Office of Enterprise Assessments
Assessment of Savannah River Site
Radioactive Waste Disposal Facilities

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Office of Nuclear Safety and Environmental Assessments
Office of Environment, Safety and Health Assessments
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Acronyms

AB/SB	Authorization Basis/Safety Basis Documentation
AHA	Assisted Hazard Analysis
CA	Composite Analysis
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CRAD	Criteria and Review Approach Document
DAS	Disposal Authorization Statement
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DOE-SR	DOE Savannah River Operations Office
DTC	Dose to Curie
EA	Office of Enterprise Assessments
EBL	Environmental Bioassay Laboratory
ELLWF	E Area Low-level Waste Facility
HTF	H Area Tank Farm
IIE	SRR Integrated Independent Evaluation
LFRG	Low-level Waste Disposal Facility Federal Review Group
LLW	Low-level Waste
LOTO	Lockout/Tagout
NRCDA	Naval Reactors Components Disposal Area
OFI	Opportunity for Improvement
PA	Performance Assessment
SDF	Saltstone Disposal Facility
SDU	Saltstone Disposal Unit (vault)
SRNS	Savannah River Nuclear Solutions, LLC
SRR	Savannah River Remediation
SRS	Savannah River Site
SWM	Solid Waste Management
RCRA	Resource Conservation and Recovery Act
RWMB	Radioactive Waste Management Basis
WAC	Waste Acceptance Criteria
WITS	Waste Information Tracking System

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EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) Office of Nuclear Safety and Environmental Assessments, within the independent Office of Enterprise Assessments (EA) conducted an assessment of radioactive waste management and disposal facilities operations at the Savannah River Site (SRS). The initial on-site scoping and observations were conducted February 1 through February 4, 2016, and follow up observations and data collections were conducted February 29 through March 3, 2016. This assessment is part of a DOE complex-wide evaluation of radioactive waste management practices. DOE Order 435.1, *Radioactive Waste Management*, and DOE Manual 435.1-1, *Radioactive Waste Management Manual*, establish requirements for waste disposal practices intended to ensure the protection of the environment and the safety and health of workers and the public during the current operations and throughout the future performance periods. This assessment focused on the Saltstone Disposal Facility and E Area Low-level Waste Facility at SRS and reviewed implementation of waste characterization processes, determination and conformance to waste acceptance criteria and inventory limits, waste disposal work planning and control for current worker protection, performance assessments, composite analysis, environmental monitoring verifying facility performance and model assumptions, and closure plans intended to ensure long-term performance of the disposal cells.

Unlike many aspects of DOE operations where significant oversight, review, and approval responsibilities are delegated to the site offices, DOE Order 435.1 and Manual 435.1-1 require the performance assessments, composite analysis, and supporting plans and updates to be reviewed and approved by the Office of Environmental Management Deputy Assistant Secretaries, based on recommendations of the Low-Level Waste Disposal Facility Federal Review Group. Previous DOE management had approved the plans and practices for the reviewed facilities based on specific technical and cost justifications that in some cases required technical interpretations of the DOE Order 435.1 and Manual 435.1-1. These approved plans became the final Program Office direction for the expected performance and operations of these facilities. This review evaluates these long term decisions with the intent of providing feedback and/or lessons learned for the approval process of future disposal facilities.

EA concluded for the facilities reviewed that there is reasonable assurance that radiation doses to the workers, current and future members of the public, and the environment from facility operations will be maintained within appropriate limits and that the performance objectives of DOE Order 435.1 and its manual will be satisfied. Positive attributes included a strong environmental monitoring program that was implemented at Saltstone, and effective use of the computer automated waste information and tracking system and waste tracking metrics at the E Area Low-level Waste Facility to optimize utilization limits for both radioactivity and volume for available disposal units.

EA also identified some practices implemented at SRS and identified in the approved plans and procedures that do not appear to fully conform to aspects of Manual 435.1-1 and DOE Order 458.1 resulting in three deficiencies. Concerns included potential for underestimating radioactivity during implementation of specific waste characterization procedures, potentially resulting in exceedance of the Waste Acceptance Criteria; incomplete environmental sampling and analysis for the E Area trenches; and potential for the spread of environmental contamination to previously uncontaminated areas resulting from addition of an unlined retention basin for handling contaminated run off from the Saltstone area. Additionally EA identified a few opportunities for improvement for consideration. Examples include, needed clarification of DOE expectations regarding waste stabilization and compressibility practices that result in the need for long-term facility maintenance for the E Area trenches; improvement in

environmental sampling and analysis for the E Area trenches; updates of the E area Performance Assessment to more clearly address barrier disruptions and biotic activity; improvements in the audits and verification of the generators' Waste Acceptance Criteria certification; and comparative evaluation of risks and costs of extended maintenance versus pre-disposal compaction and stabilization of the wastes.

In a broader context, the identified deficiencies and OFIs are intended to assure DOE management is appropriately aware of the potential risks and liabilities, has adequate means to manage those liabilities in the future and should help inform EM regarding needed clarity in its ongoing efforts to update the Department's radioactive waste management requirements.

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1.0 PURPOSE

The U.S. Department of Energy (DOE) Office of Nuclear Safety and Environmental Assessments, within the Office of Enterprise Assessments (EA), conducted an independent assessment of radioactive waste management and disposal facilities operations at the Savannah River Site (SRS) as part of a DOE-wide set of targeted assessments of radioactive waste management practices, including disposal operations and waste generator and processor operations. These assessments are intended to evaluate performance at individual facilities. In addition, the overall series of assessments are intended to evaluate the practical implementation of the current DOE Order 435.1, *Radioactive Waste Management*, and DOE Manual 435.1-1, *Radioactive Waste Management Manual*, for consideration during planned updates.

2.0 SCOPE

As specified in the *Plan for the Office of Enterprise Assessments Targeted Review of Radioactive Wastes Disposal Practices at the Savannah River Site*, dated February 2016, this assessment primarily evaluated the disposal operations at the E Area disposal cells and the Saltstone Disposal Units. The focus was on the implementation of the inventory limits and waste acceptance criteria (WAC), monitoring to verify conformance to the limits, and environmental testing, monitoring, and modeling that supports the performance assessment (PA) and composite analysis (CA) to assure dose performance objectives identified in Manual 435.1-1 are satisfied.

3.0 BACKGROUND

DOE Order 435.1-1 provides the high level regulatory requirements and responsibilities for radioactive waste management throughout DOE. Manual 435.1-1 provides specific requirements intended to protect against exposures to radioactive and hazardous wastes, including the short-term hazards for current workers, members of the public, and the environment, and long-term hazards to future potential receptors. The current order and manual were first issued in 1999 with minor changes since that time. These are currently being evaluated for revisions expected in early 2017. Notable events such as those at WIPP have indicated the need to evaluate the implementation of Waste Acceptance Criteria requirements and impacts on short and long-term performance of waste disposal facilities across the DOE complex.

The DOE Savannah River Operations Office (DOE-SR) provides local oversight and contract management of the DOE Office of Environmental Management (EM) operations at SRS through the Assistant Manager for Waste Disposition. Under contract to DOE-SR, Savannah River Remediation (SRR) manages the SRS liquid waste operations including the Saltstone Disposal Facility (SDF), and Savannah River Nuclear Solutions, LLC (SRNS), manages the solid waste management (SWM) facilities and E Area Low-level Waste Facility (ELLWF). SRNS also manages the Environmental Bioassay Laboratory (EBL), Environmental Compliance and Area Completion Projects, and Savannah River National Laboratory, each of which provide support functions, such as engineering, monitoring, analysis, and reviews for the Saltstone Disposal Facility (SDF) and ELLWF through various contract and fee-for-service agreements.

The SRS ELLWF uses approximately 100 acres for active disposal operations. Most low-level waste (LLW) disposed at the ELLWF is generated at various SRS facilities, although ELLWF also receives waste from the U.S. Naval Reactors program. During this review, EA observed disposal of waste into several disposal units, including engineered trenches, slit trenches, and the Naval Reactor Components Disposal Area (NRCDA). These operations are representative of most waste disposal activities at E Area. The engineered trenches and slit trenches are unlined shallow land excavations where containers or components are placed. Following waste container placement, the excavated soil is used to fill around and over the waste. For Slit Trenches, an interim synthetic cover is also installed to minimize water infiltration throughout the operational period prior to placement of the final cap.

The Saltstone facilities stabilize and dispose of low-level radioactive liquid wastes produced from the treatment of legacy salt wastes in the SRS Tank Farms, plus low-level liquid radioactive wastes associated with the Effluent Treatment Facility and H-Canyon. The Saltstone facilities are divided into the Saltstone Production Facility, which receives the liquid salt waste and mixes it with dry cementitious materials to form a grout, and the Saltstone Disposal Facility (SDF), which receives the grout which cures to a waste form known as saltstone and is emplaced in large pre-constructed concrete structures serving as the final disposal units.

4.0 METHODOLOGY

The DOE independent oversight program is described in and governed by DOE Order 227.1A, *Independent Oversight Program*. EA implements the independent oversight program through a comprehensive set of internal protocols, operating practices, assessment guides, and process guides. Organizations and programs within DOE use varying terms to document specific assessment results. In this report, EA uses the terms "deficiencies, findings, and opportunities for improvement (OFIs)" as defined in DOE Order 227.1A. In accordance with DOE Order 227.1A, DOE line management and/or contractor organizations must develop and implement corrective action plans for the deficiencies identified as findings. Other important deficiencies not meeting the criteria for a finding are also highlighted in the report and summarized in Appendix C. These deficiencies should be addressed consistent with site-specific issues management procedures.

The evaluation criteria for this targeted review were based on selected and applicable sections of Manual 435.1-1. The objectives, criteria, and lines of inquiry for this review were drawn from the following sections of EA CRAD 31-11, *Low-Level Radioactive Waste Management*:

- 4.1 Radioactive Waste Management Planning and Generic Safety Requirements
- 4.2 Radioactive Waste Identification, Characterization, and Monitoring
- 4.7 Waste Disposal
    - 4.7.1 Disposal Facility Siting and Approval
    - 4.7.2 Disposal Facility Design and Operations
    - 4.7.3 Facility Closure and Post-Closure Surveillance and Maintenance.

