on significant environmental issues and alternatives," and discuss impacts "in proportion to their significance." Section 3.2 of this EA presents the resource screening review that DOE used to determine which resources required the most detailed analysis.

2 PROPOSED ACTION AND ALTERNATIVES

2.1 Proposed Action

DOE would dispose of up to 10,000 gallons of stabilized (grouted) DWPF recycle wastewater from SRS at a commercial LLW facility outside of South Carolina, licensed by either the NRC or an Agreement State under 10 CFR Part 61. Prior to a disposal decision, DOE would characterize the DWPF recycle wastewater to determine whether the waste meets DOE's HLW interpretation for disposal as non-HLW. As part of this process, DOE would determine and verify with the licensee of the disposal facility that the stabilized waste meets the facility's waste acceptance criteria (WAC) and all other requirements of the disposal facility, including any applicable regulatory requirements (e.g., the *Resource Conservation and Recovery Act* [RCRA; 42 U.S.C. § 6901]) for treatment of the waste prior to disposal and applicable U.S. Department of Transportation (USDOT) requirements for packaging and transportation from SRS to the commercial facility. The timing considered for the implementation of the proposal is within several years after a decision to move forward.

Section 2.1.1 of this EA provides a description of the DWPF recycle wastewater addressed in this EA. As discussed in Sections 2.1.2 through 2.1.4, DOE has identified three alternatives for implementing the Proposed Action. Section 2.1.5 provides a high-level summary of the three alternatives, highlighting their differences.

2.1.1 DWPF Recycle Wastewater

Under normal operations, DWPF produces a dilute secondary aqueous radioactive waste stream known as DWPF recycle wastewater. This recycle wastewater resulting from DWPF vitrification operations is ultimately collected in the DWPF Recycle Collection Tank (RCT), located inside the DWPF building, and subsequently transferred to Tank 22 located in the SRS H-Area Tank Farm. While a small percentage of DWPF recycle wastewater has beneficial reuse in saltcake dissolution or sludge washing prior to vitrification, the majority is transferred to the 2H evaporator system, which separates the concentrates (evaporator bottoms) from the condensates (overheads) reducing the volume necessary for tank farm storage. The concentrates are stored in the tank farm for future salt waste processing and the condensates are routed to the Effluent Treatment Facility (ETF) for further processing prior to release to a permitted outfall. Figure 2-1 illustrates the relationship between DWPF recycle wastewater and the other facilities and processes.

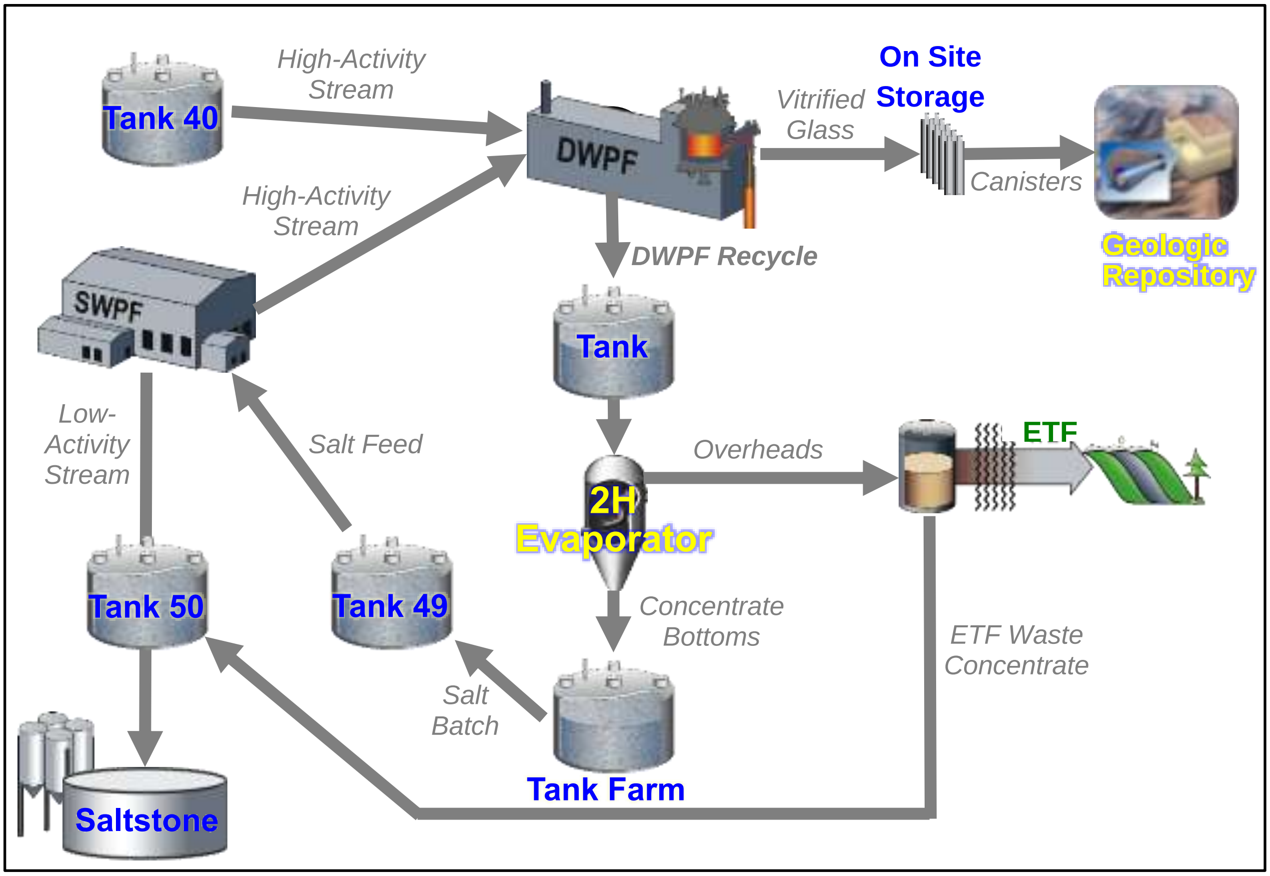

Figure 2-1. Current Process Flow for DWPF Recycle Wastewater

There are several DWPF processes that generate secondary aqueous radioactive waste as contributors to DWPF recycle wastewater. Contributors to this waste stream include:

- **Major Contributors:** There are two major contributors (in terms of volume) to the DWPF recycle wastewater stream. The first major contributor is condensate from processing the tank sludge and salt waste prior to vitrification. Vapors from the processing operations are cooled, condensed, and eventually transferred to the RCT. The second major contributor is condensate from the melter off-gas system. Off-gases from the melter are treated in an off-gas system composed of quenchers, steam atomized scrubbers, condensers, and filters; all of which remove radioactive particulate matter and volatile components before exhausting gases under an approved air permit. Condensate from the off-gas system is also collected and eventually transferred to the RCT.

- **Minor Contributors:** The four minor contributors are the sample flushes, sump flushes, decontamination solutions, and high-efficiency mist eliminator dissolution solution. These aqueous streams are collected in the RCT.

The DWPF recycle wastewater is collected in the RCT and is treated with sodium hydroxide and sodium nitrate for neutralization and corrosion protection, respectively. The treated DWPF recycle wastewater is then pumped to Tank 22 for storage and future processing. Figure 2-2 provides an aerial view of the area around Tank 22.

Figure 2-2. Aerial View Tank 22 and Surrounding Area

Tank 22 is a Type IV tank constructed between 1958 and 1962, with a capacity of approximately 1.3 million gallons. Figure 2-3 provides a graphical depiction of the construction of a typical Type IV tank.

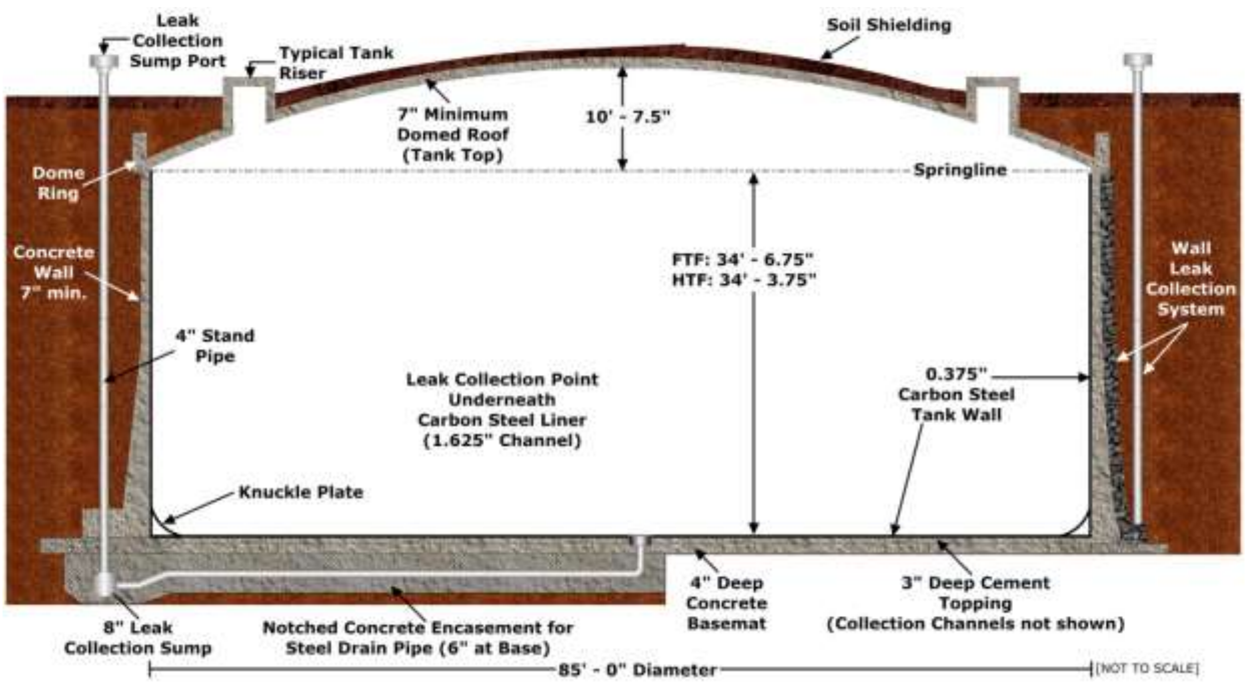

Figure 2-3. Typical Construction of Type IV Tanks (i.e., Tank 22)

The amount of DWPF recycle wastewater required to be managed increases with every gallon of tank waste treated and immobilized at DWPF. For every gallon of tank waste treated at the DWPF, more than one gallon of DWPF recycle wastewater is returned to Tank 22. The volume of DWPF recycle wastewater is expected to increase from approximately 1.5 million gallons per year to as high as 3.2 million gallons per year with the additional salt waste processing associated with SWPF operations (SRR 2019). From Tank 22, DWPF recycle wastewater, in excess of what can be beneficially reused, is routed to the 2H Evaporator system, where it is mixed with other waste streams in the evaporator feed tank. The overheads from the evaporator are routed to the ETF for further processing prior to release to a permitted outfall or disposal in the Saltstone Disposal Facility. Concentrated evaporator bottoms are returned to the tank farm for future salt waste processing. While Tank 22 had other waste streams transferred to it in the past, its primary function for many years has been receipt of the DWPF recycle wastewater stream.

Based on recent data, the sample profile of the DWPF recycle wastewater in Tank 22 would not exceed Class C limits, in accordance to NRC waste classification tables (10 CFR 61.55). This assumption was verified by laboratory analysis (see Appendix A to this EA).

DOE would also determine (and validate with the licensee of the disposal facility) that the DWPF recycle wastewater would meet the facility's WAC. The WAC are the technical and administrative requirements a waste must meet to be accepted at a disposal facility (e.g., waste characterization, waste form acceptability, quality assurance) and are established to ensure the disposal facility, in total, meets its performance objectives. Each disposal facility has its own WAC, which are dictated in part by the physical characteristics of a site. The performance objectives (10 CFR Part 61, Subpart C) are central to the level of health and safety and environmental protection that a commercial LLW disposal facility must satisfy. These objectives address protection from releases of radioactivity, operations, inadvertent intrusion, and long-term stability.

2.1.2 Alternative 1: Treatment at the Savannah River Site and Disposal at a Commercial LLW Facility

Under Alternative 1, DOE would deploy treatment capability at SRS to stabilize (grout) up to 10,000 gallons of DWPF recycle wastewater. Depending upon whether the final packaged waste form is classified as Class A, B, or C LLW,[6] it would then be shipped for disposal to either the Waste Control Specialists (WCS) site near Andrews, Texas (if determined to be Class A, B or C LLW)[7] and/or the Energy*Solutions* site near Clive, Utah (if determined to be Class A LLW),[8]

[6] In its 10 CFR Part 61 regulations, NRC has identified classes of LLW—Class A, B, or C—for which near-surface disposal is protective of human health and the environment. This waste classification regime is based on the concentration levels of a combination of specified short-lived and long-lived radionuclides in a waste stream, with Class C LLW having the highest concentration levels.

[7] WCS is licensed by the Texas Commission on Environmental Quality for the disposal of Class A, B, and C LLW that meets specified WAC. Disposal of the stabilized waste at the WCS site would be conducted in accordance with the facility's operating license (Radioactive Material License No. CN600616890/RN101702439).

[8] Energy*Solutions* is licensed by the Utah Department of Environmental Quality for the disposal of Class A LLW that meets specified WAC. Disposal of the stabilized waste at the Energy*Solutions* site would be conducted in accordance with the facility's operating license (Radioactive Material License No. UT 2300249).

depending upon waste content and facility WAC. Alternative 1 includes the following activities:

- Deploy the retrieval and on-site treatment capability at SRS and stabilize up to 10,000 gallons of DWPF recycle wastewater. It is assumed that upon stabilization, the solid waste form would meet appropriate packaging and transportation requirements.[9]
- Transport the stabilized waste form to either the WCS site or the Energy*Solutions* site, in accordance with final waste classification and WAC.
- Dispose of the stabilized waste form.

2.1.2.1 Retrieval and On-Site Treatment

DWPF recycle wastewater would be retrieved from Tank 22 (or from the transfer system between the RCT and Tank 22) and stabilized in close proximity to the tank. Pretreatment to remove radionuclides would not be required to meet disposal facility WAC or USDOT requirements to ship the final stabilized waste form as Low Specific Activity Group II (LSA-II) in an Industrial Package-2 (IP-2) or Type A package[10]. The DWPF recycle wastewater in Tank 22 would be extracted from the tank via an available tank penetration riser with a low volume pump. The suction leg of the pump would enter the riser and end slightly below the surface of the liquid in Tank 22. The pump would discharge into a small-diameter hose-in-hose transfer line (to provide secondary containment) to deliver the DWPF recycle wastewater to the solidification equipment/container located in a temporary radiological enclosure (enclosure or hut) in proximity to Tank 22, thus minimizing the amount of liquid outside the tank at any one time.

The enclosure would house any necessary radiological supplemental containments, shielding, containment ventilation, and/or access controls for protection of the workers and the environment as appropriate based on the final equipment configuration. Secondary containment would also be provided by radiological enclosures as appropriate based on the final equipment configuration. Figure 2-4 depicts the likely location of the on-site treatment capability. The temporary enclosure would house the container that would receive the DWPF recycle wastewater from Tank 22 and dry feed materials for mixing within the container. Typical cementitious material components, such as cement, fly ash and slag, would be mixed with the DWPF recycle wastewater and cured to a stabilized waste form (i.e., grout).

For this analysis, it is assumed that the waste would be grouted in a 1,200-gallon container and that this container would also serve as the disposal package for the stabilized waste form. Other containers that meet IP-2 or Type A USDOT requirements could also be used. The container would include an internal paddle that would be used for mixing the liquid and the grout materials; the paddle would remain in the stabilized waste form. The analysis in this EA assumes that the volume of the waste in the stabilized matrix would be no larger than twice the volume of

[9] Packages intended for transport of radiological materials must meet USDOT requirements provided in 49 CFR Subchapter C, "Hazardous Materials Regulations."

[10] LSA-II material (as defined in 49 CFR 173.403) can be transported in an Industrial Package Type 2 (IP-2) transportation package (as defined in 49 CFR 173.403/410/411). An IP-2 package must meet a subset of the Type A packaging tests as defined in 49 CFR 173.411 and 465). See Appendix A for more details.

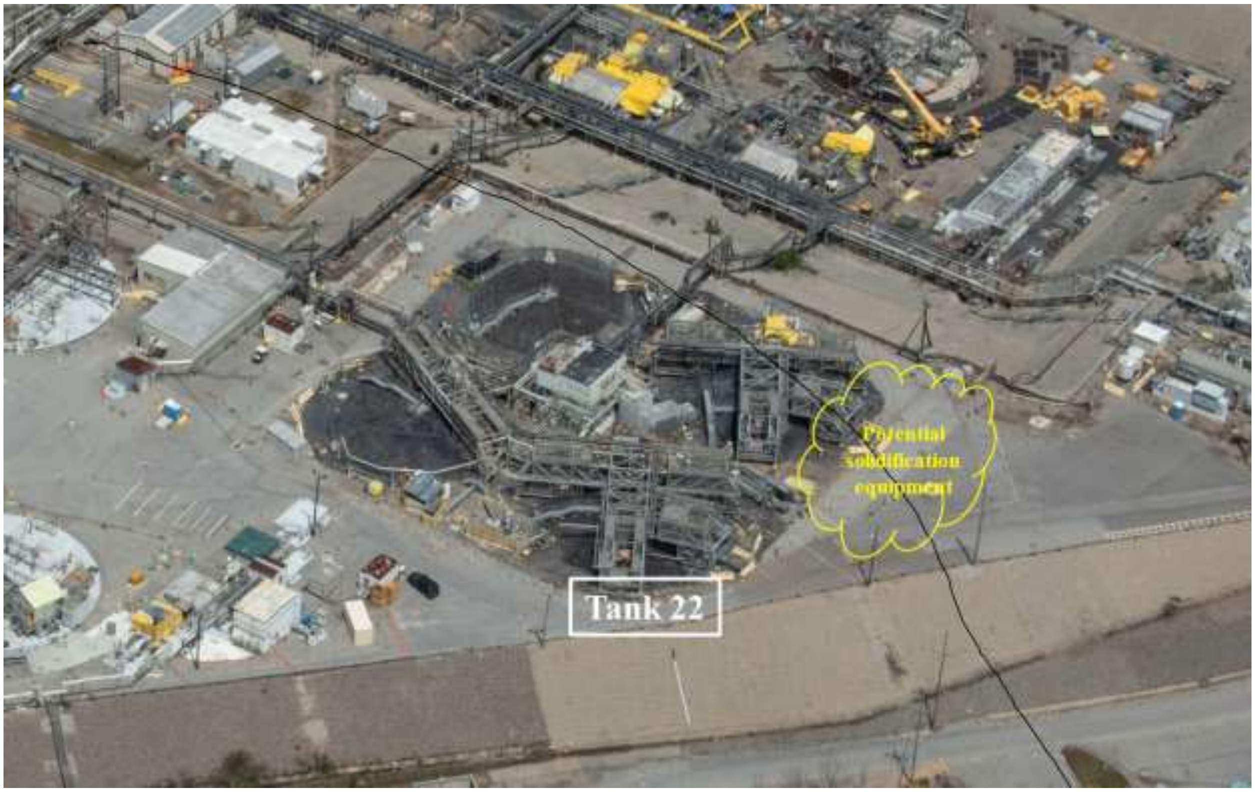

Figure 2-4. Potential Location of On-Site Treatment Capability

the liquid, prior to stabilization.[11] Therefore, 600 gallons of DWPF recycle wastewater would be grouted in each 1,200-gallon transportation and disposal container.

