SRMC-CWDA-2022-00006
Revision 0

Savannah River Site Liquid Waste Facilities Performance Assessment Maintenance Program

FY2022

Approved by:

Date: 2022.05.24
13:02:46 -04'00'

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May 2022

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SRMC SAVANNAH RIVER MISSION COMPLETION

Prepared for U.S. Department of Energy Under Contract No. 89303322DEM000068

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS/ABREVIATIONS

ARP	Actinide Removal Process
ASR	Alkali-Silica Reactivity
ADMP	Advance Design Mixer Pump
ALARA	As Low As Reasonably Achievable
APR	Air Pathway Release
ASTM	American Society for Testing and Materials
BFS	Blast Furnace Slag
CA	Composite Analysis
CAB	Citizens Advisory Board
CBP	Cementitious Barriers Partnership
CC	Clarifying Comment
CFR	Code of Federal Regulations
CLSM	Controlled Low Strength Material
CZ	Contamination Zone
DAS	Disposal Authorization Statement
De	Effective Diffusivity
DLM	Dynamic Leaching Method
DO	Dissolved Oxygen
DOE	U.S. Department of Energy
DOE-SR	U.S. Department of Energy Savannah River Operations Office
Eh	Measure of Reduction (or Oxidation) Potential
EPA	U.S. Environmental Protection Agency
FDB	F-Area Diversion Box
FEPs	Features, Events, and Processes
FFA	Federal Facility Agreement
FTF	F-Area Tank Farm
FY	Fiscal Year
GCL	Geosynthetic Clay Liner
GGBFS	Ground Granulated Blast Furnace Slag
GSA	General Separations Area
GWB	Geochemist's Workbench
HDPE	High Density Polyethylene
HRR	Highly Radioactive Radionuclide
HTF	H-Area Tank Farm
ICM	Integrated Conceptual Model
ICP-MS	Inductively Coupled Plasma – Mass Spectrometry

IHI	Inadvertent Human Intruder
K_d	Distribution Coefficient
LFRG	Low-Level Waste Disposal Facility Federal Review Group
LI	Leachability Index
LLW	Low-Level Waste
LW	Liquid Waste
LWO	Liquid Waste Organization
MCC	Moisture Characteristic Curve
MCU	Modular Caustic Side-Solvent Extraction Unit
MEP	Maximum Extent Practical
MF	Monitoring Factor
MOP	Member of the Public
N/A	Not Applicable
NDAA	National Defense Authorization Act
NEA	Nuclear Energy Agency
NRC	U.S. Nuclear Regulatory Commission
OPC	Ordinary Portland Cement
OU	Operable Unit
PA	Performance Assessment
PARC	Performance Assessment Review Committee
pH	Measure of Acidity or Alkalinity of a Solution
PMP	Probable Maximum Precipitation
PNNL	Pacific Northwest National Laboratory
POC	Point of Compliance
RADFLEx	Radionuclide Field Lysimeter Experiment
RAI	Request for Additional Information
ROD	Record of Decision
RSI	Request for Supplemental Information
RUSLE	Revised Universal Soil Loss Equation
SA	Special Analysis
SAP	Sampling and Analysis Plan
SCDHEC	South Carolina Department of Health and Environmental Control
SDF	Saltstone Disposal Facility
SDU	Saltstone Disposal Unit
SPF	Saltstone Production Facility
SHC	Saturated Hydraulic Conductivity
SOW	Statement of Work
SREL	Savannah River Ecology Laboratory

SRMC	Savannah River Mission Completion
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions, LLC
SRR	Savannah River Remediation LLC
SRS	Savannah River Site
SWPF	Salt Waste Processing Facility
TCG	Tank Closure Grout
TER	Technical Evaluation Report
TFF	Tank Farm Facilities
TTQAP	Task Technical and Quality Assurance Plan
TRR	Technical Review Report
UTRA-LAZ	Upper Three Runs Aquifer–Lower Aquifer Zone
UWMQ	Unreviewed Waste Management Question
UWMQE	Unreviewed Waste Management Question Evaluation
VSL	Vitreous State Laboratory
WAC	Waste Acceptance Criteria
WD	Waste Determination
WDA	Waste Disposal Authority
WRM	Waste Release Model
XRD	X-Ray Diffraction
XRF	X-Ray Fluorescence