The activities performed during this review are detailed in the *Plan for the Office of Enterprise Assessments Targeted Review of Radioactive Wastes Disposal Practices at the Savannah River Site* and include document reviews; onsite observations of operations, maintenance, and monitoring activities; demonstrations of sampling and analysis processes; and personnel interviews. EA reviewed foundational documents, including the Radioactive Waste Management Basis (RWMB) documents, WAC, PA, CA, PA maintenance plans, closure plans, monitoring plans, and special analysis addendums to the PA. Additional documents included implementing procedures, monitoring and sample analysis results, waste

package characterizations documents, work planning and control documentation, inventory programs, self-assessment reports, and annual updates. EA observed plan-of-the-day and pre-job brief meetings; waste package transportation, receipt, and placement; environmental monitoring and lysimeter sampling demonstrations; and tours of laboratory facilities. EA also interviewed waste characterization specialists, waste certification specialists, inventory data system managers, waste disposition and placement staff, environmental sample collections technicians, sample analysis laboratory personnel, groundwater migration modeling personnel, and facility managers. The members of the EA assessment team, the Quality Review Board, and EA management responsible for this assessment are listed in Appendix A. A detailed list of the documents reviewed, personnel interviewed, and observations made during this assessment, relevant to the findings and conclusions of this report, is provided in Appendix B.

5.0 RESULTS

5.1 Radioactive Waste Management Planning

Criteria:

Radioactive Waste Management Basis: Facilities, operations, and activities that generate, handle, process, store, package, transport or dispose of LLW shall have a RWMB consisting of physical and administrative controls to ensure the protection of workers, the public, and the environment. (DOE Order 435.1; DOE Manual 435.1-1, Chapters I and IV) CRAD 31-11, Section 4.1, Criteria 1

Training and Qualification of Personnel: Training is provided to all personnel associated with the management of radioactive wastes, including planning, identification, characterization, monitoring, generation, storing, staging, processing, treating, packaging, transportation and disposal to ensure they are competent commensurate with their responsibilities for compliance with the requirements of applicable regulations and DOE programs. (DOE Order 435.1; DOE Manual 435.1-1, Chapters I and IV) CRAD 31-11, Section 4.1, Criteria 5

Quality Assurance Program: All radioactive waste facilities, operations, and activities have a quality assurance program in accordance with applicable regulations and DOE programs. (DOE Order 435.1; DOE Manual 435.1-1, Chapters I and IV) CRAD 31-11, Section 4.1, Criteria 6

Integrated Safety Management: Appropriate safety management programs and practices, including Radiation Control, Industrial Hygiene, Fire Protection and Emergency Management, Criticality Safety (as applicable), Maintenance, Industrial Safety, Training, and Qualifications are established and implemented in effective procedures. (DOE Order 435.1; DOE Manual 435.1-1, Chapters I and IV) CRAD 31-11, Section 4.1, Criteria 8

Records Management: A program is in place to ensure that appropriate records are maintained to demonstrate that wastes are managed in an environmentally sound manner, and that recordkeeping-related activities are performed in accordance with all applicable DOE, Federal, state, and local requirements. (DOE Order 435.1; DOE Manual 435.1-1, Chapters I and IV) CRAD 31-11, Section 4.1, Criteria 11

In accordance with Manual 435.1-1, both the ELLWF and the SDF have RWMB documents and disposal authorization statements (DASs) approved by DOE. The RWMB documents appropriately provided reference to and invoked the plans, procedures, and requirements under which the LLW facilities must be operated. In the case of nuclear facilities with authorization basis/safety basis documentation (AB/SB), controls required for a RWMB are also implemented by the applicable AB/SB.

Training and qualification of personnel, quality assurance, integrated safety management, and records management are implemented for all waste management activities through site-wide institutional programs governing these areas, including SRS Manual 4B, *Training and Qualification Program Manual*; Manual 1Q, *Quality Assurance Manual*; Manual 1-01 Procedure: 1.22, *Integrated Safety Management*; and Manual 1B, Procedure 3.31, *Records Management.* These documents meet Manual 435.1-1 requirements. EA's observations related to these areas for observed work are presented in Sections 5.2 and 5.3 of this report.

Within the scope of this review of existing radioactive wastes disposal facilities and operations, the fundamental programmatic and procedural structures for radioactive waste management and planning are in place and implemented at the SRS.

5.2 Radioactive Waste Identification, Characterization, and Monitoring

Criteria:

Waste Stream Identification and Characterization: The facility has established processes that ensure hazardous and radioactive waste streams are properly identified and characterized. Waste stream characterization and analysis processes and capabilities are designed and implemented to verify conformance with the WAC. Processes incorporate appropriate levels of documentation and clearly defined data quality objectives and limiting conditions. (DOE Order 435.1; DOE Manual 435.1-1, Chapters I and IV) CRAD 31-11, Section 4.2, Criteria 1

Waste Acceptance Criteria: Each facility receiving waste for accumulation, storage, or staging; processing, treatment, or repackaging; shipping; or final disposal shall have a defined WAC. (DOE Order 435.1; DOE Manual 435.1-1, Chapters I and IV) CRAD 31-11, Section 4.2, Criteria 2

Monitoring to Certify Waste Acceptance Criteria Conformance: Each facility that receives and handles low-level radioactive waste shall have effective analysis, monitoring, and/or inventory records processes to certify that the wastes conform to the WAC, the facility safety basis, and inventory limits. Measurement, analysis, and process records techniques shall be sufficient to verify all aspects of WAC compliance (radiological, chemical, and physical attributes). (DOE Order 435.1; DOE Manual 435.1-1, Chapters I and IV) CRAD 31-11, Section 4.2, Criteria 3

Saltstone Facility

X-SD-Z-00001,*Waste Acceptance Criteria for Aqueous Waste Sent to the Z-Area Saltstone Production Facility*, is applicable to any aqueous waste transferred from Tank 50H to the Salt Feed Tank in the Z Area Saltstone Facility through a connecting transfer line. The WAC establishes "Limits" that, if not satisfied, would have an adverse impact on repository performance objective requirements. Lower level "Targets" are set as a guideline to protect a "Limit". Specific transfer acceptance criteria designated as "Targets" are sampled on a confirmatory basis (typically, quarterly, semi-annually, or for each salt batch). The sampling regime and analysis process is sufficient to ensure that Limits/Targets are satisfied in Tank 50H prior to transfer to Saltstone for processing.

E Area Low-level Waste Facility

Manual 1S, *SRS Radioactive Waste Requirements Manual,* provides the WAC requirements for characterizing, packaging, and certifying solid LLW presented to SRS SWM for disposition in ELLWF. Waste generator entities, through designated Generator Certification Official, Waste Cognizant Technical Function and Environmental Compliance Authority personnel, are responsible for identifying and

characterizing all waste streams destined for onsite disposal at SRS. This information is provided to SWM for evaluation and concurrence and entry into the Waste Information Tracking System (WITS) database. EA reviewed waste streams from the H-Area Tank Farm (HTF) and Naval Reactors and did not find any discrepancies with the waste stream information provided or its use in the WITS database.

Manual 1S, Chapter 3, provides requirements associated with developing suitable methodologies for generator characterization of waste packages and establishes the basis to ensure that all LLW packages presented to SWM for disposal have been adequately characterized to reasonably represent the contents of the waste package to permit proper disposal. Requirements include identifying all radionuclides of importance in each waste stream and determining an algorithm for assigning the radioactivity content to each package, including the fractional abundance of each radionuclide. Acceptable methods defined in Manual 1S include activation modeling, dose to curie (DTC) conversion, smear to curie conversion, or direct assay. The DTC method is often the simplest to use and with one exception (discussed later) was used effectively to characterize SRS-generated waste that EA observed being disposed during the review.

Calculation of container radionuclide inventories and total package activity using the DTC conversion method is accomplished using WITS and/or the SRS DTC computer program. WITS automatically accesses pre-populated data tables maintained by SWM containing information that the DTC program needs in order to calculate container activity for many routine SRS waste streams and specific container types. The only input variables needed by WITS for each typical package is the highest dose rate measured using the measurement protocol defined in Chapter 3 and the pre-determined waste stream composition. If the waste is packaged in a container type that is not included in the WITS data tables, WITS will prompt the user for a different calculation method.

EA's observation of waste disposal activities by SWM consisted of receipt and disposal of several shipments of LLW from the HTF and one shipment from Naval Reactors. All containers received from HTF were part of the HTF "Supernate" waste stream. HTF Calculation Q-CLC-H-00204, *Revalidation of Tank Farm Supernate Low Level Radioactive Waste Stream*, is technically acceptable and complete.

The radiological WAC conformance for LLW destined for E Area is greatly simplified by WITS, which tracks all waste packages from generation to disposal, including physical location in the disposal cells, which helps satisfy Manual 435.1-1 P 6 (e) requirements for tracking placement of waste. The WITS system automatically conducts comprehensive WAC limit checks for each waste package against all applicable WAC limits for the destination disposal unit, and flags any failures for reconciliation. The system generates package limit check reports that are used to review flagged items and determine whether the disposal unit can still receive the waste package, or if another disposal unit should be selected based on radioactivity content and/or volume considerations. EA reviewed WITS system entries and limit checking capabilities for several waste shipments destined for disposal and found this process is easily accomplished in a matter of minutes, which would not be possible using a manual look up method, greatly improving the effectiveness and accuracy of ensuring compliance with the WAC. EA also observed that waste engineers at E Area effectively use WITS limit checking capabilities to closely monitor disposal cell volume and radioactivity inventories when making decisions concerning proper waste placement. Disposal unit capacity is limited by both radioactivity and volume considerations, and the process that SWM uses includes maintenance of waste volume and activity metrics that are used as a basis for choosing the appropriate disposal units for incoming wastes. During the review, these decisions were appropriately evaluated by SWM engineers with the intent of optimizing the use of the remaining volume and remaining activity, with an ultimate goal of achieving 100% utilization for each disposal unit upon closure. For example, while within limits, SWM engineers chose not to use an engineered trench to dispose of a certain waste package with high radioactivity content in a relatively small volume package, because doing this repeatedly would result in the need to eventually close the disposal unit prematurely, based on reaching its radioactivity limit long before reaching its volume capacity.