Following an appropriate grout curing period (to be determined based on the specific characteristics of the waste), the container would be sealed and radiologically surveyed to accommodate off-site shipment.

The on-site treatment of up to 10,000 gallons of DWPF recycle wastewater would occur in batches and would not necessarily be done consecutively. The retrieval and stabilization is assumed to require two weeks for each 1,200-gallon batch. Most of that time would be associated with staging the equipment, materials, packages, and truck. The actual retrieval, transfer, and grouting would likely be done within a four-day period.

2.1.2.2 Transportation and Disposal

The final, stabilized waste form would be shipped in an IP-2 or Type A package approved for transport under USDOT requirements, as provided in 49 CFR Subchapter C, “Hazardous Materials Regulations,” to an off-site, licensed disposal facility. The specific packaging assumed for the analysis in this EA is the same IP-2 used for transportation and disposal of the stabilized

[11] For example, at the SRS Saltstone Production Facility, nominally 1.76 gallons of grout is produced for each gallon of decontaminated salt solution feed (SRR 2019).

sludge waste form from the Separations Process Research Unit (SPRU) in New York from 2013 to 2014.[12] Figure 2-5 is a photograph of the SPRU IP-2 package. These particular packagings are approximately six feet tall by six feet wide.

Figure 2-5. IP-2 Transportation Package Used at SPRU

The final stabilized waste form shipments would be made by truck in accordance with USDOT requirements. The loaded IP-2 package can contain 600 gallons of liquid mixed with cement, fly ash, and slag to form 1,200 gallons of a stabilized waste form. Each loaded package would weigh approximately 10 tons. A semi-truck is able to carry two packages per shipment; therefore, the analysis in this EA assumes approximately nine truck shipments from SRS to a LLW disposal facility. The approximate highway distance between SRS and the WCS site is 1,400 miles. The highway distance between SRS and the Energy*Solutions* site is approximately 2,200 miles.

The stabilized waste form would be evaluated while still at the SRS H-Area Tank Farm to determine whether its radiological and hazardous constituents are within the bounds of the WAC for the identified LLW disposal facility. As described in Section 1.1 of this EA, LLW that meet requirements in 10 CFR 61.55 for Class A wastes could be accepted at both the WCS site and Energy*Solutions* site for disposal. At the time of publication of this EA, LLW that exceeds the criteria for Class A waste but is within the requirements for Class C waste could only be accepted at the WCS site for disposal. Disposal of the stabilized waste form at either facility would be conducted in accordance with the facility's operating license. The potential impacts at these commercial disposal facilities were considered as part of the licensing process for these sites.

[12] Information about the SPRU campaign is available online: http://dels.nas.edu/resources/static-assets/nrsb/miscellaneous/LLWMgmtWorkshop/HurleyTonkay_SolidificationDisposalofSPRU.pdf.

2.1.3 Alternative 2: Treatment and Disposal at a Commercial LLW Facility

Alternative 2 would extract up to 10,000 gallons of DWPF recycle wastewater at SRS and ship the DWPF recycle wastewater to either the WCS site (near Andrews, Texas) or the Energy*Solutions* site (near Clive, Utah) for treatment into a stabilized waste form and disposal as LLW, depending upon waste content and facility WAC. Alternative 2 includes the following activities:

- Deploy the retrieval equipment at SRS, retrieve up to 10,000 gallons of DWPF recycle wastewater and fill approved transportation packages with liquid from Tank 22.
- Transport the DWPF recycle wastewater to either the WCS site or the Energy*Solutions* site.
- Stabilize and dispose of the waste form at the WCS site or the Energy*Solutions* site in accordance with final waste classification and WAC.[13]

2.1.3.1 On-Site Retrieval and Packaging

For retrieval, DOE would extract the DWPF recycle wastewater from Tank 22 in the same manner as described for Alternative 1. However, the DWPF recycle wastewater would not be stabilized in proximity to Tank 22. Instead, it would be loaded into packages designed and approved for transport of radioactive liquids under applicable requirements to an off-site, commercial treatment and disposal facility. The extraction of up to 10,000 gallons of DWPF recycle wastewater would occur in batches and would not necessarily be done continuously. The retrieval of each batch (approximately 690 gallons per batch) is assumed to require two weeks. Most of that time would be associated with staging the equipment, materials, packages, and truck. The actual retrieval and transfer to the transportation container would likely be done within approximately two days. For Alternatives 2 and 3 (see also Section 2.1.4), each batch is assumed to be equivalent to a single truck load (see Section 2.1.3.2).

2.1.3.2 Transportation, Treatment, and Disposal

Based on recent Tank 22 sample data (see Appendix A to this EA), DWPF recycle wastewater would likely meet the USDOT requirements for transportation in a Type A package (that has satisfied the additional requirements for transporting liquids). Examples of existing packages for Type A quantities of liquid radioactive waste are the LQ-375 and various other commercially available USDOT 7A packages. In the event final characterization of the DWPF recycle wastewater indicates Type B packaging would be required, alternative packaging options would be considered. An evaluation of the DWPF recycle wastewater against any selected packaging would be required, along with potential updates to the package design, testing, and certification.

The analysis in this EA assumes a per-package volume of approximately 230 gallons of liquid waste. Depending on the radiological inventory of each package, DOE could load a truck with one to nine 230-gallon packages. The final loading configuration would depend primarily on the

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[13] Relevant licenses and permits authorizing WCS and Energy*Solutions* to treat and/or dispose of radioactive waste can be found at http://www.wcstexas.com/facilities/licenses-and-permits/ and https://customerportal.energysolutions.com/Content/ViewContent?ContentId=3991e385-ec8d-4416-8512-e98a081a7127, respectively

radiological inventory in each package and the resulting external radiation dose rate. For the purpose of this EA, the analysis assumes that each truck shipment would include three packages. Therefore, completion of the Proposed Action would require 15 truck shipments from SRS to a facility licensed for the treatment and disposal of LLW (i.e., WCS site or Energy*Solutions* site). The approximate highway distance between SRS and the WCS site is 1,400 miles. The highway distance between SRS and the Energy*Solutions* site is approximately 2,200 miles.

Prior to shipment and stabilization, the DWPF recycle wastewater would be evaluated to determine whether its radiological and hazardous constituents (once stabilized) would be within the bounds of the WAC for the commercial disposal LLW facility. As described in Section 1.1 of this EA, LLW that meets 10 CFR 61.55 requirements for Class A wastes could be accepted at both the WCS site and the Energy*Solutions* site for disposal. At the time of publication of this EA, LLW that exceeds the criteria for Class A waste but is within the requirements for Class C waste could be accepted at the WCS site for disposal. Both the WCS and Energy*Solutions* sites are licensed to accept liquid LLW (assuming it meets the site-specific criteria above), stabilize it, and dispose of the LLW. Stabilization would be accomplished using existing capabilities at either the WCS site or the Energy*Solutions* site. As mentioned earlier, the analysis assumes that the volume of the waste in the stabilized matrix would be approximately twice the volume of the liquid prior to stabilization. Disposal of the stabilized waste form at either facility would be conducted in accordance with the facility's operating license. The potential impacts (including environmental impacts) at these commercial disposal facilities were considered as part of the licensing process for these sites.

2.1.4 Alternative 3: Treatment at a Commercial Treatment Facility, Disposal at a Commercial LLW Facility

Alternative 3 would extract up to 10,000 gallons of DWPF recycle wastewater at SRS and transport the DWPF recycle wastewater for treatment to a commercial treatment facility with appropriate environmental permits and/or licenses. Following treatment, the stabilized waste form would be transported for disposal at either the WCS site (near Andrews, Texas) or the Energy*Solutions* site (near Clive, Utah) depending upon waste content and facility WAC. Alternative 3 includes the following activities:

- Deploy the retrieval equipment at SRS, retrieve up to 10,000 gallons of DWPF recycle wastewater, and fill approved transportation packages with liquid from Tank 22.
- Transport the DWPF recycle wastewater to a commercial treatment facility with appropriate environmental permits and/or licenses for stabilization.
- Transport the stabilized waste form to either the WCS site or the Energy*Solutions* site in accordance with final waste classification and WAC.
- Dispose of the waste form.

2.1.4.1 On-Site Retrieval and Packaging

Alternative 3 would extract the DWPF recycle wastewater from Tank 22 in the same manner as described for Alternative 2.

2.1.4.2 Transportation and Treatment

Alternative 3 would transport the DWPF recycle wastewater in the same manner as described for Alternative 2. As discussed in Section 2.1.3.2 of this EA, this analysis assumes approximately 15 truck shipments from SRS to a LLW treatment facility. There are several treatment facilities in the United States permitted and/or licensed to receive liquid LLW and stabilize it. For purposes of this EA, DOE is evaluating the transportation of the DWPF recycle wastewater to a commercial treatment facility in Richland, Washington.[14] Because this location is the farthest from SRS (compared to the other potential treatment facilities), use of this facility in the analysis results in a conservative estimate of the potential transportation impacts compared to other possible treatment facilities.[15] The approximate highway distance between SRS and the Richland commercial treatment facility is 2,655 miles. The DWPF recycle wastewater would be evaluated while still at the SRS H-Area Tank Farm to determine whether its radiological and hazardous constituents are within the bounds of the WAC for the identified treatment facility. Stabilization would be accomplished using existing capabilities. Treatment of the waste would be conducted in accordance with the facility's environmental permits and/or operating license. The potential impacts at these commercial disposal facilities were considered as part of the licensing process for these sites.

2.1.4.3 Transportation and Disposal

The stabilized waste form would be packaged and shipped by truck in accordance with USDOT and commercial disposal facility requirements. Packaging options are assumed to be similar to Alternative 1. This EA assumes that the treatment facility would use a Type A package similar to a 55-gallon drum. Therefore, treatment of up to 10,000 gallons of DWPF recycle wastewater would fill approximately 400, 55-gallon drums. Because the batches of 690 gallons of DWPF recycle wastewater (in three 230-gallon packages) would be mixed with another 690 gallons of stabilizing material at the treatment facility, each batch would be expected to result in approximately 26, 55-gallon drums, which could all be carried on a single truck shipment to the disposal facility. To accommodate the full 10,000 gallons of DWPF recycle wastewater evaluated in this EA, Alternative 3 would require about 15 truck shipments of stabilized waste form from the commercial treatment facility to the disposal facility.

The approximate highway distance between the commercial treatment facility and the WCS site is 1,475 miles. The highway distance between the treatment facility and the Energy*Solutions* site is approximately 644 miles. As described in Section 1.1 of this EA, LLW that meets requirements in 10 CFR 61.55 for Class A wastes could be accepted at both the WCS site and the Energy*Solutions* site for disposal. At the time of publication of this EA, LLW that exceeds the criteria for Class A waste but is within the requirements for Class C waste could be accepted at the WCS site for disposal. Disposal of the stabilized waste form at either facility would be

[14] DOE has existing basic ordering agreements with a variety of commercial companies that have treatment facilities located across the United States. These basic ordering agreements can be found at: https://www.emcbc.doe.gov/About/PrimeContracts. The commercial facility in Richland, Washington, is analyzed solely for the purposes of providing an upper bound estimate of the potential transportation impacts.

[15] As presented in Section 3.7 of this DWPF Recycle Wastewater EA, the primary health and safety impacts are those associated with shipment miles (i.e., dose to crew and potential for injuries associated with mechanical accidents).

conducted in accordance with the facility's operating license. The potential impacts at these commercial disposal facilities were considered as part of the licensing process for these sites.

2.1.5 Summary of Alternatives 1, 2, and 3

Table 2-1 presents a high-level summary of the actions associated with Alternatives 1, 2, and 3.

Table 2-1. Summary of Actions for Alternatives 1, 2, and 3

Alternative	Liquid Waste Retrieval	Transport of Liquid LLW Required	Location of Waste Stabilization	Location of Off-Site Permanent Disposal	Number of Potential Shipments
1	SRS (Tank 22)	No	SRS	WCS (Andrews County, Texas) – 1,400 miles or Energy*Solutions* (Clive, Utah) – 2,200 miles	9
2	SRS (Tank 22)	Yes	WCS (Andrews County, Texas) – 1,400 miles or Energy*Solutions* (Clive, Utah) – 2,200 miles	WCS (Andrews County, Texas) or Energy*Solutions* (Clive, Utah)	15
3[a]	SRS (Tank 22)	Yes	Liquid LLW Treatment Facility (assumes permitted and licensed facility in Richland, WA) – 2,655 miles	WCS (Andrews County, Texas) – 1,475 miles or Energy*Solutions* (Clive, Utah) – 644 miles[b]	30

N/A = not applicable.

a. Alternative 3 assumes 15 shipments (liquid waste) from SRS to a permitted and/or licensed treatment facility and 15 shipments of the stabilized waste form from the treatment facility to a LLW disposal facility, for a total of 30 shipments.

b. Miles shown correspond to the distances from the permitted and/or licensed treatment facility (assumed to be in Richland, Washington) to either the WCS or Energy*Solutions* disposal facility.

2.2 No-Action Alternative

Under the No-Action Alternative, the up-to-10,000 gallons of DWPF recycle wastewater would remain in the SRS liquid waste system until disposition occurs using the systems described in Section 2.1.1. The No-Action Alternative would require another, as yet determined, process to handle the DWPF recycle wastewater during the final years of the DWPF mission (2031–2034), when DOE will no longer have the option of returning DWPF recycle wastewater to the SWPF for processing.

2.3 Alternatives Considered but Eliminated from Detailed Analysis

There are two additional commercial LLW disposal facilities in the United States—the Barnwell, South Carolina, facility and the U.S. Ecology facility near Richland, Washington. However, these facilities were eliminated from detailed analysis because their use is restricted by compact membership, which does not currently provide accommodations for a Federal waste facility.[16]

DOE on-site (i.e., E Area) and off-site (e.g., Nevada Nuclear Security Site) radioactive waste disposal facilities are not included in the alternatives analysis because the purpose of the Proposed Action is to evaluate the capability to dispose of DWPF recycle wastewater (up to 10,000 gallons) as LLW at a licensed commercial facility outside the state of South Carolina. DOE on-site and off-site disposal of LLW has been analyzed in previous NEPA documents (e.g., SRS Salt Processing Alternatives SEIS, WM PEIS). Any proposal to dispose of more than 10,000 gallons of DWPF recycle wastewater would be evaluated in a separate NEPA review, at which time DOE would determine the need to consider DOE on-site and off-site disposal.

[16] The *Low-Level Radioactive Waste Policy Act of 1980* (as amended in 1986) gives the states the responsibility for the disposal of LLW generated within their borders (except for certain waste generated by the Federal Government). The Act authorized the states to enter into compacts that would allow them to dispose of waste at a common disposal facility.

3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 Introduction

This chapter includes an analysis of the potential environmental consequences or impacts that could result from the Proposed Action and alternatives. The affected environment is the result of past and present activities at SRS and provides the baseline from which to compare impacts from the Proposed Action and alternatives; as well as the baseline to which past, present, and reasonably foreseeable future actions and the incremental impact of the Proposed Action and alternatives are added for the cumulative impacts analysis.

Section 3.2 identifies the environmental resource areas that were considered and eliminated from detailed analysis. Sections 3.3 through 3.7 present the affected environment and potential environmental consequences for each of the resource areas analyzed in detail. This EA considers the potential direct, indirect, and cumulative impacts associated with the Proposed Action and alternatives. Direct impacts are those that would occur as a direct result of the Proposed Action or alternatives. Indirect impacts are those that are caused by the Proposed Action but would occur later in time and/or farther away in distance; perhaps outside of the study area. Cumulative impacts, which are presented in Chapter 4, are impacts that result when the incremental impacts on resources from the Proposed Action and alternatives are added to impacts that have occurred or could occur to that resource from other actions, including past, present, and reasonably foreseeable future actions.

3.2 Resource Screening Review

The impact analyses in this EA have been prepared specifically for this project in order to provide sufficient information to support a decision regarding the potential environmental impacts of the Proposed Action. In further effort to reduce excessive paperwork (in accordance with 40 CFR 1500.4[j]) and consistent with CEQ and DOE NEPA implementing regulations and guidance, the analysis in this EA focuses on the subjects that are relevant to the Proposed Action and its impacts. As stated in the CEQ regulations regarding EISs:

> "Impacts shall be discussed in proportion to their significance. There shall be only brief discussion of other than significant issues. As in a finding of no significant impact, there should be only enough discussion to show why more study is not warranted (40 CFR 1502.2(b))."

Table 3-1 presents the rationale for resource areas eliminated from detailed analysis.

Table 3-1. Resource Areas Eliminated from Detailed Analysis

Resource Area	Rationale
Land	Proposed Action and alternatives would not involve any land disturbance activities and would not affect current land uses. Retrieval activities (for all alternatives) in the SRS H-Area Tank Farm would occur within existing paved areas. Stabilization activities (Alternative 1) would also occur in existing paved areas.
Visual	Proposed Action and alternatives would only involve temporary scaffolding and work areas. None of these temporary structures would be visible from off-site locations nor would they be any different than existing structures in the tank farm.
Geology and soils	Proposed Action and alternatives would not involve any land disturbance activities and would therefore not affect geology or soils in the area. There would be no changes to existing facilities that would affect their ability to withstand a design-basis seismic event.
Water resources (surface, groundwater, wetlands)	Proposed Action and alternatives would not involve any land disturbance activities and would not affect any surface waters, groundwater, or wetlands. Retrieval activities (for all alternatives) in the SRS H-Area Tank Farm would occur within existing paved areas. Stabilization activities (Alternative 1) would also occur in existing paved areas. Secondary containment would be provided during retrieval and stabilization activities to catch any inadvertent spills and to prohibit introduction of contaminants in the storm drains.
Cultural and paleontological resources	Proposed Action and alternatives would not involve any land disturbance activities and would therefore not affect any potential cultural or paleontological resources. The SRS H-Area Tank Farm is an industrial area and has been actively used since the 1950s.
Ecological resources (biota, threatened and endangered species)	Proposed Action and alternatives would not involve any land disturbance activities and would not affect any ecological resources. The SRS H-Area Tank Farm is an industrial area and has been actively used since the 1950s.
Noise	The SRS H-Area Tank Farm is a highly industrialized area with ongoing noise sources. The Proposed Action and alternatives would not substantively contribute to the current noise profile at the site. The SRS H-Area Tank Farm is approximately seven miles from the closest site boundary at the Savannah River; therefore, noise from the tank farm is not noticeable from off-site locations.
Socioeconomics and environmental justice	Proposed Action and alternatives would be a temporary activity using existing on-site personnel. No new jobs or workers would be required. There would be no disproportionately high and adverse human health impacts on minority or low-income populations.
Infrastructure and utilities	Proposed Action and alternatives would not result in any measurable infrastructure and utility changes compared to existing requirements. The increase in truck traffic for the limited duration of the Proposed Action would be negligible.
Industrial safety	Proposed Action and alternatives would not require additional workers or introduce new types of operations that would result in additional occupational injuries.