EA identified one vulnerability with implementation of the DTC method. This vulnerability involved not using the highest dose rate measurement on a waste package, resulting in the potential for non-conservatism in the calculated waste package curie content, and possibly disposing the package improperly if the actual radioactivity content unknowingly exceeded WAC limits for the disposal unit. The Manual 1S, Chapter 3, protocol requires that at least four dose rate readings be taken at 5 feet (far field) from the package surface on four box sides, with the highest measured reading to be used in WITS and/or the DTC program to calculate package activity. In the observed example, a large B50 Box from HTF, which contained a slurry pump, was characterized in 2015 using the DTC method. This was a non-standard container not included in the WITS DTC data tables. Therefore, HTF appropriately performed a separate radiological characterization using the DTC program, documenting its results and specific modeling assumptions in an engineering calculation. The calculated activity was 18 Ci, based on a 99 mR/hr highest-measured far-field dose rate. However, several months later as the package was loaded on a flatbed trailer for shipment to E Area, transportation shipment surveys discovered unexpectedly high dose rates on the bottom of the box at a location where approximately 8 feet of the container overhung the end of the flatbed (a location not measured during the original characterization). The package was not transported, and the SWM waste engineer was contacted to inform him of the situation. The engineer questioned HTF regarding the need to re-characterize the box in light of the significantly higher dose rate readings. HTF took the position that it had characterized the box in accordance with the chapter 3 procedural requirements and that the new data did not invalidate the calculated radioactivity content. The box was disposed in a slit trench in February 2016.

The contact and 1 foot dose rates were 12 R/hr and 4 R/hr respectively, voiding the Radiological Work Permit (RWP) in use. These levels were significantly (11 and 7 times) higher than the contact and 1 foot dose rates taken during the prior characterization measurements. However, no far-field dose rate measurement at 5 feet was taken for comparison with the prior highest 99 mR/hr far field reading. Based on the contact and 1 foot readings, a reading at 5 feet from the bottom would likely have significantly exceeded the original far-field characterization measurement taken from the side, resulting in a higher curie calculation. A higher calculated radioactivity content based on higher dose rate measurements could have impacted the decision to dispose of the box in the slit trench because of WAC radioactivity limit considerations. While Chapter 3 requires the highest measurements be used during waste characterization, it does not address unanticipated conditions, such as when survey results (taken for any reason) that are significantly higher than those taken for characterization warrant an updated calculation of radioactivity content, nor does it address the relevance of the top or bottom of a waste container, which are still technically sides. In this case, highest dose rate measurements were not considered, possibly rendering the original calculation of package radioactivity non-conservative and potentially in excess of the WAC. This example highlights a concern that in some cases, measurement, analysis, and process techniques defined in Manual 1S, Chapter 3, as implemented, are not always sufficient to verify and ensure WAC compliance, as required by DOE Manual 435.1-1 (**Deficiency**)

5.3 Waste Disposal Operations

5.3.1 Disposal Authorization Statement

Criterion:

Disposal Authorization Statement: A DAS shall be obtained prior to construction of a new LLW disposal facility. (DOE Order 435.1; DOE Manual 435.1-1, Chapter IV) CRAD 31-11, Section 4.7.1, Criteria 4

A DAS was issued on September 28, 1999 including both the ELLWF and the Saltstone Disposal Facility. In 2008, based on the recommendation of a Low-level Waste Disposal Facility Federal Review Group (LFRG) PA review team, the EM Deputy Assistant Secretary for Regulatory Compliance

determined that separate compliance evaluations of the PAs performed by the LFRG and distinct DASs would enhance regulatory oversight of the two facilities. New DASs were issued for the ELLWF in 2008 and for the SDF in 2009. Hydraulic pressure structural challenges of the original rectangular disposal cells resulted in leaks at Saltstone. SDF changed the design to use cylindrical disposal cells. Special analyses addressing the leaks and the design changes were performed as addendums to the PA and were reviewed in support of an updated DAS in 2012. This revised DAS for the SDF remains in effect.

The DASs for both facilities were issued based on the required reviews and acceptance of the PAs, CA, preliminary monitoring plans, preliminary closure plans, and PA and CA maintenance plans by EM Deputy Assistant Secretaries under recommendations of the LFRG. As required by Manual 435.1-1, the appropriate documents were included in review processes and accepted before issuance of the DASs.

5.3.2 Performance Assessment

Criteria:

Performance Assessment: A site-specific radiological PA and CA shall be prepared and maintained. The performance assessment shall include calculations for a 1,000 year period after closure of potential doses to representative future members of the public and potential releases from the facility to provide a reasonable expectation that the performance objectives identified in M435.1-1 IV P(1) are not exceeded as a result of operation and closure of the facility. (DOE Order 435.1; DOE Manual 435.1-1, Chapter IV) CRAD 31-11, Section 4.7.1, Criteria 2

Performance Assessment: The PA shall be maintained to evaluate changes that could affect the performance, design, and operating bases for the facility. (DOE Order 435.1; DOE Manual 435.1-1, Chapter IV) CRAD 31-11, Section 4.7.2, Criteria 2

The PA for the SDF provides reasonable assurance that the performance objectives will be satisfied. The basic modeling assumptions and data are reasonable and well supported. Annual summaries are submitted for review in a timely manner and include appropriate documentation of increases in the total disposed inventory and environmental monitoring results that indicate the performance of the facility. Reviewed monitoring results support the conclusions in the annual updates that doses are and will remain within the performance objectives. Ongoing laboratory and waste matrix sample testing continues to support the assumptions and conclusions of the PA for the SDF with respect to waste form stability and leach rates of nuclides from the matrix. The PA criteria for the SDF are satisfied.

Similar to the PA for the SDF, the PA for the ELLWF considers the post-drilling scenario to provide the principal path for receptor uptake modeling. In this process the modeling assumes that at some future time a well is drilled at the 100-meter boundary from the trenches or vaults and that the receptor draws some portion of water for consumption and use from this source. Based on this model, the PA indicates that prospective doses to a representative member of the public due to releases from the waste trenches are calculated to peak at approximately 8 mrem per year. Including a sensitivity analysis on some of the assumptions for the modeling, the PA concludes the total effective dose equivalent to a representative member of the public will not exceed the performance objective of 25 mrem in a year.

While the provided calculations indicate that the performance objectives would be satisfied, the PA for the ELLWF is incomplete in providing documentation of some reasonably foreseeable potential pathways and analysis ensuring the performance objectives are satisfied. Some assumptions stated in the PA were not directly supported or delineated and should be clearly documented. Some appear to be inconsistent with other SRS documents. Specific details are illustrated in the following examples:

- Pine forest encroachment and root penetration of the erosion and infiltration barriers was identified as a potential pathway for degradation of the SDF closure cap as analyzed in WSRC-TR-2003-00436, *Saltstone Disposal Facility Closure Cap Configuration and Degradation Base Case*, and noted in the ELLWF Closure Plan (SRNL-RP-2009-00075). Impacts on an up and out biological pathway are not adequately described in the ELLWF PA to ensure compliance with the Manual 435.1-1 IV.P(2)(c) requirement that PAs shall address natural processes that may disrupt barriers against release and transport of radioactive materials. WSRC-STI-2007-00306, *E-Area Low Level Waste Facility DOE 435.1 Performance Assessment* figure 1-3 and SRNL-RP-2009-00075 rev 0 *Closure Plan for the E-Area Low-level Waste Facility* figure 5 indicate the 12 inch thick erosion barrier is located 36 inches below the surface, within the reach of pine tree root encroachment.

- The PA in section 1.9.1 states "The erosion barrier has been shown to be effective for at least 10,000 years (Phifer and Nelson 2003) so that all the layers between the waste and the erosion barrier always remain in place at their design thickness, approximately 10.37 feet of material always exits above the waste." This statement contrasts with other sections of the PA and closure plan that anticipate corrosion and collapse of the waste containers resulting in up to 13 feet of localized displacement between 50 and 500 years following closure. This subsidance will result in non-contiguous layering and breach of the erosion barrier. While the PA modeling assumes an increased level of infiltration following container degradation and slumping immediately after the institutional control period, it is unclear from the documentation that the impact of localized barrier incongruity on erosion and biologic intrusion has been fully addressed. SRNS is performing testing of metal coupons in local soil conditions to assist in estimating the mean times to waste container structural failure. The closure plan estimates this process will take between 50 and 500 years depending on the type of container or waste form. The closure plan also anticipates that container degradation induced slumping that occurs within the 100-year interim closure period will be addressed by active maintenance and planned in-situ compaction prior to placement of the final cap. However, for waste forms in which the degradation is expected to take longer, slumping will occur beyond the anticipated 100-year administrative control period. This is not consistent with the stated assumption that the erosion barrier will never be penetrated and contrary to Manual 435.1-1 Chapter IV section P 6 and Q 1 requirements that facilities and wastes should be operated and closed so as to achieve long-term stability and minimize the need for active maintenance.

- Although the post-drilling scenario may be the most plausible process for significant future receptor uptake, statements in the PA for the ELLWF discounted the impacts of the phenomenon indicated above in consideration of other potential exposure path ways. The PA Part A Summary of Key Assumptions states, "Of 47 pathways identified by which radionuclides released from the ELLWF have the potential for reaching humans, only two were identified as of possible consequence: 1) leaching of the waste form resulting in contamination of local groundwater, and 2) gaseous diffusion into the atmosphere above the disposal units." Part C *Background* Section 4.2 *Transport and Exposure Pathway Screening* provides a listing of the potential pathways followed by general assumptions of the significance of each pathway. While most assumption are plausible the PA does not provide a technical basis supporting the assumptions. The PA does not fully address potential disturbances of the barriers noted above in the evaluation of these discounted pathways, specifically with respect to biological intrusion. Further these generally assume all processes dilute the concentrations of migrated materials. While generally true, there are potential biological food chain concentration mechanism that should be considered.

The PA is incomplete in providing documentation addressing some reasonably foreseeable natural processes that might disrupt barriers against release and transport of radioactive materials. The PA does not clearly document the basis for assumptions discounting evaluation of some potential pathways

ensuring the performance objectives are fully satisfied. DOE Manual 435.1-1 *Radioactive Waste Management Manual* Chapter IV P2 c, requires that PAs shall address natural processes that may disrupt barriers against release and transport of radioactive materials. The E Area Low-Level Waste Facility (ELLWF) performance analysis (PA) Part C Section 4.2 used generalized assumptions to discount the contributions of several natural transport mechanisms without well documented support. As such, the PA is incomplete in providing documented analysis of some plausible pathways (up and out biotic activity, root infiltration, cap slumping) that could impact dose to the receptors over the 1000 year performance period. (See **OFI-SWM-01**.)