As a result of the screening review presented in Table 3-1, this EA analyzes the following resource areas in detail: (1) air quality, (2) human health (normal operations), (3) human health (accidents and intentional destructive acts), (4) waste management, and (5) transportation. Sections 3.3 through 3.7 present these analyses.

Under the No-Action Alternative, the potential impacts identified for the Proposed Action related to these five resource areas may not be realized as analyzed in this EA. However, the 10,000 gallons of DWPF recycle wastewater would still be processed for ultimate disposition at some point in the future. Therefore, there would be impacts associated with treatment and disposition of the 10,000 gallons of DWPF recycle wastewater; these impacts would occur at a future date and would be similar to the impacts evaluated in the SRS Salt Processing Alternatives SEIS (DOE 2001) and the SRS HLW Tank Closure EIS (DOE 2002).

3.3 Air Quality

3.3.1 Affected Environment

SRS is near the center of the Augusta (Georgia)–Aiken (South Carolina) Interstate Air Quality Control Region Code No. 53. None of the areas within SRS or the surrounding counties is designated as non-attainment with respect to the National Ambient Air Quality Standards (NAAQS) for criteria air pollutants (EPA 2019). The nearest areas with non-attainment status (eight-hour ozone) are in counties near Atlanta, Georgia, approximately 150 miles west of SRS (EPA 2019).

The primary sources of air pollutants at SRS are the biomass boilers in K Area and L Area, diesel-powered equipment throughout SRS, DWPF, soil vapor extractors, groundwater air strippers, the Biomass Cogeneration Facility and back-up oil-fired boiler on Burma Road, and various other processing facilities. Other sources of emissions include vehicle traffic and controlled burning of forested areas, as well as temporary emissions from various construction-related activities. Table 3-2 gives the potential annual air emissions from SRS based on 2018 operations (SRNS 2019a). SRS operates under a Title V operating permit (SRNS 2019a).

The *Clean Air Act* Prevention of Significant Deterioration regulations (40 CFR 51.166) designate the Augusta–Aiken Air Quality Control Region as a Class II area. The Prevention of Significant Deterioration regulations were developed to manage air resources in areas that are in attainment of the NAAQS. Class II areas have sufficient air quality to support industrial growth. Class I areas are areas in which very little increase in air pollution is allowed due to the pristine nature of the area. There are no Prevention of Significant Deterioration Class I areas within approximately 60 miles of SRS (SCDHEC 2019a).

Table 3-2. 2018 Potential Annual Air Emissions from SRS

Pollutant Name	Potential Emissions (tons/year)
Sulfur dioxide	571
Total particulate matter	386
Particulate matter <10 microns	272
Particulate matter <2.5 microns	248
Carbon monoxide	660
Ozone (volatile organic compounds)	228
Nitrogen oxides	822
Nitrogen dioxide	661
Lead	0.239
Sulfuric acid mist	5.64

Source: SRNS 2019a

3.3.1.1 Nonradiological Air Emissions

Table 3-3 presents the applicable regulatory ambient standards and ambient air pollutant concentrations attributable to sources at SRS. These concentrations are based on potential emissions (SRNS 2019a). Concentrations shown in Table 3-3 attributable to SRS are in compliance with applicable guidelines and regulations. Data from nearby ambient air monitors in Aiken, Barnwell, and Richland counties in South Carolina are presented in Table 3-4. The data indicate that the NAAQS for particulate matter, lead, ozone, sulfur dioxide, and nitrogen dioxide are not exceeded in the area around SRS.

Table 3-3. Comparison of Ambient Air Concentrations from Existing Savannah River Site Sources with Applicable Standards or Guidelines

Criteria Pollutant	Averaging Period	More Stringent Standard or Guideline (micrograms per cubic meter)[a]	Ambient Air Concentration (micrograms per cubic meter)[b]
Carbon monoxide	8 hours	10,000[c]	292
	1 hour	40,000[c]	1,118.2
Nitrogen dioxide	Annual	100[c]	42.1
Ozone	8 hours	0.07 ppm[c]	(d)
PM_{10}	24 hours	150[c]	50.7
$PM_{2.5}$	24 hours	35[c]	(d)
	Annual	12[c]	(d)
Sulfur dioxide	3 hours	1300[c]	723
	1 hour	75 ppb	(d)
Lead	Rolling 3-month	0.15[c]	0.11

PM_n = particulate matter less than or equal to n microns in aerodynamic diameter; ppm = parts per million; ppb = parts per billion.

a. The more stringent of the Federal or state standard is presented if both exist for the averaging period. The computations for determining if the applicable standard is met are found in appendices to 40 CFR Part 50. Source: EPA 2019.

b. Source: DOE 2015a.

c. Federal and state standard.

d. No concentration reported.

Table 3-4. Ambient Air Quality Standards and Monitored Levels in the Vicinity of the Savannah River Site

Criteria Pollutant	Averaging Period	More Stringent Standard or Guideline (micrograms per cubic meter)[a]	Ambient Air Concentration (micrograms per cubic meter)	Location (South Carolina)
Carbon monoxide	8 hours	10,000	2,863[b]	Richland County
	1 hour	40,000	3,350[b]	Richland County
Nitrogen dioxide	Annual	100	6.6[b]	Aiken County
Ozone	8 hours	0.070 ppm	0.059 ppm[c]	Aiken County
PM_{10}	24 hours	150	61[b]	Aiken County
$PM_{2.5}$	24 hours	35	17[c]	Richland County
	Annual	12	8.10[c]	Richland County
Sulfur dioxide	3 hours	1300	39.3[b]	Barnwell County
	1 hour	75 ppb	4 ppb[c]	Richland County
Lead	Rolling 3-month	0.15	0.002[b]	Richland County

PM_n = particulate matter less than or equal to n microns in aerodynamic diameter; ppb = parts per billion.

a. Source: SCDHEC 2019b.

b. 2007 data; source DOE 2015a.

c. 2017 data; source DOE 2015a.

3.3.1.2 Radiological Air Emissions

Atmospheric radionuclide emissions from SRS are limited under the U.S. Environmental Protection Agency's (EPA's) National Emissions Standards for Hazardous Air Pollutants regulations in 40 CFR Part 61, Subpart H. The EPA annual effective dose equivalent limit to members of the public is 10 millirem (mrem) per year. The total effective dose for 2018 at SRS was 0.088 mrem per year, two orders of magnitude below the 10-mrem-per-year limit (SRNS 2019a). Nearly 80 percent of the radionuclides emitted at SRS are tritium compounds.

3.3.2 Alternative 1 Impacts

DOE would retrieve up to 10,000 gallons of DWPF recycle wastewater from Tank 22 and transfer that recycle wastewater through a hose-in-hose to a temporary enclosure for stabilization. The riser penetration to the Tank 22 head space would be sealed to prohibit release of emissions to the air. The liquid would be discharged into the IP-2 container located within the enclosure. At the same time, cementitious materials (grout) would be added to the package and an internal paddle would thoroughly combine the mixture to the required specifications. The container inlet would be outfitted with a ventilation hose that captured any vapors or particulates that were discharged from the inlet as a result of the filling and stabilization actions. The ventilation hose would be routed through high-efficiency particulate air filters on the exhaust side to prevent entrained radiological materials from being released to the atmosphere. The filters are more than 99.95 percent effective in containing radionuclides. The resultant emissions outside of the temporary enclosure would contain negligible concentrations of radionuclides. Air sampling is performed as part of routine operating procedures at the SRS tank farms and would be used to monitor and verify these conditions during implementation of the Proposed Action. There would be no substantial greenhouse gas emissions from any of the activities at SRS. Once the packages were filled and mixed, the lid would be installed for lifting, transportation, and disposal.

The stabilized waste form would be shipped from SRS to WCS or Energy*Solutions* (approximately 1,400 or 2,200 miles, respectively) in about nine total truck shipments of up to two IP-2 packages each, for a total of 17 packages. These nine trucks would produce negligible air emissions, including greenhouse gases, relative to the overall vehicle emissions associated with interstate trucking and other private and commercial vehicles on the highways.

Disposal of the 17 packages at the WCS site near Andrews, Texas, or the Energy*Solutions* site near Clive, Utah, would not cause any additional air emissions beyond those already expected and evaluated from their ongoing disposal operations.

3.3.3 Alternative 2 Impacts

The potential air quality impacts at SRS associated with the DWPF recycle wastewater retrieval and filling of the transportation packages would be the same as discussed in Section 3.3.2. Under Alternative 2, however, the packages would contain DWPF recycle wastewater and are assumed to be transported to WCS or Energy*Solutions* for stabilization. Because the package assumed in the analysis for this EA has a capacity of 230 gallons of liquid and the analysis assumes three packages per truck shipment, the transportation of 10,000 gallons of DWPF recycle wastewater would require approximately 15 truck shipments. The air emissions associated with this transportation would be slightly larger than that expected for Alternative 1; however, the 15 shipments would still result in negligible vehicle air emissions, including greenhouse gases, relative to the overall vehicle emissions associated with interstate trucking and other private and commercial vehicles on the highways.

Stabilization actions are typically performed at WCS and Energy*Solutions* under their respective licenses. The containers of stabilized waste form would be disposed of at the WCS site or the Energy*Solutions* site. This stabilization and disposal would not cause any additional air emissions beyond those already expected and evaluated from the respective ongoing treatment and disposal operations.

3.3.4 Alternative 3 Impacts

The potential air quality impacts at SRS associated with the DWPF recycle wastewater retrieval and filling of the transportation packages would be the same as discussed in Section 3.3.2. Under Alternative 3, however, the packages would contain DWPF recycle wastewater and are assumed to be transported to a permitted and/or licensed treatment facility in Richland, Washington, for stabilization. Section 2.1.4.2 of this EA identifies that transportation of 10,000 gallons of DWPF recycle wastewater would require approximately 15 truck shipments from SRS to the treatment facility (approximately 2,655 miles per shipment). The air emissions, including greenhouse gases, associated with this portion of the transportation would be higher than under Alternative 2 because the material would travel more miles, but still would be negligible overall.

Stabilization actions are typically performed at treatment facilities under their respective environmental permits and/or licenses. The analysis in this EA assumes that approximately 400, 55-gallon waste drums would result from stabilization at the commercial treatment facility, which would then be transported from the treatment facility to be disposed of at the WCS site or the Energy*Solutions* site. The 15 shipments of 26 drums each would result in negligible vehicle emissions, including greenhouse gases, relative to the overall vehicle emissions associated with interstate trucking and other private and commercial vehicles on the highways. Similar to Alternatives 1 and 2, the treatment and disposal actions at WCS or Energy*Solutions* would not cause any additional air emissions beyond those already expected from their respective ongoing disposal operations.

3.3.5 No-Action Alternative Impacts

Under the No-Action Alternative, DOE would not conduct the Proposed Action. Instead, DOE would maintain the status quo, which is represented by the continued management of tank wastes and eventual closure of the tanks in accordance with the System Plan (SRR 2019), the SRS Salt Processing Alternatives SEIS (DOE 2001), and the SRS HLW Tank Closure EIS (DOE 2002). There would be additional, incremental air emissions associated with the eventual treatment and disposal of the 10,000 gallons of DWPF recycle wastewater. These impacts were addressed in the existing NEPA analyses (DOE 2001, 2002).

3.4 Human Health – Normal Operations

3.4.1 Affected Environment

Primary sources and levels of background radiation exposure to individuals in the vicinity of SRS are assumed to be the same as those to an average individual in the U.S. population. These exposures are shown in Table 3-5. Background radiation doses are unrelated to SRS operations.

Table 3-5. Radiation Exposure of Individuals in the Savannah River Site Vicinity Unrelated to Savannah River Site Operations[a]

Source	Effective Dose (millirem per year)
Natural background radiation	
Cosmic and external terrestrial radiation	54
Internal terrestrial radiation	29
Radon-220 and -222 in homes (inhaled)	228
Other background radiation	
Diagnostic x-rays and nuclear medicine	300
Occupational	0.5
Industrial, security, medical, educational, and research	0.3
Consumer products	13
Total (rounded)	**620**

a. An average for the United States.
Source: NCRP 2009

Releases of radionuclides to the environment from SRS operations provide another source of radiation exposure to individuals in the vicinity of SRS. Types and quantities of radionuclides released from SRS operations are listed in the annual SRS environmental reports. The annual doses to the public from recent releases of radioactive materials (2013–2017) and the average annual doses over this 5-year period are presented in Table 3-6. These doses fall within radiological limits established per DOE Order 458.1 and are much lower than background radiation.

Using a risk estimator of 600 latent cancer fatalities (LCFs) per 1 million person-rem (or 0.0006 LCF per rem) (DOE 2003), the annual average LCF risk to the maximally exposed member of the public due to radiological releases from SRS operations from 2013 through 2017 is negligible (0.0000001). That is, the estimated probability of this person developing a fatal cancer at some point in the future from radiation exposure associated with one year of SRS operations is about 1 in 10 million.

LATENT CANCER FATALITY

A death resulting from cancer that has been caused by exposure to ionizing radiation. For exposures that result in cancers, the generally accepted assumption is that there is a latent period between the time an exposure occurs and the time a cancer becomes active.

RADIATION DOSE UNITS

Individual doses from radiation are most often expressed in "mrem." Collective doses, which represent more than one person, are most often expressed in "person-rem." One person-rem equals 1,000 person-mrem.

Table 3-6. Annual Radiation Doses to the Public from Savannah River Site Operations for 2013–2017 (total effective dose)

Members of the Public	Year	Atmospheric Releases[a]	Total Liquid Releases[b] (all liquid + irrigation)	Total[c]
Maximally exposed individual (mrem)	2013	0.052	0.14	0.19
	2014	0.044	0.12	0.16
	2015	0.032	0.15	0.18
	2016	0.038	0.15	0.19
	2017	0.027	0.22	0.25
	2013–2017 average	0.039	0.16	0.20
Population within 50 miles (person-rem)[d]	2013	2.2	2.5	4.7
	2014	1.7	2.0	3.7
	2015	1.1	2.6	3.7
	2016	1.4	3.5	4.9
	2017	0.97	3.4	4.4
	2013–2017 average	1.5	2.8	4.3
Average individual within 50 miles[e] (mrem)	2013	0.0028	0.0091	0.012
	2014	0.0022	0.0064	0.0086
	2015	0.0014	0.0088	0.01
	2016	0.0018	0.0091	0.011
	2017	0.0012	0.01	0.011
	2013–2017 average	0.0019	0.0087	0.011

a. DOE Order 458.1 and *Clean Air Act* regulations in 40 CFR Part 61, Subpart H, establish a compliance limit of 10 millirem per year to a maximally exposed individual for airborne releases.
b. Includes all water pathways, not just the drinking water pathway. Though not directly applicable to radionuclide concentrations in surface water or groundwater, an effective dose equivalent limit of four mrem per year for the drinking water pathway only is frequently used as a measure of performance.
c. DOE Order 458.1 establishes an all-pathways dose limit of 100 mrem per year to individual members of the public.
d. About 781,060, based on 2010 Census data. For liquid releases occurring from 2013 through 2017, an additional 161,300 water users in Port Wentworth, Georgia, and Beaufort, South Carolina (about 98 river miles downstream), are included in the assessment.
e. Obtained by dividing the population dose by the number of people living within 50 miles of SRS for atmospheric releases; for liquid releases, the number of people includes water users who live more than 50 miles downstream of SRS.
Note: Sums and quotients presented in the table may differ from those calculated from table entries due to rounding.
Sources: SRNS 2014, 2015, 2016a, 2017, 2019b

No excess fatal cancers are projected in the population living within 50 miles of SRS from one year of normal operations from 2013 through 2017. To put this number in perspective, it may be compared with the number of fatal cancers expected in the same population from all causes. The average annual mortality rate associated with cancer for the entire U.S. population from 2013 through 2016 (the last four years for which final data are available) was 185 per 100,000 (HHS 2016a, 2016b, 2017, 2018). Based on this national mortality rate, the number of fatal cancers expected to occur in 2017 in the population of 781,060 people (SRNS 2019b) living within 50 miles of SRS would be 1,445.

SRS workers receive the same dose as the general public from background radiation, but they also receive an additional dose from working in facilities with nuclear materials. Table 3-7 presents the annual average individual and collective worker doses from SRS operations from 2013 through 2017. These doses fall within the regulatory limits of 10 CFR Part 835. Statistically, the average total worker dose of 112.1 person-rem per year translates to a worker population LCF risk of 0.067.

Table 3-7. Radiation Doses to Savannah River Site Workers from Operations 2013–2017 (total effective dose equivalent)

Occupational Personnel	From Outside Releases and Direct Radiation by Year					
	2013	2014	2015	2016	2017	Average
Average radiation worker dose (mrem)[a]	60	59	51	40	39	50
Total worker dose (person-rem)	88.6	93.0	95.1	111.3	172.5	112.1
Number of workers receiving a measurable dose	1,472	1,584	1,884	2,799	4,411	2,430

a. No standard is specified for an "average radiation worker"; however, the maximum dose to a worker is limited as follows: the radiological limit for an individual worker is 5,000 mrem per year (10 CFR Part 835). However, DOE's goal is to maintain radiological exposure as low as reasonably achievable. DOE has, therefore, established the administrative control level of 2,000 mrem per year; the site contractor sets facility administrative control levels below the DOE level (DOE 2017a).

Sources: DOE 2014, 2015b, 2016, 2017b, 2018a

3.4.2 Alternative 1 Impacts

DOE would retrieve up to 10,000 gallons of DWPF recycle wastewater from Tank 22 and transfer that waste to the solidification equipment/container located in a temporary radiological enclosure in proximity to Tank 22. Because there would be no radiological emissions or effluents associated with Alternative 1, and no direct radiation dose off-site, there would be no doses to the public.

The retrieval and stabilization is assumed to require two weeks for each 1,200-gallon batch. Most of that time would be associated with staging the equipment, materials, packages, and truck. The actual retrieval, transfer, and grouting would likely be done within a four-day period. Approximately 25 to 30 workers would be involved in the operation, but only approximately 10 workers would be involved in radiological operations that could result in doses. Based on actual exposure data for 2017 (see Table 3-7), the average dose to an SRS tank farm worker that receives a dose is approximately 50 mrem per year, which equates to 0.2 mrem per day (assuming 250 days of work per year). Consequently, under Alternative 1, the average SRS tank farm worker would be expected to receive a dose of approximately 0.8 mrem for each 1,200-gallon batch, and the total worker dose for each 1,200-gallon batch would be approximately 0.008 person-rem. The retrieval and stabilization of 10,000 gallons of DWPF recycle wastewater would require nine, 1,200-gallon batches, which would result in an average worker dose of 7.2 mrem and a total worker dose of 0.072 person-rem. Table 3-8 presents the LCF risk associated with these worker doses. All doses are well within the administrative control level for SRS workers (500 mrem per year). During all operations, DOE would implement measures to minimize worker exposures and maintain doses as low as reasonably achievable. Measures to be implemented could consist of the use of shielding, personal protective equipment, and training mock-ups to improve the efficiency of operations and reduce exposure times.

Table 3-8. Worker Radiological Risk from Normal Operations: Alternative 1

Receptor	Dose for Project	Radiological Risk (LCF)[a]
Average worker	7.2 mrem	0.0000043
Total workers	0.072 person-rem	0.000043

LCF = latent cancer fatality.

a. The LCF risk is based on a dose-to-risk conversion factor of 0.00060 per rem (DOE 2003).

Under Alternative 1, the final, stabilized waste form would be contained within an IP-2 or Type A package approved for transport under USDOT requirements, as provided in 49 CFR Subchapter C, “Hazardous Materials Regulations,” for transport of the waste to an off-site, licensed disposal facility (WCS or Energy*Solutions*). Section 3.7.2 of this EA presents the radiological impacts associated with this transport.

The stabilized waste form would be evaluated while still at the SRS H-Area Tank Farm to determine whether its radiological and hazardous constituents are within the bounds of the WAC for the planned LLW disposal facility. As described in Section 1.1 of this EA, LLW that meet requirements in 10 CFR 61.55 for Class A wastes could be accepted at both the WCS site and Energy*Solutions* site for disposal. As of the publication of this EA, LLW that exceeds the criteria for Class A waste but is within the requirements for Class C waste could only be accepted at the WCS site for disposal.

Because the final, stabilized waste form would be verified to meet the appropriate disposal facility’s waste classification and acceptance criteria (derived for compliance with performance objectives) prior to transport, there would be no additional radiological exposures to the off-site public or the disposal facility workforce than expected under their existing license for LLW disposal. The stabilized waste form would meet the criteria in DOE’s HLW interpretation discussed in Section 1.2 of this EA. This would ensure that the disposal of the stabilized waste form would not cause an increase to the long-term radiological health impacts at the disposal facility beyond those identified during the licensing process.

3.4.3 Alternative 2 Impacts

Alternative 2 would transfer up to 10,000 gallons of DWPF recycle wastewater from SRS into an approved transportation package (assumed to be 230-gallon packages) and ship the waste to either the WCS site or the Energy*Solutions* site for treatment into a stabilized waste form and disposal as LLW, depending upon waste content and facility WAC. For retrieval, DOE would extract the DWPF recycle wastewater in the same manner as described for Alternative 1. However, the DWPF recycle wastewater would not be stabilized in proximity to Tank 22. Instead, the DWPF recycle wastewater would be loaded into containers designed and approved for transport. The extraction of up to 10,000 gallons of DWPF recycle wastewater would occur in batches and would not necessarily be done continuously. The retrieval of each batch (which is assumed to be equivalent to a single truck load (see Section 2.1.3.2) is assumed to require two weeks. Most of that time would be associated with staging the equipment, materials, packages, and truck. The actual retrieval and transfer would likely be done within two days, limiting radioactive exposure to workers. Approximately 15 batches would be required to package the entire 10,000 gallons of DWPF recycle wastewater into approved transportation packages.

Approximately 25 to 30 workers would be involved in the operation, but only approximately 10 workers would be involved in radiological operations that could result in measurable doses. Based on actual exposure data for 2017 (see Table 3-7), the average dose to an SRS tank farm worker that receives a dose is approximately 50 mrem per year, which equates to 0.2 mrem per day (assuming 250 days of work per year). Consequently, under Alternative 2, the average worker would be expected to receive a dose of approximately 0.4 mrem for each batch, and the total worker dose for each batch would be approximately 0.004 person-rem. The retrieval and packaging of 10,000 gallons of DWPF recycle wastewater (15 batches) would result in an average worker dose of 6 mrem and a total worker dose of 0.06 person-rem. Table 3-9 presents the LCF risk associated with these worker doses. All doses are well within the administrative control level for SRS workers (500 mrem per year). As explained in Section 3.4.2, DOE would implement measures to minimize worker exposures.

Table 3-9. Worker Radiological Risk from Normal Operations: Alternatives 2 and 3

Receptor	Dose for Project	Radiological Risk (LCF)[a]
Average worker	6 mrem	0.0000036
Total workers	0.06 person-rem	0.000036

LCF = latent cancer fatality; mrem = millirem.

a. The LCF risk is based on a dose-to-risk conversion factor of 0.0006 per rem (DOE 2003).

The transportation of 10,000 gallons of DWPF recycle wastewater would require approximately 15 shipments. Section 3.7.3 of this EA presents the radiological impacts associated with this transport.

Stabilization actions are performed regularly at WCS and Energy*Solutions* under their respective licenses. The potential impacts from stabilization would not result in any notable increase in human health impacts beyond those already expected from ongoing LLW treatment operations, as stabilization of waste is integral to facility operations at those sites. Approximately 400, 55-gallon waste drums would result from the stabilization, which would be disposed of at the WCS site or the Energy*Solutions* site. This disposal would not result in any notable human health impacts beyond those already expected from their ongoing disposal operations.

The potential health impacts from disposal of the stabilized waste form under Alternative 2 would be the same as discussed for Alternative 1 in Section 3.4.2.

3.4.4 Alternative 3 Impacts

Alternative 3 would extract the DWPF recycle wastewater in the same manner as described for Alternative 2. Consequently, the potential human health impacts at SRS associated with waste retrieval and filling of the transportation packages would be the same as discussed in Section 3.4.3 (see Table 3-9). As explained in Section 3.4.2, DOE would implement measures to minimize worker exposures.

Under Alternative 3, the packages would contain DWPF recycle wastewater and are assumed to be transported to a commercial treatment facility for stabilization. Section 2.1.4.2 of this EA identifies that transportation of 10,000 gallons of DWPF recycle wastewater would require 15 shipments from SRS to the commercial treatment facility (assumed to be in Richland, Washington, approximately 2,655 miles per shipment). Section 3.7.4 of this EA presents the radiological impacts associated with this transport.

Stabilization actions are performed regularly at commercial treatment facilities under their environmental permits and/or licenses. The potential impacts from stabilization would not result in any notable increase in human health impacts beyond those already expected from ongoing LLW treatment operations, as stabilization of waste is integral to facility operations at these facilities. Treatment of up to 10,000 gallons of DWPF recycle wastewater would fill approximately 400, 55-gallon drums. Because the batches of 690 gallons of DWPF recycle wastewater (in three 230-gallon packages) would be mixed with another 690 gallons of stabilization material at the treatment facility, each batch would be expected to result in approximately 26, 55-gallon drums, which could all be carried on a single truck shipment to the disposal facility (e.g., the WCS site or the Energy*Solutions* site). Section 3.7.4 of this EA presents the radiological impacts associated with this transport. The potential health impacts from disposal of the stabilized waste form for Alternative 3 would be the same as discussed for Alternative 1 in Section 3.4.2.

3.4.5 No-Action Alternative Impacts

Under the No-Action Alternative, DOE would not conduct the Proposed Action. Instead, the up-to-10,000 gallons of DWPF recycle wastewater would remain in the SRS liquid waste system until disposition occurs using the systems described in Section 2.1.1. Under the No-Action Alternative, DOE would not provide alternative treatment and disposal options for up to 10,000 gallons of DWPF recycle wastewater at an off-site, licensed commercial facility. As a result, the No-Action Alternative would impact planning activities to develop a disposal capability for DWPF recycle wastewater for the three years between the completion of SWPF mission (estimated 2031) and DWPF mission (estimated 2034) (SRR 2019), when DOE will no longer have the option of returning DWPF recycle wastewater to the SWPF for processing. The minimal worker doses attributable to retrieval and stabilization resulting from the Proposed Action would be partially or completely offset by worker doses resulting from similar activities under the No-Action Alternative, which were analyzed in the SRS Salt Processing Alternative SEIS (DOE 2001) and the SRS HLW Tank Closure EIS (DOE 2002).

3.5 Human Health – Accidents and Intentional Destructive Acts

3.5.1 Affected Environment

An accident is a sequence of one or more unplanned events with potential outcomes that endanger the health and safety of workers or the public. An accident can involve a combined release of energy and hazardous substances (radiological or nonradiological) that might cause prompt or latent health effects. The sequence begins with an initiating event, such as human error, equipment failure, or earthquake, followed by a succession of other events that could be dependent or independent of the initial event and that dictate the accident progression and extent of materials released.

In preparing this EA, DOE reviewed the *Concentration, Storage, and Transfer Facilities Documented Safety Analysis* (Tank Farm DSA; WSRC 2017), which provides a detailed analysis of potential accidents that could occur in this area (including Tank 22). Additionally, DOE reviewed previous NEPA analyses of the potential impacts from accidents for similar operations involving the retrieval of waste from the SRS H-Area Tank Farm (DOE 1994, 2001, 2002). Information from the Tank Farm DSA and the previous NEPA analyses form the starting point for the accident analysis in this EA. Sections 3.5.2 through 3.5.4 summarize the impacts to the public and workers from potential accidents associated with the three alternatives for implementing the Proposed Action.

3.5.2 Alternative 1 Impacts

3.5.2.1 Accidents

DOE would retrieve up to 10,000 gallons of DWPF recycle wastewater from Tank 22 and transfer that recycle wastewater to the solidification equipment/container located in a temporary radiological enclosure in proximity to Tank 22. The DWPF recycle wastewater would be extracted from the tank via an available tank penetration riser with a low-volume pump. The suction leg of the pump would enter the riser and end slightly below the surface of the liquid in Tank 22. The pump would discharge into a small-diameter hose-in-hose transfer line (to provide secondary containment) to deliver the DWPF recycle wastewater to the solidification equipment/container located in the temporary radiological enclosure in proximity to Tank 22, thus minimizing the amount of liquid outside the tank at any one time. The enclosure would house the container that would receive DWPF recycle wastewater from Tank 22 and dry feed materials for mixing within the container. Typical cementitious material components (i.e., cement, fly ash, and slag) would be mixed with the DWPF recycle wastewater and cured to a stabilized waste form (i.e., grout).

For this analysis, it is assumed that the DWPF recycle wastewater would be grouted in a 1,200-gallon container and that this container would also serve as the disposal package for the stabilized waste form. Other containers that meet IP-2 or Type A USDOT requirements could also be used. The container would include an internal paddle that would mix the DWPF recycle wastewater and the grout materials; the paddle would remain in the stabilized waste form. A loss of primary containment or incorrect transfer of DWPF recycle wastewater could lead to material release, including leaks, spills, sprays, and overflows (WSRC 2017).

For this EA, the transfer error/waste release design-basis accident (DBA) includes a large number of initiating events and slightly different accident progressions. However, these events are similar in that they could all lead to a release of DWPF recycle wastewater from primary containment. This EA presents the consequences of a transfer error/waste release DBA as well as the risks. The consequence analysis conservatively assumes the accident occurs without regard to the probability of the initiating event. If the consequences of a potential accident are not significant, the risks would be even less significant. Risks, which take into account the probability of an accident occurring, are obtained by multiplying the consequences and the probability. Transfer error/waste release accidents are estimated to have a probability of occurrence of 0.01 to 0.001 per year (WSRC 2017; DOE 2002).

The general progression for all initiators is as follows (derived from WSRC 2017):

1. Core pipe containment is lost, releasing DWPF recycle wastewater.
2. Up to 600 gallons of DWPF recycle wastewater is released to the environment.
3. Workers in proximity of the release are exposed to direct radiation exposure.
4. The off-site exposure time for the release is assumed to be eight hours.
5. The on-site exposure time for the release is assumed to be three hours.

Consequences and Risks. In the Tank Farm DSA, conservative values for the source term (see text box for further discussion) were chosen to ensure a bounding analysis (WSRC 2017). The analysis in this EA shows that the unmitigated and mitigated off-site consequences to the maximally exposed individual (MEI) would be less than or equal to 17 to 28 mrem for the bounding transfer error/waste release DBA scenario (derived from WSRC 2017). These consequences are approximately 1,000 times below the DOE exposure guidelines of 25 rem for a member of the public at the nearest site boundary. Statistically, the MEI's chance of developing an LCF would be 0.00001 to 0.000017. When probability is taken into account, the risk to the MEI of developing an LCF from a transfer error/waste release would be a maximum of 0.0000001 to 0.00000017.

> **SOURCE TERM**
>
> Source term refers to the amount of radiological material released to the environment with a potential for harm to the public and onsite workers. The radiological source term is calculated by the following equation:
>
> Source Term = MAR × ARF × RF × DR × LPF
>
> Where,
>
> - **MAR is Material-at-Risk:** the amount and form of radioactive material at risk of being released to the environment under accident conditions. The material evaluated in the Tank Farm DSA would be the sludge solution expected to occur during tank closure activities, which would contain significantly higher concentrations of radionuclides as compared to DWPF recycle wastewater.
> - **ARF is Airborne Release Fraction:** the fraction of MAR that becomes airborne as a result of the accident.
> - **RF is Respirable Fraction:** the fraction of airborne radioactive material that is small enough to be inhaled by a human.
> - **DR is Damage Ratio:** the fraction of MAR that is damaged in the accident and available for release to the environment.
> - **LPF is Leak Path Factor:** the fraction of respirable radioactive material that has a pathway out of the facility for dispersal in the environment.

Although the Tank Farm DSA did not evaluate consequences to the population within a 50-mile radius of SRS, the SRS HLW Tank Closure EIS (DOE 2002) evaluated these consequences for a similar accident.[17] Based on a 600-gallon transfer error/waste release, the potential dose to the 50-mile population surrounding SRS would be approximately 265 person-rem. Statistically, this means that 0.16 LCF could be expected if such an accident occurred. When probability is taken into account, the risk that an LCF would occur within the 50-mile population from a transfer error/waste release would be a maximum of 0.0016.

With regard to potential on-site impacts, for the transfer error/waste release DBA scenario, the potential consequences to the maximally exposed worker would be less than or equal to 30 to 38 mrem (derived from WSRC 2017). These consequences are well below DOE's administrative control level of 2,000 mrem per year for a worker, and below the SRS contractor's administrative control level of 500 mrem per year. Statistically, the maximally exposed worker's chance of developing an LCF would be 0.000018 to 0.000083. When probability is taken into account, the risk to the maximally exposed worker of developing an LCF from a transfer

[17] The SRS HLW Tank Closure EIS (DOE 2002) evaluated a transfer error/waste release involving 15,600 gallons of tank waste. To correlate those results to the Proposed Action in this EA, the results from DOE (2002) were scaled to account for a 600-gallon release. In addition, the results were scaled to account for the current population surrounding the site. The population impacts in DOE (2002) were based on 620,000 persons; the current population estimate is 781,060 persons.

error/waste release would be a maximum of 0.00000018 to 0.00000083. No more than two workers are likely to receive such a maximum dose. Table 3-10 presents the DBA consequences for Alternative 1.

Table 3-10. Potential Consequences Associated with Transfer Error/Waste Release DBA[a]

MEI Dose (mrem)	MEI LCF	Population Dose (person-rem)	Population LCF	Maximally Exposed Worker (mrem)	Maximally Exposed Worker LCF
17–28	0.00001–0.000017	265	0.16	30–38	0.000018–0.000083

LCF = latent cancer fatality; MEI = maximally exposed individual; mrem = millirem.

a. Risks can be obtained by multiplying these consequences and the accident probability (0.01–0.001).

The disposal of the stabilized waste form at either the WCS or Energy*Solutions* site would not change the accident impacts at those sites compared to their ongoing disposal operations.

3.5.2.2 Intentional Destructive Acts

With regard to intentional destructive acts (i.e., acts of sabotage or terrorism), security at its facilities is a major priority for DOE. Following the terrorist attacks of September 11, 2001, DOE has implemented measures to minimize the risk and consequences of potential terrorist attacks on its facilities and continues to identify and implement measures to defend and deter attacks. The safeguards applied to protecting SRS involve a dynamic process of enhancement to meet threats; these safeguards will evolve over time. DOE maintains a system of regulations, orders, programs, guidance, and training that form the basis for maintaining, updating, and testing site security to preclude and mitigate any postulated terrorist actions.

There is no accepted basis for determining the probability of intentional attacks at any site, or the nature or types of such attacks. In general, the potential consequences of intentional destructive acts are highly dependent on distance to the site boundary and size of the surrounding population—the closer and higher the surrounding population, the higher the consequences. Impacts from intentional destructive acts are also largely based on the amount of material that could be released (i.e., the material at risk) in the event of such an act. The conservative assumptions inherent in the accidents analyzed in this EA assume initiation by natural events, equipment failure, or inadvertent worker actions. These same events could be caused by intentional malevolent acts by saboteurs or terrorists. For example, high explosives could be used to damage buildings in the same way as an earthquake. However, the resulting radiological release and consequences to workers and the public would be similar, regardless of the nature of the initiating event. Therefore, the accident impacts presented for each of the alternatives in this EA are representative of the types of impacts that could result from an intentional destructive act. This is true for all three alternatives.

3.5.3 Alternative 2 Impacts

The potential human health impacts to the public and workers at SRS associated with accidents and intentional destructive acts related to DWPF recycle wastewater retrieval and filling of the transportation packages under Alternative 2 would be bounded by the impacts under

Alternative 1. This conclusion is supported by the fact that only 230 gallons of waste could be released under Alternative 2 versus the 600 gallons per container in Alternative 1.

Stabilization actions are performed regularly at WCS and Energy*Solutions* under their respective licenses. The potential accident impacts from stabilization would not result in any notable increase in human health impacts beyond those already expected from ongoing waste treatment operations, as stabilization of waste is integral to facility operations at those sites. Approximately 400, 55-gallon waste drums would result from the stabilization and would be disposed of at the WCS site or the Energy*Solutions* site. The disposal of stabilized waste form at either the WCS or Energy*Solutions* site would not change the accident impacts at those sites compared to their ongoing disposal operations.

3.5.4 Alternative 3 Impacts

The potential human health impacts to the public and workers at SRS associated with accidents and intentional destructive acts related to DWPF recycle wastewater retrieval and filling of the transportation packages under Alternative 3 would be bounded by the impacts under Alternative 1. This conclusion is supported by the fact that only 230 gallons of waste could be released under Alternative 3 versus the 600 gallons per container in Alternative 1.

Under Alternative 3, the packages would contain DWPF recycle wastewater and are assumed to be transported to the commercial treatment facility for stabilization. Stabilization actions are performed regularly at treatment facilities under their existing environmental permits and licenses. The potential accident impacts from stabilization would not result in any notable increase in human health impacts beyond those already expected from ongoing waste treatment operations, as stabilization of waste is integral to facility operations at these sites. Similar to Alternatives 1 and 2, the disposal of stabilized waste form at WCS or Energy*Solutions* would not result in any notable accident impacts beyond those already expected from their ongoing disposal operations.