5.3.3 Composite Analysis

In Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 94-2, *Conformance with Safety Standards at DOE Low-Level Nuclear Waste and Disposal Sites,* the DNFSB noted that the PA process addressed only the dose contributions from a single disposal facility while the applicable DOE Orders regarding protection of the public applied to all source terms and activities which would remain on site following operations. The associated technical document specifically referenced the potential impact of the source term contribution from the Mixed Waste Management Facility (MWMF), adjacent to the SRS E Area disposal facility, on satisfying performance objectives. In response, DOE instituted requirements in Manual 435.1-1 for developing a Composite Analysis (CA) an analysis that accounts for all sources of radioactive material that may contribute to the long-term dose projected to a hypothetical member of the public from an active or planned low-level waste disposal facility. The CA is intended to account for all sources of radioactive material that may be left at the DOE site and may interact with the low-level waste disposal facility. Performance measures shall be consistent with DOE requirements for protection of the public and environment and evaluated for a 1,000 year period following disposal facility closure. The composite analysis results shall be used for planning, radiation protection activities, and future use commitments to minimize the likelihood that current low-level waste disposal activities will result in the need for future corrective or remedial actions to adequately protect the public and the environment. DOE Order 458.1, *Radiation Protection of the Public and the Environment,* establishes a primary dose limit of 100 mrem in a year for doses to a hypothetical member of the public due to sources that remain on site after operations have ceased, and CA guidance and the implementation plan for DNFSB Recommendation 94-2 include an administrative limit of 30 mrem to address uncertainties in modeling projections. However, unlike the PA requirements for determining the doses to a representative future member of the public at the point of compliance shall correspond to the point of highest projected dose or concentration beyond a 100 meter buffer zone surround the disposed waste, the implementation plan response to the DNFSB Recommendation 94-2 identified the point of compliance for the CA as follows: “A future site boundary, based on current land use plans or discussions with state and local stakeholders, provides a point of evaluation for the Composite of interacting source terms.” The SRS End State Vision future land use plan states that DOE or other successor governmental entities will maintain ownership and control of the site with unchanged boundaries “in perpetuity.”

In conformance with the requirements in Manual 435.1-1, SRS developed SRNL-STI-2009-00512, REV. 0, *Savannah River Site DOE 435.1 Composite Analysis*. The CA uses the General Separations Area groundwater flow modeling, incorporates source terms from various historical operations and facilities, and incorporates results for the PAs at Saltstone, the ELLWF, the F-Area Tank Farm and HTF, the Transuranic Pad 1, and other facilities throughout the SRS. The superposition or confluence of source terms usually occurs at the points where onsite streams, such as Upper Three Runs and Four Mile Branch, combine sources from the various facilities up stream. Because it is assumed the site boundary will never change, the point of public access and compliance location for the CA is evaluated where the tributary streams, Upper Three Runs, Lower Three Runs, Four Mile Branch, and Steel Creek leave the existing SRS site boundary. The uptake models based on surface water usage (recreational, residential, and

agricultural) calculated the maximum cumulative dose to a hypothetical member of the public over the next 1,000 years to be less than 3 mrem in a year, well below the administrative limit of 30 mrem in a year.

Manual 435.1-1 defines the composite analysis as a planning tool intended to provide a reasonable expectation that current low-level waste disposal activities will not result in the need for future corrective or remedial actions to ensure protection of the public and the environment. Therefore in addition to the required dose determination at the existing site boundary, the CA provides a sensitivity analysis that considers the possibility of a reduced industrial utilization foot print for SRS operations. As with the primary CA calculations, the points of compliance for the sensitivity analysis are determined by where the streams would leave a hypothetical reduced site boundary. The results of this sensitivity analysis are also well within the administrative limit of 30 mrem in a year.

The assumptions and modeling of the CA fully satisfy the review criteria and DOE requirements. However, while the CA sensitivity analysis provides a sound basis for ensuring doses to the hypothetical member of the public are within the regulatory and administrative limits, they are predicated on the assumption that DOE or successor organizations will maintain institutional control at the site boundary in perpetuity. As a planning tool, the CA sensitivity analysis could be enhanced to address uncertainty in the assumption of perpetual institutional control by including analysis of close-in superposition of the source terms, such as from the ELLWF and the MWMF and the old radiological waste burial facility.

5.3.4 Hazards Analysis and Control

Criterion:

Hazards Analysis and Control: Hazards associated with the handling, sample, or assay analysis and disposal of waste have been identified, analyzed, and documented. An appropriate set of controls have been identified in the facility safety basis and implementing procedures. Hazard analysis and controls consider normal operations and potential off-normal conditions, such as a container breach, facility fire, or natural phenomenon events. (DOE Order 435.1; DOE Manual 435.1-1, Chapter IV)

Saltstone Facility

Hazards associated with facility operations and maintenance activities are managed using the SRS Institutional programs, performance documents, and management procedures associated with these areas (e.g., Manual 8Q, *Employee Safety Manual*; Manual 2S, *Conduct of Operations Manual*; etc.), driving flow down of institutional requirements to the waste management activity-level work. While Saltstone does not use facility specific Emergency Operating Procedures, the facility's abnormal operating procedures adequately address the range of potential off-normal conditions, such as a line break or component failure. Such events as facility fire or natural phenomenon are managed through the SRS site wide emergency management program. EA was unable to observe waste treatment activities during the assessment because the HTF equipment that supports transfer operations to Saltstone was either undergoing repair or unavailable.

EA observed several plan-of-the-day meetings, shift turn-over meetings, pre-job briefings, lockout/tagout (LOTO) evolutions associated with a maintenance work package, operator rounds, and an operations meeting related to a trend analysis for the production run of February 25, 2016. Additionally, EA conducted walk downs of operational facilities, disposal units, and associated outdoor areas. EA also observed completion of daily rounds and round sheets by operators including verification of impairments

and status of fire suppression systems, backup generators, fuel storage tanks, instrument air, LOTOs, etc. EA observed good conduct of operations and adherence to procedural checklists during these activities.

Maintenance workers and supervision appropriately addressed hazards and requisite controls, including hazardous energy sources and confined spaces during conduct of pre-job briefings associated with Work Order 01466840, *Replace Failed Motor ECR Room Air Handling Unit*. The briefing demonstrated good use of reverse briefing techniques (a briefing technique used to enhance worker engagement, where workers are asked to present portions of the briefing materials; e.g., tasks, hazards or controls), Human Performance Improvement efforts (such as error reduction tools), review of the approved activity hazard analysis, safe work permits, and critical steps for conducting the work. The briefing met the requirements of Procedure OPS-SO-LWO.01, Rev. 13, *Pre-Job Briefings*. EA also observed several LOTO evolutions in support of this work package. Electrical workers performed zero energy verifications in accordance with LOTO requirements contained in Manual 8Q *Employee Safety Manual*, Procedure 32, *Hazardous Energy Control*, as well as National Fire Protection Association 70E, including establishing appropriate arc flash and electrical shock boundaries, donning appropriate Category 1 personal protective equipment for the hazard potential identified, and verifying actual absence of energy (including confirming meter functionality). Additionally, before conducting work, individuals verified the status of their voltage-rated gloves (as within the required testing interval). However, EA observed a voltage-rated piece of rescue equipment (Shepherds Hook) in use had no unique identification or way for workers to confirm whether the item was approved or within its current testing regime, as required by Manual 8Q, Procedure 32, *Hazardous Energy Control*. Maintenance supervision subsequently confirmed with a site electrical safety subject matter expert that the equipment was not within the current testing regime. The subject matter expert also stated that through application of the SRS institutional procedures, SRR and SRNL recognized the need to include this item in the testing and/or control process for voltage-rated equipment. Workers appropriately verified lock and tag placement, as well as key placement within a lock box in the Saltstone control room, before conducting any hands-on work.

E Area Low-level Waste Facility

EA observed waste disposal operations at an engineered trench, a slit trench, and the NRDA. All observed SWM waste disposal activities were governed by SWM operations procedures that adequately conveyed the scope of work and steps to be performed. Observed pre-job briefings were effective in conveying the specific work scopes to be performed, associated hazards, and controls to be employed. Applicable RWPs for the work appropriately called out expected radiological conditions and suspension limits. The pre-job brief for engineered trench operations included a thorough discussion of waste placement requirements contained in the engineered trench operations procedure. Work group supervisors also verbally quizzed workers concerning appropriate actions to be taken in response to specific events, off normal conditions, or emergencies and discussed various what if scenarios and responses.

Radiological hazards are controlled through use of RWPs and operations procedures that contain specific controls to address potential radiological and criticality hazards. Apart from the radiological hazards, the most prevalent hazards associated with waste disposal activities are related to industrial safety concerns, including using heavy equipment, forklifts, cranes and hoists, and rugged terrain. Many of the hazard controls for these hazards are contained in Manual 8Q, and industrial safety hazards were appropriately controlled during operations. For example, all workers had appropriate personal protective equipment, such as hardhats, safety shoes, and reflective vests, and spotters were used to manage equipment movement. Overhead crane hoisting equipment had an approved lift rigging sketch for use in moving Naval Reactors components to their assigned disposal locations. An electrical hazard associated with NRCDA railcar unloading was also appropriately identified and controlled through development and worker implementation of a LOTO order that had been developed for the specific work.

Industrial hygiene hazards are also possible during SWM activities, including exposure to elevated noise, as well as equipment fumes and heat and cold stress, depending on seasonal variations. EA found that the assisted hazard analysis (AHA) reports for the procedures governing observed work did not identify these industrial hygiene hazards, which are considered to be bounded by the Individual Hazard Analysis (IHA) process described in Manual 8Q, Procedure 122, *Task Level Hazard Analysis*. Although no controls for these hazards were defined in the AHA disposition reports, the potential for heat stress was discussed during one of the pre-job briefings.

Overall, hazards associated with the handling and disposal of waste at Saltstone and E Area have been properly identified, analyzed, and documented through use of site-level work planning and control processes.

5.3.5 Waste Acceptance Criteria, Inventory Control, and Receipt Acceptance

Criteria:

Waste Acceptance Criteria and Inventory Control: WAC for receipt of material to the facility are established based on the facility capabilities in conformance to the facility safety basis, hazards analysis, and limitations in the DAS. Processes are established and implemented to ensure inventory controls, WAC conformance, and documentation of wastes container constituents. Facility inventory records are maintained to accurately reflect receipt, disposal, effluent (leachate or off-gassing) release, and decay transformation of wastes and hazardous materials. Audit and inventory reconciliation processes are implemented. Records archive processes are established to ensure retrievability and traceability to specific waste generators, shipments, and packages. (DOE Order 435.1; DOE Manual 435.1-1, Chapter IV)

Receipt Acceptance: A process is established to verify conformance to the WAC. The process may include a review of certification documentation, shipping manifests, periodic sampling, and/or monitoring of received packages or shipments. Transfer for receipt shall not be authorized unless the supplying facility can certify conformance to the WAC. (DOE Order 435.1; DOE Manual 435.1-1, Chapter IV)

Saltstone Facility

Saltstone conducts facility operations in accordance with approved procedures to meet specified conditions, defined as LIMITS/TARGETS, for the treatment of salt solution and disposal of resulting Saltstone grout. Saltstone Operations only accepts waste and controls inventory through a batch process restricted to the capacity of Tank 50H. Sampling and analysis of the tank contents and a sum-of-fractions calculation is performed and used to compare the radionuclide inventory to the limits. Batches are approved for transfer to the SDF only after verifying compliance with the LIMITS/TARGETS. EA reviewed the procedures and documentation of sampling and calculations for previous batches. This methodology provides reasonable assurance of accurate waste receipt, acceptance, and inventory control. However, EA did note potential weakness in the institutional assessments of generator WAC compliance processes. While cross cutting to all generator WAC certification process evaluations, this weakness is potentially more relevant to the component transfers to the E area and is further discussed in the section below.