3.5.5 No-Action Alternative Impacts

Under the No-Action Alternative, DOE would not conduct the Proposed Action. Instead, the up-to-10,000 gallons of DWPF recycle wastewater would remain in the SRS liquid waste system until disposition occurs using the systems described in Section 2.1.1. Under the No-Action Alternative, DOE would not provide alternative treatment and disposal options for up to 10,000 gallons of DWPF recycle wastewater at an off-site, licensed commercial facility. As a result, the No-Action Alternative would impact planning activities to develop a disposal capability for DWPF recycle wastewater for the three years between the completion of the SWPF mission (estimated 2031) and the DWPF mission (estimated 2034) (SRR 2019), when DOE will no longer have the option of returning DWPF recycle wastewater to the SWPF for processing. The potential accident consequences of the No-Action Alternative would still include the possible transfer error DBA that was analyzed in the SRS HLW Tank Closure EIS (DOE 2002).

3.6 Waste Management

This section presents waste management activities for the Proposed Action and alternatives. This section also describes the management and disposal of the secondary waste streams from the Proposed Action.

Transportation of wastes could include both solid wastes (Alternatives 1 and 3; post-stabilization) and DWPF recycle wastewater (Alternatives 2 and 3; prior to stabilization) and would be conducted using standard, regulated, and approved truck transport of approved packages. Under normal operations, there would be no additional waste generated from these transportation activities. The health impacts associated with the transportation actions are described in Section 3.7.

3.6.1 Affected Environment

3.6.1.1 Savannah River Site

SRS generates and manages the following waste types:

- HLW
- Transuranic (TRU) waste (including mixed TRU waste)
- LLW
- MLLW
- Hazardous waste
- Solid (sanitary) waste

High-Level Radioactive Waste: The *Atomic Energy Act of 1954* and the *Nuclear Waste Policy Act of 1982* define HLW as:

> "(A) the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and
>
> (B) other highly radioactive material that the [Nuclear Regulatory] Commission, consistent with existing law, determines by rule requires permanent isolation."

In an October 10, 2018, *Federal Register* notice (83 FR 50909) and a June 10, 2019, supplemental notice (84 FR 26835), DOE issued its interpretation that the HLW definition means that some reprocessing waste may properly be classified as non-HLW "where the radiological characteristics of the waste in combination with appropriate disposal facility requirements for safe disposal demonstrate that disposal of such waste is fully protective of human health and the environment." Specifically, it is DOE's interpretation that a reprocessing waste may be determined to be non-HLW if the waste meets either of the following two criteria (from 84 FR 26835):

> "(I) does not exceed concentration limits for Class-C low-level radioactive waste as set out in section 61.55 of title 10, Code of Federal Regulations, and meets the performance objectives of a disposal facility; or
>
> (II) does not require disposal in a deep geologic repository and meets the performance objectives of a disposal facility as demonstrated through a performance assessment conducted in accordance with applicable requirements."

As described in Section 2.1.1 of this EA, under the Proposed Action, up to 10,000 gallons of DWPF recycle wastewater would be retrieved from the SRS liquid waste system, and DOE would dispose of the stabilized waste at a commercial LLW facility outside of South Carolina, licensed by either the NRC or an Agreement State under 10 CFR Part 61. Prior to a disposal decision, DOE would characterize the DWPF recycle wastewater to verify with the licensee of the commercial LLW disposal facility whether the waste meets DOE's HLW interpretation for disposal as non-HLW. No HLW is expected to be generated as a result of the Proposed Action or alternatives.

Transuranic Waste: DOE defines TRU as radioactive waste containing more than 100 nanocuries (3,700 Becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for: (1) HLW; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the EPA, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; or (3) waste that the NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61. TRU waste generated at SRS typically consists of items with trace amounts of plutonium, such as clothing, tools, rags, residues, and debris. SRS packages its TRU waste for transport to WIPP near Carlsbad, New Mexico, for disposal. WIPP is DOE's deep geologic repository established for permanent disposal of TRU waste and was established under the *WIPP Land Withdrawal Act* (Public Law 102-579). No TRU waste is expected to be generated as a result of the Proposed Action or alternatives.

Low-Level Radioactive Waste: DOE defines LLW as radioactive waste that is not HLW, SNF, TRU waste, byproduct material (as defined in Section 11e.(2) of the *Atomic Energy Act of 1954*, as amended), or naturally occurring radioactive material. At SRS, LLW produced by most generators typically consists of such items as miscellaneous job control waste, equipment, plastic sheeting, gloves, and soils that are contaminated with radioactive materials. The LLW category also includes several waste streams from large-scale waste management operations. Miscellaneous job control waste incidental to the DWPF recycle wastewater stream could include personal protective equipment (e.g., gloves, booties) and is expected to be generated as a result of the Proposed Action. These waste quantities would be negligible compared with existing LLW quantities generated by existing operations at SRS and would be disposed of in existing facilities in E Area.

Based on recent Tank 22 sample data (see Appendix A to this EA), DOE has a reasonable basis to anticipate that the DWPF recycle wastewater will meet the first criterion of the HLW interpretation. As such, the DWPF recycle wastewater could be managed and disposed of in a commercial LLW facility. At the time of implementing any of the alternatives, additional characterization would be performed to confirm compliance with the first criterion and that disposal facility requirements are met.

The SRS Solid Waste Management (SWM) group is responsible for receiving LLW from site generators and, in some cases, from off-site generators, primarily the Naval Reactors Program. SWM is also responsible for verifying the waste received is as characterized by the generator and that the waste meets the receiving facility's WAC. In most cases, newly generated LLW accepted by SWM is taken directly to one of the disposal units shown in Table 3-11. In general, trenches are opened as needed, and there could be more than one trench of a single type open at any given time. Over the five-year period from fiscal year (FY) 2011 through FY 2015, LLW managed by the SRS SWM group averaged about 19,000 cubic yards per year (SRNS 2016b, p. 14). In addition to the solid LLW Disposal Units listed in Table 3-11, SRS also operates Saltstone Disposal Units, which are permanent disposal units, to contain solidified (grouted) liquid LLW at SRS. A total of 13 Saltstone Disposal Units are planned, ranging in size from approximately 2.8 million gallons of grout capacity to 32 million gallons of grout capacity (SRR 2019).

Table 3-11. Types of Solid LLW Disposal Units Used at SRS

Disposal Unit Type	Typical Capacity per Unit[a]	Description
Engineered trenches	Total: 61,200 yd^3 Effective: 46,200 yd^3	Used primarily for disposal of LLW in B-12 and B-25 boxes and sealands. Once full, it is backfilled and covered with a minimum of four feet of clean soil.
Slit trenches	Total: 37,800 yd^3 per set of five segments Effective: 21,500 yd^3 per set of five segments	Designated for construction/decontamination and decommissioning debris, contaminated vegetation, and contaminated soil disposal. Once full, it is backfilled and covered with a minimum of four feet of clean soil.
Component-In-Grout trenches	Total: 21,600 yd^3 Effective: 8,500 yd^3	Similar to slit trenches, but once waste components are in place, they are encapsulated in grout. Used to dispose of bulky and containerized LLW that has higher radioactive inventories than LLW going to standard slit trenches.
Low-activity waste vault	Total: 40,000 yd^3	The at-grade concrete structure's capacity is equivalent to about 12,000 B-25 boxes. It is designed to receive, store, and dispose of LLW radiating less than or equal to 200 mrem per hour at five centimeters from the box surface.
Intermediate level vault	Total: 5,600 yd^3	Subsurface concrete structure designed for LLW that radiates greater than 200 mrem per hour at five centimeters from the unshielded container, or LLW that contains significant amounts of tritium. The vault has a removable cover to allow top loading, and the cells are encapsulated with grout as the waste is placed for disposal.
Naval reactor component disposal area	Total: 4,400 yd^3	At-grade laydown area designed for permanent disposal of activated metal or surface-contaminated Naval reactor program components (e.g., care barrels, adapter flanges, closure heads, and pumps). There are two Naval reactor component disposal areas, each with capacity shown, but one has been closed to further component placement.

yd^3 = cubic yard

a. Typical trench capacities are presented with two values: total and effective. The "total" value represents the typical design size of the trench, and the "effective" value represents an approximate value for the maximum volume of waste and waste containers that can be disposed of in the trench.

Source: SRNS 2016b, pp. 21–25

Mixed LLW: MLLW is LLW that contains source, special nuclear, or byproduct material subject to the *Atomic Energy Act of 1954*, as amended, and a hazardous component subject to RCRA. MLLW is generated by various SRS activities and operations, including environmental cleanup, decontamination and decommissioning, and construction. This waste typically includes materials such as solvent-contaminated wipes, cleanup and construction debris, soils from spill remediation, RCRA metals, and laboratory samples. MLLW is sent off-site to RCRA-regulated treatment, storage, and disposal facilities, such as those operated by WCS or Energy*Solutions*, but may first be held in one of several SRS on-site storage facilities that have the necessary permits to accept the waste. One of the permitted storage sites for both MLLW and hazardous waste is a section of the TRU storage pads, which has a storage capacity of 390 cubic yards.

Over the five-year period from FY 2011 through FY 2015, MLLW managed by the SRS SWM group averaged about 210 cubic yards per year (DOE 2015a, p. 3-51). No MLLW waste is expected to be generated as a result of the Proposed Action or alternatives.

Hazardous Waste: Hazardous waste is generated by multiple SRS activities and operations, including those noted above for MLLW. Typical hazardous waste at SRS includes materials such as RCRA metals, solvents, paints, pesticides, and hydrocarbons. Polychlorinated biphenyl (PCB) wastes, though regulated under the *Toxic Substances Control Act* rather than RCRA, are managed under the hazardous waste program. As with MLLW, hazardous waste is generally sent off-site to commercial RCRA-regulated treatment, storage, and disposal facilities, but may first be held in one of several SRS on-site storage facilities that have the necessary permits to accept the waste. Certain hazardous wastes are recycled, including metals, excess chemicals, solvent, and chlorofluorocarbons. PCB wastes are generally sent off-site for commercial treatment and disposal, but some meet regulatory standards to be disposed of in the local Three Rivers Landfill.

Over the five-year period from FY 2011 through FY 2015, hazardous waste managed by the SRS SWM group averaged about 52 cubic yards per year (SRNS 2016b, p. 14). No hazardous waste is expected to be generated as a result of the Proposed Action or alternatives.

Solid (sanitary) Waste: Solid waste refers to waste that is neither hazardous nor radioactive and consists of two categories: (1) municipal and (2) construction and demolition. Municipal-type waste is generally referred to as sanitary waste on the SRS and is commonly disposed of in municipal sanitary landfills. Construction and demolition waste consists of bulky debris- and rubble-type waste. No substantial quantities of solid waste are expected to be generated as a result of the Proposed Action or alternatives.

3.6.1.2 Waste Control Specialists

WCS is licensed by the Texas Commission on Environmental Quality for the disposal of Class A, B, and C LLW that meets specified WAC. Disposal of the stabilized waste at the WCS Federal Waste Facility (FWF) would be conducted in accordance with the facility’s operating license (Radioactive Material License No. CN600616890/RN101702439).

The FWF opened on June 6, 2013, and has a current licensed capacity of up to 26,000,000 cubic feet and 5,600,000 curies. The FWF footprint that has been evaluated as part of the current license is approximately 80 acres. The design and license allow the disposal facility to be developed in phases consistent with the need to dispose of the volume of LLW received. Additional phases of the disposal facility will be constructed as needed and within the licensed capacity requirements. The 10,000 gallons of DWPF recycle wastewater would represent approximately 2,700 cubic feet of stabilized waste, or 0.01 percent of the WCS licensed capacity.

3.6.1.3 Energy*Solutions*

Energy*Solutions* operates a LLW disposal facility west of the Cedar Mountains in Clive, Utah. Clive is located along Interstate-80, approximately 60 miles west of Salt Lake City, Utah. The facility is accessed by both road and rail transportation. The Clive LLW disposal facility is licensed by the Utah Department of Environmental Quality for the disposal of Class A LLW that meets specified WAC. Disposal of the stabilized waste at the Energy*Solutions* site would be conducted in accordance with the facility's operating license (Radioactive Material License No. UT 2300249). The currently licensed waste disposal capacity is about 5.04 million cubic yards (136 million cubic feet). The 10,000 gallons of DWPF recycle wastewater would represent approximately 2,700 cubic feet of stabilized waste, or 0.002 percent of the Energy*Solutions* licensed capacity.

3.6.2 Alternative 1 Impacts

The retrieval and stabilization of up to 10,000 gallons of DWPF recycle wastewater would produce an estimated 17 IP-2 containers of stabilized waste form, which would be expected to meet the disposal criteria for LLW as defined in 10 CFR 61.55.

The actions at SRS would generate standard job control waste that would include items such as personal protective equipment (e.g., gloves, booties), the in-tank pump and hose, and the temporary radiological enclosure. This job control waste would be classified as LLW and would be disposed of on site in E Area. These waste quantities (probably less than 10 cubic yards) would be negligible compared with LLW quantities generated by existing operations at SRS.

The transport of the stabilized waste form to WCS or Energy*Solutions* would not generate any additional waste quantities.

Based on recent sampling data (presented in Appendix A to this EA), DOE has a reasonable basis to anticipate that this waste will meet the first criterion of the HLW interpretation. At the time of implementing any of the alternatives, additional characterization would be performed to confirm compliance with the first criterion and that disposal facility requirements are met.

After verification that the final, stabilized waste form met the WAC for the particular disposal facility, these containers would be transported to either WCS or Energy*Solutions* for disposal. The wastes would only be accepted for disposal if their volume and radiological and hazardous constituents fell within the bounds of the facilities' existing licenses. As a result, the LLW would result in negligible waste management impacts for the disposal facilities.

3.6.3 Alternative 2 Impacts

The waste management impacts at SRS for Alternative 2 would be similar to those for Alternative 1. Alternative 2 would not include the stabilization actions at SRS, so there could be slightly less job control waste associated with this alternative produced at SRS, however, there would still be personal protective equipment, pumps and hoses, and a temporary radiological enclosure that would require disposal as LLW on site in E Area. These waste quantities would be negligible compared with LLW quantities generated by existing operations at SRS.

The transport of the DWPF recycle wastewater to WCS or Energy*Solutions* would not generate any additional waste quantities.

The stabilization of the liquid at either WCS or Energy*Solutions* would be within the facilities' existing licenses for these actions and would not generate additional waste types beyond those already expected and associated with their licenses. The wastes would only be accepted for treatment and disposal if their volume and radiological and hazardous constituents fell within the bounds of the facility's existing licenses. As a result, the LLW would result in negligible waste management impacts for the disposal facilities.

3.6.4 Alternative 3 Impacts

The waste management impacts at SRS for Alternative 3 would be identical to those for Alternative 2.

The transport of the DWPF recycle wastewater to a commercial treatment facility would not generate any additional waste quantities.

The stabilization of the DWPF recycle wastewater at a commercial treatment facility would be within the facility's existing environmental permits and/or license for these actions and would not generate additional waste types beyond those already expected and associated with the license.

The transport of the stabilized waste form to WCS or Energy*Solutions* would not generate any additional waste quantities.

The stabilized wastes would only be accepted for disposal at WCS or Energy*Solutions* if their volume and radiological and hazardous constituents fell within the bounds of the facilities' existing licenses. As a result, the LLW would result in negligible waste management impacts for the disposal facilities.

3.6.5 No-Action Alternative Impacts

Under the No-Action Alternative, DOE would not conduct the Proposed Action. Instead, DOE would maintain the status quo, which is represented by the continued management of tank wastes and eventual closure of the tanks in accordance with the 2001 ROD to the SRS Salt Processing Alternatives SEIS (DOE 2001) and as addressed in the SRS HLW Tank Closure EIS (DOE 2002). Waste management would continue as planned by the System Plan (SRR 2019). Under the No-Action Alternative, DOE would not provide alternative treatment and disposal options for up to 10,000 gallons of DWPF recycle wastewater at an off-site, licensed commercial facility. As a result, the No-Action Alternative would impact planning activities to develop a disposal capability for DWPF recycle wastewater for the three years between the completion of the SWPF mission (estimated 2031) and the DWPF mission (estimated 2034) (SRR 2019), when DOE will no longer have the option of returning DWPF recycle wastewater to the SWPF for processing.

3.7 Radiological Transportation

3.7.1 Affected Environment

Transportation of LLW is strictly regulated. USDOT regulates packaging, labeling, preparation of shipping papers, handling, marking, and placarding of shipments and establishes standards for personnel as well as conveyance (e.g., truck and train) performance and maintenance (49 CFR 173.401). USDOT and the NRC set radioactive material packaging standards (10 CFR Part 71). In addition, in accordance with DOE Order 460.2A, DOE LLW shipments must comply with all internal DOE requirements.

Proper packaging is a key element in transport safety. LLW must be packaged to protect workers, the public, and the environment during transport. Often, the same package is used for both transport and disposal. This would be the case for Alternative 1, which would use an IP-2 or Type A package for transportation and disposal. Selection of appropriate packaging is based on the level and form of radioactivity. The expected level of radioactivity from the Proposed Action and alternatives would be consistent and no more than that allowed under the regulatory limits associated with the chosen package (i.e., IP-2, Type A, or Type B). For incident-free transportation, the potential radiological exposure of workers and the public is directly related to the external dose rates associated with the LLW packages.

Under the Proposed Action, the liquid DWPF recycle wastewater or stabilized waste form would be transported by truck. Vehicle and loads would be inspected by DOE and State inspectors (where required) before shipment. States may also inspect shipments to confirm regulatory compliance. The shipments would use the most direct routes that minimize radiological risk. As shown in Figure 3-1, the DWPF recycle wastewater or stabilized waste form shipments would be transported over Federal highways for the majority of the route.

Data from the Federal Motor Carrier Safety Administration (FMCSA) for 2017 indicate that large trucks are involved in 35.9 accidents per 100 million miles traveled (FMCSA 2019). From 2001 to 2010, USDOT reported 75 transportation-related radioactive waste incidents, or seven to eight per year. No transportation incident resulted in radiation exposure (WCS 2019). In the event an accident involving a shipment of LLW occurs, a response system is in place. DOE supports training and emergency planning through its Transportation Emergency Preparedness Program. State, Tribal, and local government officials respond to any such accident within their jurisdictions. DOE also responds to transport emergencies at the request of States and Tribes. Radiological assistance program teams are available to provide field monitoring, sampling, decontamination, communications, and other related services.

Figure 3-1. Federal Highway System with Approximate Locations of the Savannah River Site; Energy*Solutions* near Clive, Utah; WCS near Andrews, Texas; and Richland, Washington

*DOE has existing basic ordering agreements with a variety of commercial companies that have treatment facilities located across the United States. These basic ordering agreements can be found at: https://www.emcbc.doe.gov/About/PrimeContracts. The commercial treatment facility in Richland, Washington, is analyzed solely for the purposes of providing an upper bound estimate of the potential transportation impacts.

3.7.2 Alternative 1 Impacts

The nine shipments that each contain two IP-2 packages loaded with stabilized waste form would be shipped from SRS to WCS (approximately 1,400 miles) or to Energy*Solutions* (approximately 2,200 miles). The packages (49 CFR 178.350) would meet all appropriate USDOT requirements for the transport of the stabilized waste to an off-site disposal facility, in accordance with 49 CFR Subchapter C, "Hazardous Materials Regulations." In 2017, DOE conducted 7,700 radioactive waste and materials shipments, traveling more than 2.6 million miles, with no USDOT recordable accidents (DOE 2018b). The impacts of transporting LLW have been analyzed in numerous NEPA documents. The WM PEIS (DOE 1997) includes a comprehensive analysis of LLW transportation impacts.

The WM PEIS found that transporting the large volumes of LLW analyzed in the WM PEIS has the potential to affect the health of the truck crew and the public along the transportation route. These health effects include both radiological and nonradiological impacts. The radiological impacts are the result of radiation received during normal operations and accidents in which the waste containers are assumed to fail. Nonradiological impacts could occur as a result of exposure to vehicle exhaust and physical injury from vehicle accidents. In the WM PEIS, DOE determined that the impacts of transporting approximately 25,000 shipments of LLW (over a distance of approximately nine million miles) would be as follows (DOE 1997, Section 7.4.2):

- Less than 0.5 fatality from radiological doses to either the truck crews or the public along the transportation route;[18]
- Less than 0.5 fatality from vehicle emissions; and
- One fatality resulting from physical injuries from traffic accidents.

Consistent with the CEQ's instruction to discuss potential impacts "in proportion to their significance" (40 CFR 1502.2[b]), DOE determines the appropriate level of detail of impact analysis, including transportation impact analysis, on a case-by-case basis. This determination is based on the nature of the proposed action and alternatives and the potential significance of potential impacts as discussed in 40 CFR 1508.27.

DOE analyses have consistently shown that the impacts of the transportation of radioactive materials are generally small and often overwhelmed by the nonradiological impacts of that same transportation. For DOE actions where only minimal impacts are expected from the transportation of radioactive materials, completely new quantitative analysis may not be necessary to assess the potential impacts of transporting radioactive materials or waste. Instead, DOE may use a simple screening analysis with appropriately conservative estimates to identify an upper bound on potential impacts, show whether potential impacts would be significant, and determine the need for further analysis.

Similar analyses (e.g., similar material, packaging, start points, and end points) may be incorporated by reference (40 CFR 1502.21) and used to develop an estimate for use in a

[18] The WM PEIS (DOE 1997) analyses reflect a lower dose-to-LCF risk factor than DOE uses today. The updated factor reflects an increase of approximately 20 percent over the impacts calculated in 1997.

screening analysis. Combining aspects of previously existing analysis and new analysis can help reduce duplicative effort and paperwork (40 CFR 1506.4).

The results of this screening approach can be used to determine if more substantial analysis is necessary. If the results of this analysis show that the potential risk is small or non-existent, further analysis may not be helpful to decision-makers or the public. In such cases, DOE may include a negative declaration of significant impact, accompanied by a brief explanation of the methodology and sources relied upon in arriving at conclusions regarding potential risks (see 40 CFR 1502.24).

Considering the potential impacts identified in the WM PEIS to the public along the route for 25,000 shipments of LLW, the potential incident-free impacts to the public from nine shipments under Alternative 1 in this EA would be negligible. The majority of the potential incident-free transportation-related impacts to health and safety would be borne by the workers involved in the transportation activities.

The incident-free analysis summarized in Table E-5 of the WM PEIS assumed an external dose rate from LLW packages of one mrem per hour at 3.3 feet. The driver and backup driver (i.e., crew) would be the closest workers to the package for any substantial length of time during the transport. Dose rate intensity decreases as a function of increased distance from the source. The ratio of dose rate intensity decreases by the square of the ratio of the increased distance. For instance, if the crew is about 10 feet from the package on the bed of the truck, the expected dose rate to the crew from that package would be 1/9th (11 percent) of the dose rate at 3.3 feet. Therefore, the expected dose rate to the crew would be approximately 0.11 mrem per hour during the time of transport from SRS to the disposal facility. This is still a conservative assumption because it takes no credit for any shielding, such as that provided by the truck cab, between the package and the crew.[19]

Assuming the farthest distance from SRS (2,200 miles to Clive, Utah), the analysis assumes a 44-hour duration per shipment and that a crew of two would conduct all nine trips over the life of the project. The total worker dose to a driver for a single shipment would be 4.84 mrem. The total crew dose for the nine trips would be approximately 0.087 person-rem for Alternative 1. The potential for an LCF associated with this level of radiation exposure is 0.000052.

With respect to accidents, per FMCSA statistics (FMCSA 2019), the probability that a crash would occur during the 19,800 miles (2,200 miles times nine trips) would be about one chance in 140. Since the WM PEIS determined that one nonradiological fatality could occur as a result of LLW shipments of approximately nine million miles, there would be less than 0.25-percent chance of a traffic fatality associated with Alternative 1. In the event an accident did occur, release of radiological material also would be unlikely. IP-2 and Type A packages must pass various tests, and only one percent of those involved in accidents have failed; of those, only 39 percent have released their contents (NRC 2003). Additional data from the International Atomic Energy Agency indicate that Type A packages perform well in many accident conditions. Combining event data from the United States and the United Kingdom over a period of about 20

[19] Even if the potential dose rate to the driver and crew approached the USDOT limit, DOE would have options to limit worker exposure (e.g., move the packages closer to the rear of the truck bed or add temporary shielding).

years identified information on 22 accidents involving consignments of multiple Type A packages on a single conveyance. There was a release of radioactive contents in only two of these events, and those releases were small (IAEA 2012, p. 52). In the very unlikely event the IP-2 or Type A container failed, the contents would be a stabilized waste form that would not be dispersible. Because the stabilized waste is not dispersible, impacts to water and ecological resources would also be unlikely. Consistent with the studies of LLW transportation impacts by DOE (DOE 1997), the transportation of the stabilized LLW in an IP-2 or Type A package would result in negligible impacts.

3.7.3 Alternative 2 Impacts

For Alternative 2, the transportation of liquid DWPF recycle wastewater would involve 15 truck shipments. Much of the same information provided in Section 3.7.2 for Alternative 1 impacts applies to the shipment of DWPF recycle wastewater for Alternative 2.

The 15 shipments loaded with liquid DWPF recycle wastewater would be shipped from SRS to WCS (approximately 1,400 miles) or to Energy*Solutions* (approximately 2,200 miles) under Alternative 2. The packages would be demonstrated suitable for transportation of the specific waste forms in accordance with USDOT requirements.

Considering the potential impacts identified in the WM PEIS to the public along the route for 25,000 shipments of LLW, the potential incident-free impacts to the public from 15 shipments under Alternative 2 in this EA would be negligible. The majority of the potential incident-free transportation-related impacts to health and safety would be borne by the workers involved in the transportation activities.

The potential dose rate to workers (the crew) from transportation of the packages to the farthest distance (Clive, Utah) would be similar to that described for Alternative 1; however, for Alternative 2, there would be 15 shipments instead of 9. Under Alternative 2, each trip is also assumed to take 44 hours. The total worker dose to a single driver for a single shipment would be 4.84 mrem. The total crew dose for the 15 trips would be approximately 0.145 person-rem for Alternative 2. The potential for an LCF for this level of radiation exposure to anyone on the crew associated with the transportation is 0.000088.

With respect to accidents, according to FMCSA (2019), the probability that a crash would occur during the 33,000 miles (2,200 miles times 15 trips) would be about one chance in 84. Since the WM PEIS determined that one nonradiological fatality could occur as a result of LLW shipments of approximately nine million miles, there would be less than 0.4-percent chance of a traffic fatality associated with Alternative 2. In the event an accident did occur, the probability of a release of radiological material also would be extremely unlikely.

As reported in Section 2.1.3.2, based on recent Tank 22 sample data (see Appendix A to this EA), DWPF recycle wastewater would likely meet the USDOT requirements for transportation in a Type A liquid package. Type A packagings for liquid must pass more stringent tests than IP-2 or Type A packagings for solids. Specifically, for liquid Type A packagings, USDOT requires a free-drop test from a height of at least 30 feet and a penetration test from a distance of at least 5.5 feet. Non-liquid Type A packagings require a drop test from a height of 1 to 4 feet and penetration test from a distance of 3.3 feet. When evaluated against these tests and other requirements for Type A packagings, the packaging will prevent loss or dispersal of radioactive contents (49 CFR Part 173).

Additionally, IAEA (2012, p. 273) reports that the radionuclide activity limits (A_1 and A_2) found in 49 CFR Part 173 were developed to ensure that members of the public or first responders to an accident involving a transportation container would not be subject to radiological exposures that would result in impacts greater than five rem, which corresponds to the annual exposure limit for radiation workers. The accident scenario that formed the basis of the activity limits assumed that an exposed person was within one meter of the release for 30 minutes, which is highly unlikely.

Appendix B to this DWPF Recycle Wastewater EA provides a detailed evaluation of a potential transportation accident scenario associated with a shipment of liquid DWPF recycle wastewater in a Type A package. DOE performed a conservative analysis to estimate the potential impacts that could occur from the release and aerosolization of the entire contents of a Type A package of liquid DWPF recycle wastewater to the atmosphere (exposure to downwind receptors) in the event of a maximum reasonably foreseeable accident during transport. The severe accident considered in this consequence assessment is characterized by extreme mechanical (impact) and thermal (fire) forces. Appendix B (Table B-2) lists the estimated population exposure doses and LCF risks over the short and long term under neutral and stable weather conditions for generic rural, suburban, and urban population zones. The highest estimated radiological dose, for a hypothetical accident in an urban area under stable weather conditions, was reported as 143 mrem (0.00009 LCF) for the maximally exposed individual, and 5,260 person-rem (3.2 LCFs).

Accidents of this severity are expected to be extremely rare. The release of a Type A container’s entire contents is estimated to occur approximately 0.4 percent of the time given that a truck accident does occur (NRC 1977), with about a 10-percent release of its contents estimated 1.6 percent of the time given that a truck accident does occur (NRC 1977). Incorporating the frequency of a truck accident during the shipments of liquid DWPF recycle wastewater under Alternative 2 (one chance in 84, or 0.012), the probability that a severe accident causes the release of all of a container’s contents would be approximately 0.0000476, or one in 21,000. Appendix B (Table B-3) also presents the population risk of contracting a fatal cancer when both the consequence and probability of a maximum reasonably foreseeable accident are considered using conservative assumptions (e.g., urban environment). For Alternative 2, the risk is approximately 0.000152.

In the event final characterization of the DWPF recycle wastewater indicates Type B packaging would be required, liquid DWPF recycle wastewater shipments under Alternative 2 would be in a Type B package. Type B packages must pass more stringent tests than IP-2 or Type A packages and are expected to survive accident conditions without losing their integrity. Type B packages are strictly designed to contain their contents under accident as well as non-accident conditions. Type B packaging must withstand severe puncture, drop, thermal, and water immersion tests simulating transportation accident conditions (FEMA 2013). While the consequence of release from a Type B package would be similar to that of a release from a Type A package, these additional requirements mean that the probability of release, and thus overall risk, would be lower.

3.7.4 Alternative 3 Impacts

For Alternative 3, the transportation of liquid DWPF recycle wastewater would involve 15 truck shipments from SRS to a commercial treatment facility and 15 truck shipments of the treated (stabilized) DWPF recycle wastewater from the commercial treatment facility to the commercial disposal facility. Much of the same information provided in Section 3.7.2 for Alternative 1 and Section 3.7.3 for Alternative 2 impacts applies to the transportation activities for Alternative 3. The packages would be demonstrated suitable for transportation of the specific waste forms in accordance with USDOT requirements.

3.7.4.1 Liquid DWPF Recycle Wastewater Shipments from SRS to Commercial Treatment Facility

The 15 shipments loaded with liquid DWPF recycle wastewater are assumed to be shipped from SRS to a commercial treatment facility (assumed to be in Richland, Washington, approximately 2,655 miles) for Alternative 3. As stated in Section 2.1.4.2 of this EA, the assumption of waste treatment occurring in Richland results in a bounding estimate for potential transportation impacts, such that if DOE were to use a commercial treatment facility less than 2,655 miles away, the transportation impacts likewise would be less than presented in this EA. Considering the potential impacts identified in the WM PEIS to the public along the route for 25,000 shipments of LLW, the potential incident-free impacts to the public from 15 shipments under Alternative 3 in this EA would be negligible. The majority of the potential incident-free transportation-related impacts to health and safety would be borne by the workers involved in the transportation activities.

The potential dose rate to workers (the crew) from transportation of the packages to the commercial treatment facility would be similar to Alternative 1; however, for Alternative 3 there would be 15 shipments instead of nine, and the shipments would be longer. Under Alternative 3, each trip is assumed to take about 53 hours. The total worker dose to a single driver for a single shipment to the commercial treatment facility would be 5.83 mrem. The total crew dose for the 15 trips would be approximately 0.175 person-rem for the first portion of the transportation for Alternative 3. With respect to accidents, according to FMCSA (2019), the probability that a crash would occur during the 39,825 miles (2,655 miles times 15 trips) to the commercial treatment facility would be about one chance in 70. Since the WM PEIS determined that one nonradiological fatality could occur as a result of LLW shipments of approximately 9 million miles, there would be less than 0.45-percent chance of a traffic fatality associated with the shipment of DWPF recycle wastewater in Alternative 3. In the event a severe accident did occur, the consequences of a release of radioactive material would be similar to those identified for Alternative 2 in Section 3.7.3 and further described in Appendix B. The probability of a severe accident involving liquid DWPF recycle wastewater under Alternative 3 would be slightly different than under Alternative 2. Incorporating the frequency of a truck accident during the shipments of liquid DWPF recycle wastewater under Alternative 3 (one chance in 70, or 0.014), the probability that a severe accident causes the release of all of a container’s contents would be approximately 0.0000571, or one in 18,000. The population risk of contracting a fatal cancer when both the consequence and probability of a maximum reasonably foreseeable accident are considered using conservative assumptions (e.g., urban environment) for Alternative 3, is approximately 0.000183.

3.7.4.2 Treated (Stabilized) DWPF Recycle Wastewater Shipments from the Commercial Treatment Facility to the Commercial Disposal Facility

After the DWPF recycle wastewater was stabilized at the commercial treatment facility, it would be shipped to either WCS (1,475 miles per shipment) or Energy*Solutions* (644 miles per shipment) for disposal. As identified in Section 2.1.4.3 of this EA, Alternative 3 would require 15 shipments from the commercial treatment facility to the disposal facility. Each shipment is assumed to contain 26, 55-gallon containers. Using the farthest distance for analytical conservatism, the 15 shipments to WCS would result in a total shipment distance of 22,145 miles. Each trip is assumed to take approximately 30 hours. The total worker dose to a driver for a single shipment would be 3.3 mrem. The total crew dose for the 15 trips would be approximately 0.099 person-rem for the second portion of the transportation for Alternative 3. The total worker impacts associated with Alternative 3 would be the combination of the impacts of transporting the DWPF recycle wastewater to the commercial treatment facility and the drums of the stabilized waste form from the commercial treatment facility to the disposal facility. These totals are provided in Table 3-12 as a comparison to the potential impacts of the other alternatives. With respect to accidents during the shipment of the stabilized waste form between treatment facility and disposal facility under Alternative 3, according to FMCSA (2019), the probability that a crash would occur in the 22,145 miles to the disposal facility would be about one chance in 126. Since the WM PEIS determined that one nonradiological fatality could occur as a result of LLW shipments of approximately nine million miles, there would be less than 0.25-percent chance of a traffic fatality associated with the stabilized waste form associated under Alternative 3. In the event an accident did occur, the probability of a release of radiological material also would be unlikely, as described in Alternative 1. Consistent with the studies of LLW transportation impacts in DOE (1997), the transportation of the stabilized LLW in an IP-2 or Type A package would result in negligible impacts.

3.7.5 Summary of Potential Transportation-Related Impacts for Alternatives 1–3

The potential incident-free impacts to the public from shipments under Alternatives 1, 2, and 3 in this EA would be negligible. Table 3-12 summarizes the potential transportation-related impacts for workers for Alternatives 1, 2, and 3. Table 3-13 summarizes the potential transportation accident-related impacts for Alternatives 1, 2, and 3.

Table 3-12. Potential Transportation-Related Impacts to Workers

Alternative	Waste Form Transported	Driver Dose per Shipment (mrem)	Total Worker Dose (person-rem)	Total Worker LCF Risk
1	Solid	4.84	0.087	0.000052
2	Liquid	4.84	0.145	0.000088
3[a]	Liquid (from SRS to commercial treatment)	5.83	0.175	0.00011
	Solid (from commercial treatment to commercial disposal)	3.3	0.099	0.000059
	Total Alternative 3	N/A[b]	0.274	0.000169

LCF = latent cancer fatality; N/A = not applicable.

a. Alternative 3 is subdivided to illustrate the shipment of liquid waste from SRS to a permitted and/or licensed treatment facility and the shipment of the stabilized waste form from the licensed treatment facility to a LLW disposal facility.

b. It would be very unlikely that the same driver would transport both the liquid waste from SRS to the commercial treatment facility and the stabilized waste form from the commercial treatment facility to the disposal facility. Therefore the "per shipment" entries are "not applicable." All of the crew doses for all shipments are included in the total worker dose column.

Table 3-13. Potential Transportation-Related Impacts to the Population from Severe Transportation Accident[a]

Alternative	Dose	Consequence[a]	Probability[b]	Risk[c]
1	Liquid waste shipments would not occur. The stabilized waste form would not be dispersible.			
2	5,260 person-rem	3.2 LCF	0.0000476	0.000152 LCF
3	5,260 person-rem	3.2 LCF	0.0000571	0.000183 LCF

LCF = latent cancer fatality.

a. For purposes of analysis, the dose, long-term consequence, probability, and risk values are based on the conservative assumption that the accident occurs in an urban environment under stable weather conditions.

b. Calculated by multiplying the probability that a crash would occur during transport—one chance in 84 for Alternative 2 during the 33,000 miles traveled (2,200 miles times 15 trips) and one chance in 70 for Alternative 3 during the 39,825 miles traveled (2,655 miles times 15 trips) (FMCSA 2019)—by the probability of 0.4 percent (NRC 1977) that the entire contents of a Type A container would be released during the truck accident.

c. Risk equals consequence times probability.

3.7.6 No-Action Alternative Impacts

Under the No-Action Alternative, DOE would not conduct the Proposed Action. Instead, DOE would maintain the status quo, which is represented by the continued management of tank wastes and eventual closure of the tanks in accordance with the System Plan (SRR 2019), the 2001 ROD for the SRS Salt Processing Alternatives SEIS (DOE 2001), and the SRS HLW Tank Closure EIS (DOE 2002). There would not be any off-site radiological transportation associated with the No-Action Alternative.

4 CUMULATIVE IMPACTS

This chapter presents an analysis of the potential cumulative impacts resulting from the Proposed Action evaluated in this EA. CEQ regulations at 40 CFR 1508.7 define cumulative impacts as "the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

4.1 Incremental Impacts of Proposed Action

As noted in Chapter 3 of this EA, the implementation of the Proposed Action has some potential for impacts in air quality, human health (under both normal operations and facility accident conditions), waste management, and radiological transportation. These potential impacts, however, were demonstrated to be minor.