E Area Low-level Waste Facility

EA observed receipt and acceptance of a truck shipment of 11 waste containers from HTF for disposal in an engineered trench. The shipment paperwork included a uniform LLW manifest number (HT002306)

signed by the HTF Generator Certification Official on February 2, 2016. SWM workers used SRS Manual SW15, Procedure SW15.1-SOP-REC-01, *Low Level Waste Receipt*, to process this incoming shipment for placement into a temporary staging area, and Procedure SW15.1-SOP-ENGT-01, *Engineered Trench Operations*, to dispose of the containers in the assigned engineered trench. These step-by-step procedures govern the receipt acceptance and disposal operations respectively. Conduct of operations was appropriate, and workers appropriately initialed each procedure step upon completion.

SWM workers performed receipt inspection (including records review and matching physical containers, numbers, and weights with manifest information, and container integrity and accuracy of container labeling) in accordance with the step-by-step procedure. SWM workers entered each container, including the assigned location and disposal unit, into WITS, and verified there were no limit failures, and a SWM designated representative signed the shipment manifest, indicating acceptance. EA also observed disposal of these containers into the engineered trench, which workers performed using the engineered trench operations procedure. In accordance with this procedure, workers completed Attachment 8.1, *Engineered Trench Disposal Datasheet*, including the specific trench used, the specific trench grid coordinates where the container was placed, and the container structural integrity at placement. This information allows for containers to be retrieved at a later time if necessary. This process satisfies the requirements from DOE Manual 435.1-1 IV P (6) (e.) for tracking placement of wastes. All completed operations procedures are transferred to SRS records management for archiving and are available for later retrieval as necessary.

ELLWF's waste certification, evaluation and receipt inspection program consists of several aspects including, but not limited to: 1) Waste stream review and approval prior to receipt, 2) characterization review and acceptance prior to receipt, 3) independent assessments of the generating facilities program, and 4) training and approval of GCOs. Manual 1S *SRS Radioactive Waste Requirements Manual*, Chapter 2, Section 5.6.4, states that "once the waste reaches the Treatment, Storage, or Disposal facility, final checks are performed to assess compliance with the facility WAC. Checks can include, but are not limited to: Manifest/documentation review; Waste package assays (as applicable); Waste package radiographs (prohibited materials); and Intrusive waste package inspections." EA found that aside from document review, SWM does not currently or routinely utilize any of the other final checks outlined in Manual 1S to validate the accuracy of the waste contents and information presented in the shipment paperwork. There are no procedurally implemented requirements or currently instituted practices for performing validation of WAC conformance and certification, such as random sampling, waste package assays, confirmatory surveys, spectrographic monitoring, radiographs, or intrusive waste package inspections as allowed by Manual 1S and DOE Manual 435.1-1. (See **OFI-SWM-2**.)

EA reviewed recent institutional assessments of generator WAC compliance for HTF and Saltstone, and found that these assessments were not sufficiently comprehensive to alleviate the above concern. EA reviewed the completed SRR Functional Area Performance Evaluation CRAD templates for Functional Area 24 (FA 24 Waste Management), which documented results of evaluations of generator characterization and certification processes at HTF in March 2015 and DWPF and Saltstone in January, 2016. These completed CRAD template results are used as input into the waste management sections of larger scale facility Integrated Independent Evaluation (IEE) final reports. While the templates had appropriately defined performance objectives and acceptance criteria to evaluate generator waste characterization and certification, the completed templates lacked sufficient objective evidence of performance-based observations in support of conclusions of effective performance for each acceptance criterion. The "*Work Environments/Activities Performance Observed*" sections contained only generic descriptions of performance-based observations, such as "*LLW packaging/verification activities, LLW container inventory check*," without details on the specific evolutions observed to support conclusions of effective performance contained in the Evaluation Results Section. For example, the evaluation results section requires a detailed report regarding project/facility/organization status versus acceptance criteria. For HTF, Acceptance Criteria 2 requires "*The waste characterization program is implemented, regularly*

evaluated and updated, and is controlled through a formal documentation system." The results section for this criterion consists of a single paragraph that essentially restates the acceptance criteria and adds a few subjective comments such as "*The WCE provides formal calculation notes for characterization of non-routine wastes and maintains a close relationship between the facility system engineers, waste TSD engineers and facility waste management personnel to ensure accurate curie calculations are provided for waste packages*". The results narrative provides no examples of what was observed or reviewed to support such conclusions, and the same exact verbiage is also presented in acceptance criterion 2 of the DWPF/Saltstone results as well as the activities observed section. Other Acceptance Criteria results sections from these assessment reports also contain similar concerns with insufficient objective substantiation of conclusions. (See **OFI-SRR-1**.)

With regard to generator self-assessments, EA also reviewed recent HTF self-assessments of waste management operations, including characterization and WAC compliance. These self-assessments were thorough, generally effective in identifying issues and areas for improvement, and contained sufficient objective evidence of a performance-based approach in the documentation of results.

5.3.6 Support Facility and Disposal Cell Design and Operations

Criteria:

Support Facility and Disposal Cell Design and Operations: The following facility requirements and general design criteria, at a minimum, apply:

- *LLW systems and components shall be designed to maintain waste confinement.*
- *Ventilation: Staging, assay, and disposal facilities are designed and maintained with appropriate ventilation controls that consider normal conditions, such as off-gassing, and potentially off-normal situations, such as an energetic event or area fire. Ventilation controls shall prevent deflagration or detonation; protect health and safety of facility workers from acute and chronic exposures; and ensure that airborne effluents are maintained within applicable requirements and guidelines.*
- *Disposal facilities are designed and maintained with appropriate monitoring and controls for personnel exposures to direct radiation, contamination, chemical, and physical hazards, considering both normal and potential off-normal situations.*
- *Disposal facilities are designed and maintained to control contamination or prevent or minimize release of the material during normal operations and during off-normal conditions or emergency events.*
- *Facilities shall include sufficient capacity for controlling site runoff and dewatering of disposal cell operations (i.e., removal, containment, monitoring, and if necessary treatment, and/or effluent release of leachate and contact water).*
- *Disposal facilities and systems are designed, maintained, and managed to conform to applicable National Fire Protection Association code requirements. (DOE Order 435.1; DOE Manual 435.1-1, Chapter IV) CRAD 31-11, Section 4.7.2, Criteria 4*

Saltstone Facility

With one exception, the Saltstone support facility and disposal operations that EA observed met the requirements of DOE Order 435.1, Manual 435.1-1, and Order 458.1. Most disposal facilities are designed and maintained to control contamination or prevent or minimize release of the material during normal operations and during off-normal conditions or emergency events. However, EA observed a deficiency with the implementation of one aspect of DOE Order 458.1, *Radiation Protection of the Public and the Environment*. Specifically, management of potential environmental radioactive contamination resulting from low-level radioactive contaminated storm water runoff from Saltstone Disposal Unit 4 (SDU 4) and the associated contamination areas around the facility was inadequate. Corrective measures taken to address runoff from contamination areas in response to heavy rain events and the associated impact to Storm Water Outfall Z-01 do not meet the requirements of DOE Order 458.1 (4) g., this subsection addresses *Control and Management of Radionuclides from DOE Activities in Liquid Discharges*. This section specifically states a requirement to "Manage the disposition of non-process water potentially containing radionuclides from DOE activities to protect soil and groundwater and prevent the creation of future cleanup sites."

Rainwater which carries contamination from the SDU 4 area to the storm water drain line flows to Basin No. 4. This basin only discharges if the water level reaches the height of spillway. The spillway from Basin No. 4 flows to Storm Water Outfall Z-01, where additional radiological contamination was deposited due to an overflow during heavy rains in February 2013. A second area (so far radiologically uncontaminated) has been excavated to expand sedimentation basin capabilities to 100-year storm event, minimizing further contamination of the Z-01 outfall. However the addition of this unlined excavation to expand capacity, which if used would result in the spread of radiological contamination to a previously uncontaminated area, does not meet the requirements of DOE Order 458.1 (4) (g) for managing the disposition of non-process water potentially containing radionuclides from DOE activities to protect soil and groundwater and prevent the creation of future cleanup sites. **(Deficiency)**

E Area Low-level Waste Facility

ELLWF active disposal units are open and generally uninhabited areas designed to accept waste for permanent disposal and therefore are not equipped with ventilation systems or real-time radiological monitoring systems. As discussed in Section 5.3.2, SWM personnel conduct routine environmental monitoring and sampling to detect any potential migration of contaminations from the disposal units. During waste placement activities, radiological exposures are managed through the use of radiological work permits and job coverage. Off-normal events, such as fire, spills, releases, and natural phenomenon events, invoke specific emergency operating procedures, driving the appropriate response actions to ensure personnel safety.

Trench areas are controlled areas. Aside from potential external exposure to radiation fields, SWM considers these areas radiologically uncontaminated. Contamination monitoring is principally performed as localized checks of the containers during waste placement or as sample analysis prior to sump dewatering activities following a heavy rain. As described later in Section 5.3.7, lysimeter coverage in E Area is intended to monitor for any releases of contaminants to the upper permeable soils surrounding the waste trenches prior to reaching groundwater. However lysimeter coverage is not comprehensive around all active disposal units, and plans for adding lysimeters adjacent to active disposal cells are largely undocumented. Lysimeters are typically placed after a segment is backfilled and covered. SWM does not coordinate waste placement with lysimeter or sampling well placement. Therefore, some waste containers that are covered with fill and no longer available for visual inspection could breach or degrade and release contaminants into the soil or into adjacent active areas of open trenches, without any contamination monitoring to protect workers in open portions of the trench and/or detect environmental

migration. While trench areas do undergo limited radiation and contamination surveys on a monthly basis, and health physics coverage is provided during trench operations, contamination surveys during observed trench operations were limited to shipment receipt surveys and forklift forks after completion of waste placement. Contamination surveys of forklift tires and direct measurements of ground surfaces were not performed, and workers are not required to undergo hand and foot monitoring before leaving these areas. Such ground surveys, equipment tire surveys, and/or personnel clearance checks would serve as the initial or only indicator of an emerging off-normal condition, such as a leaking or ruptured container. The lack of these surveys could result in the inadvertent spread of contamination to clean areas outside of radiological controls. (See **OFI-SWM-3**.)

5.3.7 Environmental Monitoring

Criteria:

Monitoring Plan: A preliminary monitoring plan for an LLW disposal facility shall be prepared and submitted to Headquarters for review with the PA and CA. Plans shall be implemented to ensure sufficient monitoring of groundwater, surface water, gaseous or particulate effluent releases, and ambient radiation conditions to evaluate conformance to the PA and CA objectives. (DOE Order 435.1; DOE Manual 435.1-1, Chapter IV) CRAD 31-11, Section 4.7.1, Criteria 3

Monitoring: Capabilities and procedures shall be implemented to ensure sufficient monitoring of ground, surface, leachate, or contact water; gaseous or particulate effluent releases; and ambient radiation conditions to evaluate conformance to the PA. The monitoring plan shall be updated within one year following issuance of the DAS to incorporate and implement conditions specified in the DAS and address changes identified during operations. Plans will be reviewed and updated whenever changes in conditions or operations are identified. (DOE Order 435.1; DOE Manual 435.1-1, Chapter IV) CRAD 31-11, Section 4.7.2, Criteria 7

DOE Manual 435.1-1 IV requires the following attributes for the monitoring plan:

- The site-specific performance assessment and composite analysis shall be used to determine the media, locations, radionuclides, and other substances to be monitored.

- The environmental monitoring program shall be designed to include measuring and evaluating releases, migration of radionuclides, disposal unit subsidence, and changes in disposal facility and disposal site parameters which may affect long-term performance.

- The environmental monitoring programs shall be capable of detecting changing trends in performance to allow application of any necessary corrective action prior to exceeding the performance objectives

Both the Saltstone facility and the ELLWF have developed and implemented monitoring plans.

Saltstone Facility

The Saltstone monitoring plan is documented in SRR-CWDA-2013-00026, *Performance Assessment Monitoring Plan for the Saltstone Disposal Facility at the Savannah River Site*. Additional underlying plans and procedures provide further instructions for sample collection, laboratory analysis, and data reporting and trending.

EA reviewed the groundwater monitoring plans and monitoring results for the Saltstone area for the last five years and found that the sample request and analysis process comprehensively included all significant constituents in the waste. Positive signals exceeding the gross alpha and gross beta Practical Quantitation Limits triggered more detailed analysis for a wide range of analytes. Samples at a few locations, including samples that evaluate the impact of the SDU 4 leak, showed positive indications for Tc-99. All analyses indicate that the values are well below the applicable performance dose objectives. The positive indications in the data do not indicate any challenges to the assumptions for the modeling supporting the PA. General flow patterns support the assumptions in the General Separations Area flow model.

E Area Low-level Waste Facility

The ELLWF monitoring plan is documented in SRNL-RP-2009-00534, *Performance Assessment Monitoring Plan for the E-Area Low Level Waste Facility*. The ELLWF is adjacent to the old radioactive waste burial ground, which received wastes between 1952 and 1972. It is also adjacent to the Mixed Waste Management Facility, which received waste from 1968 through 1995 and was closed under a CERCLA/RCRA ROD in 2007. While the old radioactive waste burial facility is mostly on the other side of a groundwater divide, the MWMF facility is in an up gradient location that contributes to a known migrating plume of tritium that extends partially under the ELLWF facility. The monitoring plan states that this plume makes separating the signals from the various facilities in groundwater samples problematic.

In an effort to monitor only for the signal from the ELLWF engineered trenches and slit trenches, lysimeters have been placed in the vadose zone (upper, more permeable soil above the confining clays and deeper Gordon aquifer) near the edges of the trenches. Lysimeters are PVC pipes with a porous ceramic sampling head attached at the bottom. Per interviews with sampling managers, the effective sampling range for a lysimeter is between 5 and 10 feet around the location of the sample head, but that is subject to the local flow paths, fissures, and confining layers in the surrounding soil that impact water mobility. Samples are collected semiannually and sent for laboratory analysis in accordance with a predetermined sample request process. Typical collected sample volumes are approximately 250 ml, which is less than the 1,000 ml currently used by the counting laboratory for sensitive non-volatile alpha beta screening protocol. ELLWF personnel indicated that lysimeters are typically placed after initial backfill and in areas that would not likely be impacted by operations to avoid damage by the heavy equipment during waste placement. While allowing lag time in placement of the lysimeter protects them from damage by heavy equipment, this may leave a period of time during waste emplacement in which no monitoring capability is in place to detect a leaking or ruptured container. Further, EA observed that many of the trenches only had lysimeters on the sides and ends closest to the access road. ELLWF personnel indicated that this is partially due to the surface contours toward the opposite ends of the trenches that make installation more challenging. Because of the limited range of sampling for the lysimeters, leaching from a waste container at the far end of a trench would likely go undetected. This is contrary to the Manual 435.1-1 IV R (b.) and (c.) requirements that the monitoring program be designed to include measuring and evaluating releases and migration of radionuclides which may affect long term performance and be capable of detecting changing trends in performance to allow any necessary corrective action prior to exceeding the performance objectives. (**Deficiency)**

Routine groundwater well sampling is performed by SRNS Environmental Compliance and Area Completion Projects in support of the RCRA permits for the Mixed Waste Management Facility (MWMF). Some of these sampling wells are located down gradient from the E Area trenches and vaults. This sampling is analyzed by the SRNS EBL and reported back through SRNS Environmental Compliance and Area Completion Projects for RCRA compliance evaluation of the mixed waste facility. These samples are analyzed for tritium, several other radionuclides, and many non-radiological chemical

hazards in accordance with the RCRA permit. Although the final report data may be available upon request to the reviewers for the E Area, a formal documented process is not currently implemented to support confirmation of the ELLWF performance objectives and PA verification. Currently any signals identified in these sampling wells are presumed to be from facilities other than the ELLWF. The Environmental Bioassay Laboratory (EBL) is not currently requested to analyze for potential markers of the ELLWF waste constituents in these samples. (See **OFI-SWM-4**.)

Samples that are collected from the ELLWF lysimeters are sent for analysis at the same EBL laboratories that are used by the SDF and RCRA facility radiological analysis. In an effort to ensure only necessary analysis is performed, a cost-recovery chargeback system is used to limit the requested counting processes and analytes reported. The EBL is instructed only to analyze and report the specific requested analytes. Current ELB counting protocols used for ELLWF samples are set for reporting only the low energy beta signals in the H-3 channel, even though a liquid scintillation counter also can receive signals in the mid energy range "carbon-14" channel, and the high energy range "phosphorus-32 channel". Since the analyte requests are for tritium, only the results in the tritium channel data will be reported. Unlike the SDF which reliably draws larger samples from the sampling wells, the ELLWF lysimeter sample volumes are typically limited to a few ml. SDF analysis using a 1,000 ml sample includes gross alpha beta screening as well as a broad range of other analyte measurement techniques. However the routine requests from the ELLWF are currently limited to 10 ml liquid scintillation counting for tritium, which does not encompass the major isotopes present in many waste packages. Alpha beta screening analysis that could identify migration of other isotopes is not routinely requested or performed. Contrary to the requirements of Manual 435.1-1 the analysis process does not screen or evaluate the presence of significant radionuclide constituents in the waste other than tritium. Depending on the analysis period, H-3 may not be a significant contributor to receptor doses. The ELLWF monitoring plan does not effectively use the PA to determine the radionuclides and other substances to be monitored. The monitoring program is not adequately designed to measure and evaluate releases, migration of radionuclides, or detect changing trends in performance to allow corrective actions. **(Deficiency)**

5.3.8 Closure Plan Development and Maintenance

Criteria:

Closure Plan: The disposal facility design and operation must be consistent with the disposal facility closure plan and lead to disposal facility closure that provides a reasonable expectation that performance objectives will be met. (DOE Order 435.1; DOE Manual 435.1-1, Chapter IV) CRAD 31-11, Section 4.7.2, Criteria 6

Closure Plan Development and Maintenance: A preliminary closure plan shall be developed and submitted to Headquarters for review with the PA and CA. The closure plan shall be updated following issuance of the DAS to incorporate conditions specified in the DAS. (DOE Order 435.1; DOE Manual 435.1-1, Chapter IV) CRAD 31-11, Section 4.7.3, Criteria 1

Prompt Closure Processes: Closure of a disposal facility shall occur within a five-year period after it is filled to capacity, or after the facility is otherwise determined to be no longer needed. (DOE Order 435.1; DOE Manual 435.1-1, Chapter IV) CRAD 31-11, Section 4.7.3, Criteria 2

Institutional Controls and Monitoring: Monitoring plans shall be implemented to support verification of performance objectives during a period of post-closure administrative control. (DOE Order 435.1; DOE Manual 435.1-1, Chapter IV) CRAD 31-11, Section 4.7.3, Criteria 4

An essential aspect of operating a disposal facility is to ensure that, after the waste is in place, it will not require additional treatment, relocation, or significant long-term maintenance to satisfy the performance objectives for safety of the public and environment. Multiple sections of DOE Manual 435.1-1 reiterate the need for disposal facility siting, design, operations, and waste forms to achieve long-term stability, minimize slumping, and minimize the need for long-term maintenance.