4.2 Evaluation of Past, Present, and Reasonably Foreseeable Future Actions

As part of the analysis of cumulative impacts for this EA, DOE considered both the timing and the region of influence for each environmental resource area that could be affected by implementation of the Proposed Action. The timing considered for the implementation of the proposal is within several years after a decision to move forward. This EA focuses on SRS. The other areas involving the Proposed Action include the national highway system for transporting from 9 to 15 truck shipments and the area surrounding WCS and Energy*Solutions* LLW disposal facilities near Andrews, Texas, and Clive, Utah, respectively. The Proposed Action would have a miniscule,[20] incremental impact on total radioactive material shipments on the national highway system; therefore, a detailed cumulative impacts analysis of radiological transportation is not warranted. Additionally, since the stabilized LLW would only be accepted at WCS or Energy*Solutions* if its volume and radiological characteristics were demonstrably within the WAC and allowable volumes, the waste would be consistent with other wastes accepted by the facilities. There would be no incremental impact to be evaluated.

The reasonably foreseeable actions identified for consideration in this EA include:

- Continued closure of waste tanks at SRS,
- Proposed plutonium pit production at SRS,
- Potential processing of surplus plutonium at SRS,
- Potential acceptance of SNF from foreign and domestic research reactors and processing of material through H Canyon,
- Initial operations of the SWPF, and
- Potential long-term commercial treatment and disposal of DWPF recycle wastewater for three years between the completion of the SWPF mission (estimated 2031) and the DWPF mission (estimated 2034).

[20] According to the NRC (https://www.nrc.gov/materials/transportation.html), about three million packages of radioactive materials are shipped each year in the United States.

These reasonably foreseeable actions are discussed separately below.

4.2.1 Continued Closure of Waste Tanks

As detailed in the System Plan (SRR 2019), as of 2019, DOE has grouted and operationally closed eight waste tanks. Five additional tanks have had the bulk of their waste removed. The System Plan identifies several goals and priorities over the next two decades. A couple of these include the complete operational closure of the F-Area Tank Farm by FY 2028; the removal of all bulk waste from old-style tanks in the SRS H-Area Tank Farm that are below the water table by FY 2023; closure of 44 of the 51 tanks by FY 2035; and closure of the last of the H-Tank Farm tanks by FY 2037. Overall, these activities would continue to lower the overall health and safety risk at SRS; however, these closure activities would be concurrent with the Proposed Action. As described in Section 1.5 of this EA, the potential environmental impacts of these tank closure activities are provided in the SRS HLW Tank Closure Final EIS (DOE 2002).

The Proposed Action would be implemented in a single location in the SRS H-Area Tank Farm (see Figures 2-2 and 2-4 in Chapter 2 of this EA). The implementation of the Proposed Action would also be limited to two weeks per batch, and its total duration would depend on how many batches DOE elected to process at any one time. Considering the limited space available in the SRS H-Area Tank Farm, the activities related to the Proposed Action and alternatives would be closely coordinated with the tank farm operating contractor to ensure they would not interfere with ongoing tank closure activities. This coordination of scheduled activities would minimize the potential for additional cumulative human health impacts to the involved and noninvolved workers.

4.2.2 Proposed Plutonium Pit Production at SRS

On June 10, 2019, the National Nuclear Security Administration (NNSA), a semi-autonomous agency within DOE, announced its intent to prepare an EIS for plutonium pit production at SRS (84 FR 26849). NNSA’s proposed action is to produce a minimum of 50 pits per year at a repurposed Mixed-Oxide Fuel Fabrication Facility (MFFF) at SRS, with additional surge capacity, if needed, to enable NNSA to meet the requirements of producing pits at a rate of no fewer than 80 pits per year by 2030 for the nuclear weapons stockpile.

The MFFF is a partially constructed building in F Area, and the pit production mission is proposed to be constructed totally within its previously disturbed footprint. Considering that the Proposed Action in this EA would be focused around the immediate area of the SRS H-Area Tank Farm, it is unlikely that any cumulative impacts would occur between these two projects.

4.2.3 Potential Processing of Surplus Plutonium at SRS

In the *Surplus Plutonium Disposition Final Supplemental Environmental Impact Statement* (DOE/EIS-0283-S2; DOE 2015a), DOE analyzed the environmental impacts of alternatives for the disposition of 13.1 metric tons of surplus plutonium for which a disposition path is not assigned, including 7.1 metric tons of surplus pit plutonium and 6 metric tons of surplus non-pit plutonium. In its ROD, DOE announced its decision to prepare and package the six metric tons of surplus non-pit plutonium using facilities at SRS to meet the WIPP WAC and ship the surplus non-pit plutonium to WIPP for disposal. DOE has not made a decision on the other surplus plutonium. The associated activities at SRS would occur mostly in K Area, with additional TRU storage in E Area. The potential timing associated with these actions is uncertain and would likely occur after the Proposed Action has been completed. Therefore, cumulative impacts are unlikely.

4.2.4 Potential Acceptance of SNF from Foreign and Domestic Research Reactors and Processing of Material through H Canyon

SRS manages SNF (including target materials) originated from the Atomic Energy Commission and DOE production activities, as well as SNF from foreign and domestic research reactors. The SNF currently is safely stored pending disposition at SRS. The receipt, storage, and disposition of SNF supports programmatic missions of the DOE's Office of Nuclear Energy, Office of Science, and NNSA.

The environmental impacts of the SNF management at SRS were analyzed in the *Savannah River Site, Spent Nuclear Fuel Management Final Environmental Impact Statement* (DOE/EIS-0279; DOE 2000) and associated supplement analyses. This EIS included future receipts of SNF for foreign and domestic research reactors and evaluated conventional processing of SNF through H Canyon. The cumulative impacts from these activities are described in Section 5 of DOE/EIS-0279 and in the *Environmental Assessment for the Acceptance and Disposition of Spent Nuclear Fuel Containing U.S.-Origin Highly Enriched Uranium from the Federal Republic of Germany* (DOE/EA-1977; DOE 2017c). The small population health effects associated with the Proposed Action of this DWPF Recycle Wastewater EA would not appreciably contribute to the cumulative impacts from the SNF management activities at SRS.

4.2.5 Initial Operations of SWPF

DOE is currently completing the tie-ins and testing associated with processing salt waste through the SWPF. According to the System Plan (SRR 2019), the SWPF is scheduled to begin hot commissioning in March 2020. The initiation of operations of the SWPF is not expected to have any impact on the ability to access the SRS H-Area Tank Farm. As described in Section 1.5 of this EA, the potential environmental impacts of operating the SWPF are provided in the SRS Salt Processing Alternatives SEIS (DOE 2001). Similar to tank closure activities (see Section 4.2.1, above), the activities related to the Proposed Action of this DWPF Recycle Wastewater EA would be closely coordinated with the tank farm operating contractor to ensure they would not interfere with SWPF startup activities. This coordination of scheduled activities would minimize the potential for additional cumulative human health impacts to the involved and non-involved workers.

4.2.6 Long-Term Commercial Treatment and Disposal of DWPF Recycle Wastewater

Currently, DWPF recycle wastewater is returned to the tank farm (Tank 22) for volume reduction by evaporation or is beneficially reused in tank closure activities (i.e., saltcake dissolution or sludge washing). As DOE completes tank closure activities in the future, DOE will not have the capability to beneficially reuse the DWPF recycle wastewater. The up to 10,000-gallon volume proposed in this EA would inform DOE planning efforts on disposal options for the latter stages of tank closure (2031–2034), when facilities and systems currently used for reuse and management of DWPF recycle wastewater would no longer be operational. Therefore, it is reasonably foreseeable that, depending on the outcome of this proposal, DOE could elect to implement commercial treatment and disposal of a larger volume of DWPF recycle wastewater in the future. In any event, if DOE proposed to commercially treat and dispose of more than 10,000 gallons of DWPF recycle wastewater, it would perform a separate NEPA evaluation for that proposal.

The potential volume that DOE considers reasonably foreseeable would be the total volume of DWPF recycle wastewater that is estimated to be produced after the SWPF mission is complete, but before the DWPF mission is complete (2031–2034). According to the System Plan (SRR 2019, p. 41), this value is approximately 380,000 gallons, or approximately 38 times the volume considered in this EA.

The potential impacts to air quality for the Proposed Action are provided in Sections 3.3.2, 3.3.3, and 3.3.4 of this EA for the three action alternatives. Because the Proposed Action would have only minor contributions to air quality impacts in the region, the potential cumulative impacts of on-site stabilization of approximately 38 times the volume considered in this EA would also likely be minimal.

The potential impacts to human health for normal operations for the Proposed Action are provided in Sections 3.4.2, 3.4.3, and 3.4.4 of this EA for the three action alternatives. The potential health impacts at SRS are highest for Alternative 1 because it is assumed to take twice as long as Alternatives 2 and 3. The estimated total worker dose for stabilizing 10,000 gallons of DWPF recycle wastewater is 0.072 person-rem. If 38 times this volume were processed, using the same assumptions, the resultant total worker dose would be 2.74 person-rem. The corresponding risk of an LCF in the exposed worker population would be 0.00164 LCF, or essentially zero.

The potential impacts to human health under accident conditions for the Proposed Action are provided in Sections 3.5.2, 3.5.3, and 3.5.4 of this EA for the three action alternatives. The potential health impacts at SRS are equivalent for all alternatives. The primary accident scenario would be associated with a transfer error resulting in a spill of DWPF recycle wastewater on the ground. Increasing the potential volume of DWPF recycle wastewater to be processed by a factor of 38 would not change the source term for the accident, which is the contents of a 600-gallon batch. It would, however, increase the probability or risk of such an event occurring.

The potential impacts to waste management for the Proposed Action are provided in Sections 3.6.2, 3.6.3, and 3.6.4 of this EA for the three action alternatives. The potential impacts to waste management are equivalent for all alternatives. Increasing the potential volume by a factor of 38 would increase the potential LLW generated as job control waste by the same amount; however, since job control waste is typically generated every day as a part of tank farm operations, and there is adequate on-site disposal capacity at SRS, cumulative impacts are not expected. Because of the extremely small volume of waste relative to the disposal capacity at WCS and Energy*Solutions*, as reported in Sections 3.6.1.2 and 3.6.1.3, respectively, an increase by a factor of 38 would not create cumulative impacts on the disposal facilities' capacities.

The potential impacts to radiological transportation for the Proposed Action are provided in Sections 3.7.2, 3.7.3, and 3.7.4 of this EA for the three action alternatives. If DOE were to implement a campaign for approximately 380,000 gallons of DWPF recycle wastewater, it would select an alternative and optimize the approach to shipments of LLW to a treatment or treatment/disposal facility. Simply based on an increase by a factor of 38, the potential impacts to the transportation workforce would be as shown in Table 4-1.

Considering the potential impacts identified in Section 3.7 of this EA (derived from the WM PEIS) to the public along the route for 25,000 shipments of LLW, the potential incident-free impacts to the public from 38 times the potential shipments (9 to 15) under the Proposed Action would still be negligible.

The potential consequences from a severe accident that resulted in a release of radioactive material from a Type A package would be similar to those identified for Alternative 2 in Section 3.7.3 and further described in Appendix B. The probability of a severe accident would increase by a factor of 38 above those probabilities identified for Alternatives 2 and 3.

Table 4-1. Potential Cumulative Transportation Impacts for a Larger DWPF Recycle Wastewater Volume

Alternative	Total Worker Dose (person-rem)	LCF Risk
1	3.31	0.0020
2	5.52	0.0033
3[a]	10.4	0.0062

LCF = latent cancer fatality.

a. Alternative 3 impacts reflect a combination of transportation impacts from SRS to the commercial treatment facility and from the treatment facility to the commercial disposal facility.

5 AGENCIES CONSULTED

Consultations with other agencies (e.g., State Historic Preservation Officer, U.S. Fish and Wildlife Service) were not required or undertaken in connection with this EA because the Proposed Action would not impact cultural resources, historic properties, or threatened or endangered species. The following agencies were individually notified of the preparation of this EA:

- U.S. Environmental Protection Agency
- South Carolina Department of Health and Environmental Control
- Texas Commission on Environmental Quality
- Utah Department of Environmental Quality

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Appendix A: Recent Tank 22 Sample Data

In December 2018, Savannah River Remediation, SRS Tank Farm contractor, retrieved a sample of the DWPF recycle wastewater currently contained in Tank 22. This sample was transferred to Savannah River National Laboratory for analyses to determine the concentrations of radionuclides present in the wastewater.

Based upon these recent sample analyses, the following tables present the radionuclide concentrations in representative DWPF recycle wastewater in Tank 22 (*Tank 22 Supernate Sample Characterization for Select Radionuclides*, SRNL-STI-2019-00604, Revision 0) (SRNS 2019) in order to provide reasonable assurance for the assumptions presented in this DWPF Recycle Wastewater EA.

Table A-1, "DWPF Recycle Wastewater in Solid Form," presents the expected concentrations for a stabilized waste form relevant to any of the analyzed alternatives and compares these concentrations to Class A, B, and C limits from 10 CFR Part 61 to demonstrate that the stabilized waste form is likely able to be disposed of as non-HLW. Table A-1 also compares these expected concentrations of the stabilized waste form to the activity limits for each radionuclide from 49 CFR Part 173 to demonstrate that the stabilized waste form should be able to be shipped as LSA-II material in an IP-2 transportation package. An IP-2 package must meet a subset of the Type A packaging tests as defined in 49 CFR 173.411 and 465.

Table A-1 demonstrates that a solid waste form resulting from stabilization of the material currently in Tank 22 would be significantly below the Class C limits (Class C sum of fractions [SOF] approximately 0.001), below the Class B limits (Class B sum of fractions approximately 0.2), and above Class A limits (Class A SOF approximately 7). Therefore, the stabilized waste form would be Class B waste. Table A-1 also demonstrates that the stabilized waste form could be shipped as LSA-II material in an IP-2 package (LSA-II SOF approximately 0.002).

Table A-2, "DWPF Recycle Wastewater in Liquid Form," presents concentrations for a potential liquid shipment and compares the concentrations to Class A, B, and C limits from 10 CFR Part 61 and transportation A_2 values from 49 CFR Part 173. Table A-2 demonstrates that the material in Tank 22 would be significantly below the Class C limits (Class C SOF approximately 0.003), below the Class B limits (Class B sum of fractions approximately 0.3), and above Class A limits (Class A SOF approximately 13) and would therefore be considered Class B waste. Table A-2 also demonstrates that the material tested would meet limits for a Type A package as a normal form material (A_2 SOF approximately 0.72). DOE would re-evaluate the isotopic concentrations prior to implementation of the Proposed Action and select a transportation package appropriate for the specific activity of the DWPF recycle wastewater.

The results presented in Tables A-1 and A-2 provide reasonable assurance that the waste classification and shipment package types assumed in the EA are appropriate. As noted earlier in the EA, additional DWPF recycle wastewater characterization would be performed when implementing any of the potential alternatives to confirm all requirements would be met for shipment and at the disposal facility.

Table A-1. DWPF Recycle Wastewater in Solid Form

DWPF Recycle Wastewater in Solid Form

Radionuclide	Tank 22 dpm/ml	Solid Ci/m^3	Solid nCi/g*	Class A Limit	Class A Fraction	Class B Limit	Class B Fraction	Class C Limit	Class C Fraction	Total Ci**	Ci/g***	A_2	LSA-II 1E-4 A_2/g	Fraction LSA-II
10CFR61 Table 1														
C-14	1.61E+02	3.63E-05		0.8	4.53E-05	N/A	N/A	8	4.53E-06	1.65E-04	2.13E-11	8.10E+01	8.10E-03	2.63E-09
Ni-59	<6.72E+01	1.51E-05		22	6.88E-07	N/A	N/A	220	6.88E-08	6.88E-05	8.90E-12	N/A	N/A	N/A
Nb-94	<1.62E+00	3.65E-07		0.02	1.82E-05	N/A	N/A	0.2	1.82E-06	1.66E-06	2.15E-13	1.90E+01	1.90E-03	1.13E-10
Tc-99	6.77E+03	1.52E-03		0.3	5.08E-03	N/A	N/A	3	5.08E-04	6.93E-03	8.97E-10	2.40E+01	2.40E-03	3.74E-07
I-129	<2.43E+00	5.47E-07		0.008	6.84E-05	N/A	N/A	0.08	6.84E-06	2.49E-06	3.22E-13	N/A	N/A	N/A
Np-237	<1.75E+01		2.32E-03	10	2.32E-04	N/A	N/A	100	2.32E-05	1.79E-05	2.32E-12	5.40E-02	5.40E-06	4.30E-07
Pu-238	<1.21E+02		1.60E-02	10	1.60E-03	N/A	N/A	100	1.60E-04	1.24E-04	1.60E-11	2.70E-02	2.70E-06	5.94E-06
Pu-239	<9.34E+01		1.24E-02	10	1.24E-03	N/A	N/A	100	1.24E-04	9.56E-05	1.24E-11	2.70E-02	2.70E-06	4.58E-06
Pu-240	<9.34E+01		1.24E-02	10	1.24E-03	N/A	N/A	100	1.24E-04	9.56E-05	1.24E-11	2.70E-02	2.70E-06	4.58E-06
Pu-242	<9.49E+01		1.26E-02	10	1.26E-03	N/A	N/A	100	1.26E-04	9.71E-05	1.26E-11	2.70E-02	2.70E-06	4.66E-06
Pu-244	<4.41E-01		5.84E-05	10	5.84E-06	N/A	N/A	100	5.84E-07	4.51E-07	5.84E-14	2.70E-02	2.70E-06	2.16E-08
Am-241	<1.43E+01		1.89E-03	10	1.89E-04	N/A	N/A	100	1.89E-05	1.46E-05	1.89E-12	2.70E-02	2.70E-06	7.02E-07
Am-242m	<1.08E-01		1.43E-05	10	1.43E-06	N/A	N/A	100	1.43E-07	1.10E-07	1.43E-14	2.70E-02	2.70E-06	5.30E-09
Am-243	<3.10E+00		4.11E-04	10	4.11E-05	N/A	N/A	100	4.11E-06	3.17E-06	4.11E-13	2.70E-02	2.70E-06	1.52E-07
Cm-243	<9.04E+00		1.20E-03	10	1.20E-04	N/A	N/A	100	1.20E-05	9.25E-06	1.20E-12	2.70E-02	2.70E-06	4.44E-07
Cm-244	1.34E+02		1.78E-02	10	1.78E-03	N/A	N/A	100	1.78E-04	1.37E-04	1.78E-11	5.40E-02	5.40E-06	3.29E-06
Cm-245	<7.39E+00		9.79E-04	10	9.79E-05	N/A	N/A	100	9.79E-06	7.56E-06	9.79E-13	2.40E-02	2.40E-06	4.08E-07
Cm-247	<9.12E+00		1.21E-03	10	1.21E-04	N/A	N/A	100	1.21E-05	9.33E-06	1.21E-12	2.70E-02	2.70E-06	4.48E-07
Cm-248	<1.21E+01		1.60E-03	10	1.60E-04	N/A	N/A	100	1.60E-05	1.24E-05	1.60E-12	8.10E-03	8.10E-07	1.98E-06
Cf-249	<9.80E+00		1.30E-03	10	1.30E-04	N/A	N/A	100	1.30E-05	1.00E-05	1.30E-12	2.20E-02	2.20E-06	5.90E-07
Cf-251	<8.76E+00		1.16E-03	10	1.16E-04	N/A	N/A	100	1.16E-05	8.96E-06	1.16E-12	1.90E-02	1.90E-06	6.11E-07
Pu-241	<1.72E+02		2.28E-02	350	6.51E-05	N/A	N/A	3500	6.51E-06	1.76E-04	2.28E-11	1.60E+00	1.60E-04	1.42E-07
Cm-242	<1.98E+00		2.62E-04	2000	1.31E-07	N/A	N/A	20000	1.31E-08	2.03E-06	2.62E-13	2.70E-01	2.70E-05	9.72E-09
				SOF Table 1	1.36E-02	N/A	N/A	SOF Table 1	1.36E-03					
10CFR61 Table 2														
Ni-63	<7.67E+01	1.73E-05		3.5	4.94E-06	70	2.47E-07	700	2.47E-08	7.85E-05	1.02E-11	8.10E+02	8.10E-02	1.25E-10
Sr-90	2.45E+04	5.52E-03		0.04	1.38E-01	150	3.68E-05	7000	7.88E-07	2.51E-02	3.25E-09	8.10E+00	8.10E-04	4.01E-06
Cs-137	2.90E+07	6.53E+00		1	6.53E+00	44	1.48E-01	4600	1.42E-03	2.97E+01	3.84E-06	1.60E+01	1.60E-03	2.40E-03
				SOF Table 2	6.67E+00	SOF Table 2	1.48E-01	SOF Table 2	1.42E-03					
Transportation														
Cl-36	<1.20E+02									1.23E-04	1.59E-11	1.60E+01	1.60E-03	9.94E-09
U-233	<2.40E+02									2.45E-04	3.17E-11	1.60E-01	1.60E-05	1.98E-06
U-234	<1.55E+02									1.59E-04	2.05E-11	1.60E-01	1.60E-05	1.28E-06
U-235	1.66E-01									1.70E-07	2.20E-14	N/A	N/A	N/A
U-236	<1.61E+00									1.65E-06	2.13E-13	1.60E-01	1.60E-05	1.33E-08
U-238	3.72E+00									3.81E-06	4.93E-13	N/A	N/A	N/A
Th-232	<4.09E-02									4.18E-08	5.42E-15	N/A	N/A	N/A
													SOF LSA-II	2.44E-03

*Uses a solid specific gravity of 1.7 g/cc and liquid dry feed volume ratio of 1:1 for unit conversions.
**Assumes use of package with volume equivalent of 1,200 gallons of stabilized waste form.
***1,200 gal grout at 1.7 g/cc equals 7.722E+6 g.

Table A-2. DWPF Recycle Wastewater in Liquid Form

DWPF Recycle Wastewater in Liquid Form

Radionuclide	Tank 22 dpm/ml	Liquid Ci/m^3	Liquid nCi/g*	Class A Limit	Class A Fraction	Class B Limit	Class B Fraction	Class C Limit	Class C Fraction	Total Ci**	A_2	Fraction A_2
10CFR61 Table 1												
C-14	1.61E+02	7.25E-05		0.8	9.07E-05	N/A	N/A	8	9.07E-06	6.31E-05	8.10E+01	7.80E-07
Ni-59	<6.72E+01	3.03E-05		22	1.38E-06	N/A	N/A	220	1.38E-07	2.64E-05	N/A	
Nb-94	<1.62E+00	7.30E-07		0.02	3.65E-05	N/A	N/A	0.2	3.65E-06	6.35E-07	1.90E+01	3.34E-08
Tc-99	6.77E+03	3.05E-03		0.3	1.02E-02	N/A	N/A	3	1.02E-03	2.66E-03	2.40E+01	1.11E-04
I-129	<2.43E+00	1.09E-06		0.008	1.37E-04	N/A	N/A	0.08	1.37E-05	9.53E-07	N/A	
Np-237	<1.75E+01		7.82E-03	10	7.82E-04	N/A	N/A	100	7.82E-05	6.87E-06	5.40E-02	1.27E-04
Pu-238	<1.21E+02		5.41E-02	10	5.41E-03	N/A	N/A	100	5.41E-04	4.75E-05	2.70E-02	1.76E-03
Pu-239	<9.34E+01		4.17E-02	10	4.17E-03	N/A	N/A	100	4.17E-04	3.66E-05	2.70E-02	1.36E-03
Pu-240	<9.34E+01		4.17E-02	10	4.17E-03	N/A	N/A	100	4.17E-04	3.66E-05	2.70E-02	1.36E-03
Pu-242	<9.49E+01		4.24E-02	10	4.24E-03	N/A	N/A	100	4.24E-04	3.72E-05	2.70E-02	1.38E-03
Pu-244	<4.41E-01		1.97E-04	10	1.97E-05	N/A	N/A	100	1.97E-06	1.73E-07	2.70E-02	6.41E-06
Am-241	<1.43E+01		6.39E-03	10	6.39E-04	N/A	N/A	100	6.39E-05	5.61E-06	2.70E-02	2.08E-04
Am-242m	<1.08E-01		4.83E-05	10	4.83E-06	N/A	N/A	100	4.83E-07	4.24E-08	2.70E-02	1.57E-06
Am-243	<3.10E+00		1.39E-03	10	1.39E-04	N/A	N/A	100	1.39E-05	1.22E-06	2.70E-02	4.50E-05
Cm-243	<9.04E+00		4.04E-03	10	4.04E-04	N/A	N/A	100	4.04E-05	3.55E-06	2.70E-02	1.31E-04
Cm-244	1.34E+02		5.99E-02	10	5.99E-03	N/A	N/A	100	5.99E-04	5.26E-05	5.40E-02	9.73E-04
Cm-245	<7.39E+00		3.30E-03	10	3.30E-04	N/A	N/A	100	3.30E-05	2.90E-06	2.40E-02	1.21E-04
Cm-247	<9.12E+00		4.08E-03	10	4.08E-04	N/A	N/A	100	4.08E-05	3.58E-06	2.70E-02	1.32E-04
Cm-248	<1.21E+01		5.41E-03	10	5.41E-04	N/A	N/A	100	5.41E-05	4.75E-06	8.10E-03	5.86E-04
Cf-249	<9.80E+00		4.38E-03	10	4.38E-04	N/A	N/A	100	4.38E-05	3.84E-06	2.20E-02	1.75E-04
Cf-251	<8.76E+00		3.91E-03	10	3.91E-04	N/A	N/A	100	3.91E-05	3.44E-06	1.90E-02	1.81E-04
Pu-241	<1.72E+02		7.69E-02	350	2.20E-04	N/A	N/A	3500	2.20E-05	6.75E-05	1.60E+00	4.22E-05
Cm-242	<1.98E+00		8.85E-04	2000	4.42E-07	N/A	N/A	20000	4.42E-08	7.77E-07	2.70E-01	2.88E-06
				SOF Table 1	3.87E-02	N/A	N/A	SOF Table 1	3.87E-03			
10CFR61 Table 2												
Ni-63	<7.67E+01	3.45E-05		3.5	9.87E-06	70	4.94E-07	700	4.94E-08	3.01E-05	8.10E+02	3.71E-08
Sr-90	2.45E+04	1.10E-02		0.04	2.76E-01	150	7.36E-05	7000	1.58E-06	9.61E-03	8.10E+00	1.19E-03
Cs-137	2.90E+07	1.31E+01		1	1.31E+01	44	2.97E-01	4600	2.84E-03	1.14E+01	1.60E+01	7.11E-01
				SOF Table 2	1.33E+01	SOF Table 2	2.97E-01	SOF Table 2	2.84E-03			
Transportation												
Cl-36	<1.20E+02									4.71E-05	1.60E+01	2.94E-06
U-233	<2.40E+02									9.40E-05	1.60E-01	5.87E-04
U-234	<1.55E+02									6.08E-05	1.60E-01	3.80E-04
U-235	1.66E-01									6.51E-08	N/A	
U-236	<1.61E+00									6.31E-07	1.60E-01	3.95E-06
U-238	3.72E+00									1.46E-06	N/A	
Th-232	<4.09E-02									1.60E-08	N/A	
											SOF A_2	7.22E-01

*Uses a liquid specific gravity of 1.0008 g/cc for unit conversions.
**Assumes package volume of 230 gallons of liquid.

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Appendix B: Transportation Accident Consequence Assessment for Alternatives 2 and 3

Shipment of the liquid DWPF recycle wastewater under Alternatives 2 and 3 may qualify for the use of Type A packages. This type of packaging must withstand the conditions of normal transportation without the loss or dispersal of the radioactive contents, as specified in 49 CFR 173.412, "Additional Design Requirements for Type A Packages." Packaging for shipping liquid radioactive material must also meet additional performance requirements as specified in 49 CFR 173.466, "Additional Tests for Type A Packagings Designed for Liquids and Gases." "Normal" transportation refers to all transportation conditions except those resulting from accidents or sabotage. Approval of Type A packaging is obtained by demonstrating that the packaging can withstand specified testing conditions intended to simulate normal transportation. Type A packaging usually does not require special handling, packaging, or transportation equipment.

DOE performed a conservative analysis to estimate the potential impacts from the release of the liquid DWPF recycle wastewater to the atmosphere (exposure to downwind receptors) should a worst-case-type accident occur during transport. The severe accident considered in this consequence assessment is characterized by extreme mechanical (impact) and thermal (fire) forces. This accident represents any low-probability, high-consequence events that could lead to the release of the entire liquid cargo to the environment. Therefore, accidents of this severity are expected to be extremely rare. However, the overall probability that such an accident could occur depends on the potential accident rates for such a severe accident and the shipping distance for each case.

Important for the purposes of risk assessment are the fraction of the released material that can be entrained in an aerosol (part of an airborne contaminant plume) and the fraction of the aerosolized material that is also respirable (of a size that can be inhaled into the lungs). These fractions depend on the physical form of the material. Compared to solid materials, liquid materials are relatively easy to release if the container is breached in an accident. Once released, the liquid waste could become aerosolized and dispersed downwind. Generally, aerosolized liquids are readily respirable (i.e., the respirable fraction is equal to one).

Because predicting the exact location of a severe transportation-related accident is impossible when estimating population impacts, separate accident consequences are calculated for accidents occurring in three population density zones: rural, suburban, and urban. Moreover, to address the effects of the atmospheric conditions existing at the time of an accident, two atmospheric conditions are considered: neutral and stable.[21]

[21] Neutral weather conditions constitute the most frequently occurring atmospheric stability condition in the United States. These conditions are represented by Pasquill stability Class D with a wind speed of 4 9 miles per hour in the air dispersion model used in this consequence assessment. Observations at National Weather Service surface meteorology stations at more than 300 U.S. locations indicate that on a yearly average, neutral conditions (Pasquill Classes C and D) occur about half (50%) of the time, stable conditions (Classes E and F) occur about one-third (33%) of the time, and unstable conditions (Classes A and B) occur about one-sixth (17%) of the time (Doty et al. 1976).

RISKIND (Yuan et al. 1995) is a model used to calculate the accident consequences for local populations and for the highest-exposed individual. The population dose includes the population within 50 miles of the accident site. The analysis considered the following exposure pathways:

- External exposure to the passing radioactive cloud (plume),
- External exposure to contaminated ground,
- Internal exposure from inhalation of airborne contaminants, and
- Internal exposure from the ingestion of contaminated food. (rural zone only)

Although remedial activities after the accident (e.g., evacuation or ground cleanup) would reduce the consequences, these activities are not considered in the consequence assessment with one exception. In a rural zone, crops contaminated immediately after an accident were assumed to be removed and not considered for ingestion. However, no remediation measures were assumed for subsequent growing seasons in the long term.

The highest-exposed individual for severe transportation accidents would be located at the point that would have the highest concentration of hazardous material that would be accessible to the general public. This location is assumed to be 100 feet or farther from the release point at the location of highest air concentration. For purposes of this analysis, the location of the highest-exposed individual was estimated to be at a downwind distance of approximately 500 feet for neutral-weather conditions and approximately 1,000 feet for stable-weather conditions.

This accident consequence assessment assumes that the entire contents of the Type A package would be released and aerosolized. For perspective, the release of a Type A container's entire contents could potentially occur approximately 0.4 percent of the time, given that a truck accident does occur (NRC 1977), with about a 10-percent release of its contents estimated 1.6 percent of the time, given that a truck accident does occur (NRC 1977). The aerosolized fraction of the released liquid contents under severe accident conditions could range from about 0.0001 to 0.1 (NRC 1998; DOE 2013), depending on potential over-pressurization and/or explosive and thermal stresses that might result.

Table B-1 lists the estimated radionuclide inventory released and Table B-2 lists the resultant population doses over the short and long term under neutral and stable weather conditions for generic rural, suburban, and urban population zones. Table B-2 also provides a conservative estimate of the potential resultant LCFs. Table B-3 presents the population-level risk when both the consequence and probability of a maximum reasonably foreseeable accident are considered for each of the three alternatives analyzed in this EA. The associated chances of contracting a fatal cancer in that individual's lifetime are 0 under Alternative 1 (for which liquid shipments would not occur), 0.000152 under Alternative 2, and 0.000183 under Alternative 3. The highest potential doses for an individual under neutral and stable weather conditions are estimated at 45 and 143 mrem, respectively. The associated chances of contracting a fatal cancer in that maximally exposed individual's lifetime is approximately 0.00003 and 0.00009. The analysis in this appendix conservatively assumes 100 percent of the release is aerosolized.

Of the radionuclides in the DWPF recycle wastewater, the dominant dose from the aerosolized fraction transported downwind is from cesium-137. Any portion of the released liquid that does not become aerosolized and airborne would spill on the ground at the accident location. Cesium is highly soluble in water, but once in ground contact, it frequently does not travel far because it binds tightly to the clay minerals in the surface soil (EPA 2018). Thus, external exposure from contaminated ground and re-suspended material would be possible in the immediate area. Long-term dose and LCF estimates provided in Table B-2 do not account for any cleanup over a 50-year period. Prompt cleanup of the spill on the ground would greatly reduce these conservative estimates. Similarly, should the wastewater spill into a waterbody, dilution would occur to the extent of water flow and volume of water present, but over time, the cesium, like other radionuclides, begins to accumulate in bottom sediments and organic matter (EPA 2018).

Table B-1. Estimated Radionuclide Inventory of One Shipping Container Filled with 230 Gallons of DWPF Recycle Wastewater in Liquid Form

Radionuclide	Activity (Curies)
Americium-241	5.61E-06
Americium-242M	4.24E-08
Americium-243	1.22E-06
Carbon-14	6.31E-05
Curium-242	7.77E-07
Curium-243	3.55E-06
Curium-244	5.26E-05
Curium-245	2.90E-06
Curium-247	3.58E-06
Curium-248	4.75E-06
Cesium-137	1.14E+01
Iodine-129	9.53E-07
Niobium-94	6.35E-07
Nickel 59	2.64E-05
Nickel 63	3.01E-05
Neptunium-237	6.87E-06
Plutonium-238	4.75E-05
Plutonium-239	3.66E-05
Plutonium-240	3.66E-05
Plutonium-241	6.75E-05
Plutonium-242	3.72E-05
Plutonium-244	1.73E-07
Strontium-90	9.61E-03
Technetium-99	2.66E-03
Uranium-233	9.40E-05
Uranium-234	6.08E-05
Uranium-235	6.51E-08
Uranium-236	6.31E-07
Uranium-238	1.46E-06

Table B-2. Potential Radiological Consequences to the Population from Severe Transportation Accidents[a]

	Neutral Weather Conditions[b]		Stable Weather Conditions[b]	
	Short-Term[c]	Long-Term[c]	Short-Term	Long-term
Dose (person-rem)				
Rural	0.0534	592	0.0931	1,030
Suburban	6.40	1,360	11.2	2,360
Urban[d]	14.2	3,020	24.8	5,260
Dose Risk (LCF)[e]				
Rural	0.000032	0.36	0.000056	0.62
Suburban	0.0038	0.85	0.0067	1.4
Urban	0.0085	1.8	0.015	3.2

LCF = latent cancer fatality; km^2 = square kilometers.

a. National average population densities were used for the accident consequence assessment, corresponding to densities of 6 persons/km^2, 719 persons/km^2, and 1,600 persons/km^2 for rural, suburban, and urban zones, respectively. Potential impacts were estimated for the population within a 50-mile radius, assuming a uniform population density for each zone.

b. For the accident consequence assessment, doses were assessed under neutral atmospheric conditions (Class D with winds at nine miles per hour) and under stable conditions (Class F with winds at 2.2 miles per hour). The results for neutral conditions represent the most likely consequences, given a severe accident occurs. The results for stable conditions represent weather in which the least amount of dilution is evident; the air has the highest concentrations of radioactive material, which leads to the highest doses.

c. Short-term impacts are from exposure within the first two hours of an accident, including plume passage. Long-term impacts are from exposure over a 50-year period following an accident without consideration for decontamination or cleanup efforts.

d. It is important to note that the urban population density generally applies to a relatively small urbanized area; very few, if any, urban areas have a population density as high as 1,600 persons/km^2 extending as far as 50 miles (DOE 2002; Weiner et al. 2006). The urban population density corresponds to approximately 32 million people within the 50-mile radius—well in excess of the total populations along most of the routes considered in this assessment.

e. LCFs were calculated by multiplying the dose by the health risk conversion factor of 0.0006 fatal cancers per person-rem (ISCORS 2002).

Table B-3. Radiological Risk to the Population from Severe Transportation Accident[a]

	Dose	Consequence[b]	Probability[c]	Risk[d]
Alternative 1	Liquid waste shipments would not occur. The stabilized waste form would not be dispersible.			
Alternative 2	5,260 person-rem	3.2 LCF	0.0000476	0.000152 LCF
Alternative 3	5,260 person-rem	3.2 LCF	0.0000571	0.000183 LCF

LCF = latent cancer fatality.

a. For purposes of analysis, the dose, long-term consequence, probability, and risk values are based on the conservative assumption that all travel from SRS to the commercial treatment and/or disposal facility is through an urban environment under stable weather conditions.

b. LCF value based on Table B-2, “Stable Weather Conditions, Long-term Urban” column.

c. Calculated by multiplying the probability that a crash would occur during transport—one chance in 84 for Alternative 2 during the 33,000 miles traveled (2,200 miles times 15 trips) and one chance in 70 for Alternative 3 during the 39,825 miles traveled (2,655 miles times 15 trips) (FMCSA 2019)—by the probability of 0.4 percent (NRC 1977) that the entire contents of a Type A container would be released during the truck accident.

d. Risk equals consequence times probability.

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