Saltstone Facility

SRR-CWDA-2013-00037, *Closure Plan for the Z-Area Saltstone Disposal Facility*, was updated by SRR in September 2015. The closure plan addresses evaluation of waste form stability, reduction of water infiltration, prevention of human intrusion, and minimization and impact of plant and animal intrusion-based migration of the waste constituents. The waste form utilized at SDF is a concrete grout mixture that fills the disposal unit cells. The final waste monolith is expected to be stable and have negligible void space that would allow subsidence. As required by the PA maintenance plan, ongoing laboratory and field tests and observations are performed to verify the integrity and long-term performance of the waste matrix. These tests and observations indicate that acidic groundwater attack on the matrix would have the greatest potential to impact TC-99 migration (as is noted as a primary constituent in the SDU4 area contamination). The testing results support the conclusion that the waste stability criteria are satisfied. The preliminary design of the closure cap uses a combination of natural and man-made drainage layers and barriers to inhibit groundwater infiltration into the waste monoliths. The closure plan recognizes that these barriers will degrade over time due to natural reforestation processes, but the impact of this degradation is considered in the performance evaluation modeling. The PA and closure plan indicate that the concrete structures and the waste form are expected to inhibit drilling or other forms of intrusion into the waste monolith. M435.1-1 *Chapter IV section* Q *Closure* (2) *Disposal Facility Closure* states "Closure of a disposal facility shall occur within a five-year period after it is filled to capacity, or after the facility is otherwise determined to be no longer needed." The approved closure plan acknowledges that placement of the final closure cap over the entire facility will take significant time to complete because of the large volume of covering material that must be placed. This operation is planned to begin before final waste placement operations and once major sections are filled to capacity.

The closure plan for the SDF adequately addresses each review criterion and helps ensure long-term performance of the facility with minimal need for maintenance or remediation.

E Area Low-level Waste Facility

SRNL-RP-2009-00075, *Closure Plan for the E-Area Low-Level Waste Facility*, indicates that closure will be performed in three phases: operational closure; interim closure; and final closure.

During the ongoing operational closure phase, as each trench is filled to capacity the trench is backfilled with local fill material and mounded before a synthetic operational cover is placed over the filled trench to minimize water infiltration through the waste. The already-installed operational covers are routinely inspected and repaired or replaced as necessary.

The PA anticipated that the interim closure period would begin in 2025, although at this time it is likely that operations will extend beyond 2025. Once all the ELLWF trenches and vaults are filled to capacity at the end of operations a low permeability interim cover will be installed over the entire ELLWF. The plan requires final inventories to be recorded, and the PA and monitoring plans to be updated as part of the transition to the interim closer phase. Permanent markers will be placed and land use restrictions will be registered with the appropriate local governments. Once completed the facility will begin an interim closure period expected to last throughout the 100-years of institutional control. The plan indicates that

regular and extended maintenance for trench subsidence and cover degradation is anticipated during this 100-year interim closure period.

In accordance with the WAC, waste received at the ELLWF typically consists of job wastes (e.g., plastic, anti-c coveralls, shoe covers, lab coats) inside transport containers, such as B-25 boxes, B-12 boxes, sea land containers, or 55 gallon drums; contaminated components inside similar transportation containers; or larger items, such as pipes, pumps, or reactor components that are not significantly externally contaminated and are sealed shut at the flanges and buried directly in the trenches. At the time of this assessment, empty contaminated concrete shield casks were being staged for direct disposal. The WAC requires filling void spaces where practical but does not require specific measurable criteria. In this case the potential hazards of opening the contaminated casks at the E area has been determined to make the void filling impractical. There are no currently implemented practices for compacting wastes to ensure long-term stability. In November 2001, DOE-SR approved a contractor provided plan to discontinue use of a compactor facility based on an economic evaluation of the cost of pre-disposal processing versus the cost of a larger volume waste disposal facility. Many of the boxes or components placed in the ELLWF disposal trenches since that time have had significant amounts of compressible material. The PA and closure plan indicate that the outer containers will corrode and eventually lose structural integrity. As this occurs, the covering over the trenches will collapse. The closure plan indicates that there is a high potential for localized subsidence up to13.5 feet occurring between 50 to 500 years after burial depending upon the waste form or containers. The closure plan further indicates that dynamic compaction after the operational period (prior to full container degradation) will reduce subsidence by at most 50 percent. Therefore the closure plan includes a 100-year interim closure period before dynamic compaction and placement of a final closure cap. Facility personnel indicated a similar process was used earlier for the old burial facilities and described the process as using a large weight dropped over the waste trenches from a crane to ensure compaction and collapse of any remaining un-compacted waste containers. While describing the previous application, personnel stated that rapid ejection of air or infiltrated liquids occurred when the weight penetrated voids. While successfully and safely performed for the previous facilities, this process has potential for creating airborne or environmental release of materials and should be evaluated in balance to the hazards of pre-disposal treatments.

There are sound short-term technical rationale based on the current expense and hazards of pre-disposal compacting and void filling the waste containers to justify disposal of un-compacted wastes. However, the current practice without waste form stabilization before disposal will require long-term costs, hazards of extended maintenance periods to address subsidence, delayed dynamic compaction, and potential need for future remediation to protect the public and the environment. This un-compacted disposal appears incompatible with expectations in portions of the M-435.1-1 manual for waste form stability and minimizing the need for active long-term maintenance of disposal facilities, and minimizing subsidence. Specifically these include: Manual 435.1-1 Chapter IV G Waste Acceptance (1) Technical and Administrative (d) 1. requirements that “Low level waste contribute to and not detract from achieving long-term stability of the facility, minimize the need for long-term active maintenance, and minimize subsidence“, and Manual 435.1-1 section M Site Evaluation and Facility Design, and section P (6) Disposal Facility Operations, and section Q. Closure, that facilities are designed, operated, and closed to achieve long-term stability and minimize the need for active maintenance following closure. The ELLWF PA and closure plans state that currently accepted waste disposal practices will result in subsidence and the need for extended (100 year) maintenance periods after the facility is filled to capacity. These current practices will require future expenditures to assure appropriate long term maintenance of these facilities. The identified issue is intended to assure DOE management is appropriately aware of their potential risks and liabilities and has appropriate means to manage those liabilities in the future. The DOE Office of Environmental Management should review the practices and consider the ramifications as they relate to policies and near-term verses long-term commitments. The

issue should be considered during EM efforts to update the Department's radioactive waste management directives, enhancing clarity in the intended outcomes and requirements. (See **OFI-EM-1**.)

Manual 435.1-1 requires closure of a disposal facility shall occur within a five-year period after it is filled to capacity, or after the facility is otherwise determined to be no longer needed. M435.1-1 includes an institutional control period following closure, during which minimal maintenance is required and monitoring is performed to evaluate the final performance of the stable facility. This period allows for discovery of performance challenges and any necessary modifications to ensure long-term performance. Dynamic compaction and placement of the final cover near the end of the 100-year institutional control period will either require extending this necessary performance monitoring and evaluation period, resulting in additional long term costs to DOE or successor organizations, or result in the final closure being unmonitored and unevaluated. (See **OFI-SWM-5**.) While the past practices will require extended maintenance of the already filled disposal cells, enhanced waste stability criteria and pre disposal processing for waste that has not yet been disposed of may reduce future liabilities.

6.0 FINDINGS

EA identified no findings during this assessment. Deficiencies that did not meet the criteria for a finding are listed in Appendix C of this report, with the expectation from DOE Order 227.1A for site managers to apply their local issues management processes for resolution.

7.0 OPPORTUNITIES FOR IMPROVEMENT

EA identified some OFIs to assist cognizant managers in improving programs and operations. While OFIs may identify potential solutions to findings and deficiencies identified in appraisal reports, they may also address other conditions observed during the appraisal process. EA offers these OFIs only as recommendations for line management consideration; they do not require formal resolution by management through a corrective action process and are not intended to be prescriptive or mandatory. Rather, they are suggestions that may assist site management in implementing best practices or provide potential solutions to issues identified during the assessment.

Solid Waste Management

OFI-SRR-1: Consider improving the conduct and/or documentation of Functional Area Performance Evaluation CRAD templates used to support SRR IIE reports, ensuring all conclusions are supported and based on observed field performance and objective documentary evidence presented in the results sections.

OFI-SWM-1: Consider updating the E area PA analysis of migration pathways to include receptor dose contributions driven by natural processes that result in barrier disruptions and biotic up an out pathways that are currently discounted by generalized assumptions in Part C *Background* Section 4.2 *Transport and Exposure Pathway Screening.*

OFI-SWM-2: Consider instituting procedural requirements for use of additional verification methods identified in Manual 1S such as use of assays, radiographs, and intrusive physical inspection to periodically validate the generator's certification process, and to supplement current manifest and document reviews.

OFI-SWM-3: Consider implementing additional radiological contamination survey requirements for trench work areas, equipment, and workers. Specifically these should consider clearance surveillances following work evolutions or prior to leaving the facility so as to detect potential off normal conditions such as a leaking waste container.
OFI-SWM-4: Consider improving coverage and analysis sensitivity for the ELLWF monitoring by: including sampling or data analysis from the down gradient RCRA facility sample wells; providing enhanced geometric coverage around the cells using additional lysimeters; utilizing alpha beta screening techniques for sample analysis; and expanding the range of analytes to include other significant isotopes in addition to tritium in the waste streams.

OFI-SWM-5: Consider evaluating the impact and costs of performing dynamic compaction and final closure at the end of 100 year institutional control period, as balanced with the need for monitoring following closure. Additional stable monitoring time beyond the 100 year administrative control period may be necessary to assess performance of the stable closed system.

OFI-EM-1: EM management should consider the impacts of current practices regarding waste stability and potential compressibility or void spaces inside containerized waste on the potential for cap subsidence and the risks and costs of long term maintenance. Currently DOE M 435.-1 includes expectations for waste forms to contribute to long term stability, but does not provide measurable metrics. Ongoing efforts to update the directives should clarify DOE expectations and balance the near term costs and hazards of pre-disposal waste stabilization processes relative to the long term costs and hazards for extended disposal facility maintenance.

Appendix A
Supplemental Information

Onsite Dates of Review:

Scoping: February 1-4, 2016
Data collection: February 29 – March 3, 2016

Office of Enterprise Assessments (EA) Management

Glenn S. Podonsky, Director, Office of Enterprise Assessments
William A. Eckroade, Deputy Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments
William E. Miller, Deputy Director, Office of Environment, Safety and Health Assessments
Patricia Williams, Director, Office of Worker Safety and Health Assessments
Gerald M. McAteer, Director, Office of Emergency Management Assessments

Quality Review Board

William A. Eckroade
John S. Boulden III
Thomas R. Staker
William E. Miller
Patricia Williams
Gerald M. McAteer
Michael A. Kilpatrick

EA Site Lead for the Savannah River Site

Jeff Snook

EA Reviewers

Timothy Mengers – Lead
Joseph Lischinsky
Mario Vigliani

Appendix B
Key Documents Reviewed, Interviews, and Observations

Documents Reviewed

- *Disposal Authorization Statement for the Savannah River Site's E-Area Low-Level,* July 2008
- *Waste Facility and Compliance Evaluation of the Performance Assessment for Disposal in the E-Area Low-Level Waste Facility at the Savannah River Site,* July 2008
- *Review Team Report for the E-Area Low Level Waster Facility DOE 435.1 Performance Assessment at the Savannah River Site, February* 4, 2008
- WSRC-STI-2007-00306, Rev. 0, *E-Area Low Level Waste Facility DOE435.1 Performance Assessment,* July 2008
- SRNL-RP-2009-00534, Rev. 1, *Performance Assessment Monitoring Plan for the E-Area Low Level Waste Facility,* August 2012
- SRNS-OS-2012-00148, DOE letter of review and acceptance for SRNL-RP-2009-00534, Rev. 1
- SRNL-RP-2009-00075, REV. 0, *Closure Plan For The E-Area Low-Level Waste Facility,* March 16, 2009
- DOE letter of review and acceptance for SRNL-RP-2009-00075, May 2009
- SRR-CWDA-2009-00017, Rev. 0, *Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site,* October 2009
- *Review Team Report on the Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site,* November 2009
- *Review Team Report on the FY2014 Special Analysis to the 2009 Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site,* October 2014
- SRR-CWDA-2013-00026, Rev. 1, *Performance Assessment Monitoring Plan for the Saltstone Disposal Facility At The Savannah River Site,* August 2015
- WRSC-TR-2005-00257, Rev. 5, *Groundwater Monitoring Plan for the Z-Area Saltstone Disposal Facility*, July 2010
- WSRC-STI-2008-00244, *Saltstone Disposal Facility Closure Cap Concept and Infiltration Estimates,* May 2008
- SRR-CWDA-2013-00037, Rev. 1, *Closure Plan for the Z-Area Saltstone Disposal Facility,* September 2015
- SRR-CWDA-2013-00058, Rev.1, *Dose Calculation Methodology for Liquid Waste Performance Assessments at the Savannah River Site*, July 2104
- SRNL-STI-2009-00512, REV. 0, *Savannah River Site DOE 435.1 Composite Analysis Volume I*, June 2010
- SRNS-RP-2013-00162, *Savannah River Site Land Use Plan,* May 2013
- WSRC-TR-2003-00436, Rev. 0, *Saltstone Disposal Facility Closure Cap Configuration and Degradation Base Case: Institutional Control to Pine Forest Scenario,* September 22, 2003
- Memorandum: *Disposal Authorization Statement for the Savannah River Site Saltstone Disposal Facility,* May 21, 2012
- DNFSB recommendation 94-2 and the associated DNFSB Tech/2, *Low-Level Waste Disposal Policy for Department of Energy Defense Nuclear Facilities Defense Nuclear Facilities Safety Board Technical Report*, September 14, 1994
- 1B Manual Procedure 3-31 *Records Management, Revision 10, 01/17/2013*
- 8Q Manual Procedure 122, *Task Level Hazard Analysis, Revision 11, 09/10/2015*
- 1-01 Manual Procedure 1-22 *Integrated Safety Management System, Revision 9, 07/15/2010*
- 1Q Manual Procedure 2-1 *Quality Assurance Program, Revision 10, 10/14/2011*
- 1Q Manual Procedure 2-2 *Personnel Training and Qualification, Revision* 7, 10/13/2011

- 1Q Manual Procedure 2-7 *QA Program Requirements for Analytical Measurement Systems, Revision 8,* 12/17/2008
- 1Q Manual Procedure 9-4 *Work Planning and Control, Revision 13*, 12/17/2008
- Manual 1 S, *SRS Radioactive Waste Requirements Manual, Chapters 1, 2, 4 and 5, Revision 0*, 01/01/2012
- Manual 1 S, *SRS Radioactive Waste Requirements Manual, Chapter 3, Revision 1*, 03/27/2013
- 4B Manual, Chapter 1, *Training and Qualification Program, Revision 2*, 07/31/2015
- Q-RWM-E-00001, *Savannah River Nuclear Solutions (SRNS) Solid Waste Management (SWM) Radioactive Waste Management Basis* (RWMB), Revision 4, July, 2014
- Q-RWM-Z-00001, Rev. 3, *Savannah River Remediation (SRR) Saltstone Facility Radioactive Waste Management Basis*, February 2016
- WSRC-SA-22, Rev. 24, *Savannah River Site Solid Waste Management Facility Documented Safety Analysis*
- WSRC-SA-2003-00001, Rev. 6, *Saltstone Facility Documented Safety Analysis*
- SRNL-RP-2009-00534, *Performance Assessment Monitoring Plan For The E-Area Low Level Waste Facility*
- Q-CLC-H-00204, *Revalidation of Tank Farm Supernate Low Level Radioactive Waste Stream*
- Engineering Calculation Q-CLC-H-00502, *Characterization of H-Tank Farm Containers HT13009792 and HT13009884*
- SW15 Manual, Procedure SW15.1-SOP-REC-01, *Low Level Waste Receipt, Revision 39, 02/02/2016* and associated AHA Hazard Report
- SW15 Manual, Procedure SW15.1-SOP-ENGT-01, *Engineered Trench Operations, Revision29, 01/15/2016* and associated AHA Hazard Report
- SW15 Manual, Procedure SW15.1-SOP-NRCDA-01, *Naval Reactors Component Disposal Area Operations, Revision 10, 01/12/2016* and associated AHA Hazard Report
- Manual Y10.9 Procedure 9-32050, *Control of Site Services Rigging Ordinary Lifts,* for Naval Reactors Casks, Revision 0, 02/02/2012
- SW15 Manual, Procedure SW15.5-EOP-01, *Fire/Explosion, Revision 16, 02/09/2016*
- SW15 Manual, Procedure SW15.5-EOP-02, *Spills/Releases, Revision 17, 01/20/2012*
- SW15 Manual, Procedure SW15.5-EOP-03, *Tornado, High Winds, Earthquake, Thunderstorms, and Lightning (Natural Phenomenon), Revision19, 10/10/2013*
- Requirements Specification for Software for the Waste Information Tracking System
- Solid Waste Management Waste Information Tracking System, *Low Level Waste Training Guide*
- X-SD-Z-00001, *Waste Acceptance Criteria for Aqueous Waste Sent to the Z-Area Saltstone Production Facility (WAC)*
- OPS-SO-LWO.01, Rev. 13, *Pre-Job Briefings*
- Work Package associated with Work Order 01466840, *Replace Failed Motor ECR Room Air Handling Unit*
- X-ESR-H-00052, Rev. 6, *Sampling Methodology for CSTF DSA Administrative Programs,*
- Mission statement, *Data Integrity Review Team (DIRT)*, H-Area Tank Farm
- Saltstone recent radiological surveys for outdoor areas around SDU 4 and the Z-01 basin
- SRR presentation of, *Z Area Salt Disposal Facility Update Presentation to the Citizens Advisory Board,* September 23, 2014
- SRR-WTF-2013-00012, SRR 2013 presentation of the *status of Z-Area Retention Basin No. 4 and Z-01 Storm Water Outfall*
- APO&C Functional Area Performance Evaluation, *F&H Tank Farms/ETP Solid Waste Management-Characterization and Certification, March, 2015*
- APO&C Functional Area Performance Evaluation, DWPF and Saltstone *Solid Waste Management-Characterization and Certification, January, 2016*

Interviews

- SRNS SWM Director
- SRNS SWM Facility Support Manager
- SRNS SWM Waste Stream Engineers
- SRNS SWM Waste Certification Engineers
- SRNS SWM Procedure Writer
- SRNS SWM LLW Operations First Line Managers
- SRR HTF LLW Characterization Program Lead
- SRR HTF LLW Characterization Engineer
- SRNS Lead Design Authority Engineer
- SRS Lead for Closure and Disposal Assessments
- HTF Sample Coordinator
- Saltstone Operators
- Saltstone Shift Supervision
- Saltstone Shift Manager
- Saltstone Radiation Control Technician
- Saltstone Maintenance Electricians
- Saltstone Maintenance Fitters
- Saltstone Maintenance Supervision
- Environmental Bioassay Laboratory Supervisor
- Environmental Bioassay Laboratory Technicians
- Technical Advisor for GSA at ACP
- Groundwater sampling technicians
- GSA Groundwater Modelers

Observations

- LLW Shipment Receipt and Acceptance of HTF Waste Shipment into E-Area
- E Area Engineered Trench Waste Placement Operations
- E Area Slit Trench Waste Placement Operations
- E Area Naval Reactors Disposal Area Waste Placement Operations
- SWM PODs and Shift Turnover Meetings
- SWM Pre-job briefings for Waste Shipment Receipt and Placement and Naval Reactors Component Waste Placement
- Saltstone Plan of the Day (POD) meetings
- Saltstone Shift Turn-over meetings
- Saltstone Pre-job briefings
- Saltstone placement and/or verification of several Lockout/Tagouts (LOTOs)
- Saltstone worker walk down associated with a maintenance work package
- Saltstone operator rounds completion of round sheets
- Saltstone operations meeting related to a Trend Analysis for the production run of 2/25/2016
- Saltstone walk downs of operational facilities, disposal units and associated outdoor areas
- Observed Lysimeter Sampling process
- Toured Environmental Bioassay Laboratory

Appendix C
Deficiencies

Deficiencies that did not meet the criteria for a finding are listed below, with the expectation from DOE Order 227.1A, *Independent Oversight Program*, for site managers to apply their local issues management processes for resolution.

- The H Area Tank Farms did not ensure that highest surface or far-field dose rates were used to calculate radioactivity content of a waste container as required by Manual 1S, *SRS Radioactive Waste Requirements Manual*. Manual 1S does not adequately address dose rate measurements taken on the top or bottom of a box, and whether re-calculation of activity is necessary when subsequent dose rate measurements taken for any reason are significantly higher than those used for the original characterization, which may result in non-conservative estimation of the curie content. In some cases the calculated curie content based on the higher measurements may exceed WAC limitations.

- The addition of an expanded unlined excavation in Z Area to accept contaminated overflow from Z-01 does not meet DOE Order 458.1(4) (g), *Radiation Protection of the Public and the Environment*, requirements related to environmental contamination control.

- Contrary to requirements in Manual 435.1-1 Chapter IV R (3) a, b and c., the ELLWF monitoring is not sufficient to evaluate releases, measure migration, or detect changing trends in disposal facility performance. Placement of ELLWF lysimeters does not ensure sufficient coverage to detect and evaluate releases of radionuclides from potentially ruptured or degraded waste containers that are not in close proximity to the monitors. The ELLWF monitoring and sample analysis process currently limited to tritium is not capable of detecting many of the potentially significant isotopes in the waste packages and is therefore insufficient to evaluate the performance of the disposal facility.