1.0 INTRODUCTION

The U.S. Department of Energy (DOE), through Order 435.1, *Radioactive Waste Management*, and Manual 435.1-1, *Radioactive Waste Management Manual,* requires the ongoing maintenance of all Performance Assessments (PAs) and Composite Analyses (CAs). Because PA and CA results, in part, are based on data that is uncertain due to utilization of projected conditions thousands of years into the future, a maintenance program is needed to continue to reduce uncertainty in the inputs and assumptions, providing greater confidence in the results of the analyses and in the long-term plans for public and environmental protection. Additionally, a disciplined process to address potential changes in disposal and/or closure operations (e.g., change in disposal unit design, new residual material characterization) is needed to ensure that new information or proposed changes do not adversely affect conclusions reached using PA results.

The PAs for the Savannah River Site (SRS) Saltstone Disposal Facility (SDF), F-Area Tank Farm (FTF), and H-Area Tank Farm (HTF) are managed by Savannah River Mission Completion (SRMC) for the DOE. [SRR-CWDA-2019-00001, SRS-REG-2007-00002, SRR-CWDA-2010-00128] These PAs assess the calculated dose impact on a future, hypothetical member of the public (MOP) and an inadvertent human intruder, as well as environmental impacts from the respective facilities after final closure as required by DOE Order 435.1. In addition, the PAs are used to support demonstration of compliance with pertinent requirements of the *Ronald W. Reagan National Defense Authorization Act (NDAA) for Fiscal Year 2005*, Section 3116 (hereinafter referred to as NDAA Section 3116).

The *Savannah River Site DOE 435.1 Composite Analysis* (hereinafter referred to as SRS CA) is a management tool required to assist DOE in assessing the possible impacts on the public and environment from multiple sources of legacy radioactive material at a DOE site (e.g., SRS) in order to determine where DOE may need to focus attention or take mitigating actions. The development and maintenance of the SRS CA is the responsibility of the SRS Management and Operations contractor, Savannah River Nuclear Solutions, LLC (SRNS). [SRNL-STI-2009-00512]

The purpose of the Liquid Waste (LW) PA Maintenance Program is to confirm the continued adequacy of LW PAs and to increase confidence in the results of the LW PAs. The elements of the LW PA Maintenance Program are:

- Testing and applied research
- Monitoring
- Unreviewed Waste Management Questions (UWMQs)/Performance Assessment Review Committee (PARC)
- Special Analyses (SAs)
- PA revisions

This program Implementation Plan is prepared and updated annually and submitted to the DOE Savannah River Operations Office (DOE-SR). The preparation and execution of the plan is consistent with the *Disposal Authorization Statement and Tank Closure Documentation Technical Standard* (DOE-STD-5002-2017). Beginning with the FY2010 Implementation Plan (SRR-CWDA-2010-00015), the LW PA Maintenance Program activities for the SRS LW Facilities have been contained in a separate implementation plan from that for the E-Area Low-Level Waste

Facility and the SRS CA. The purpose for this change was to better align the documents with the current SRS contract structure. A summary of LW maintenance activities for the individual PAs are summarized in Tables 2.5-1 and 3.5-1. Appendix A, Table A.1-1, contains a roll-up cost estimate summary of all LW PA Maintenance activities. This document reflects the PA-related activities completed last fiscal year (FY) or earlier in some cases, planned for the current FY, and captured out-year activities for estimation and planning purposes. Actual work performed in the out-years will be adjusted based on new program information and will be dependent on the contract baseline funding and associated actual allocated budget for that year.

Section 2.0 includes a summary of the LW PA Maintenance Program activities for the SDF and Section 3.0 contains the activities for FTF and HTF. Each section includes activities relating to the following areas:

- Monitoring
- Research and Development
- Planned Review and Analysis
    - Status of Disposal Authorization Statement (DAS) Conditions/Limits
    - Low-Level Waste Disposal Facility Federal Review Group (LFRG) Key and Secondary Issues
    - Unreviewed Waste Management Question Evaluations (UWMQEs)
    - SAs
    - LFRG PA Reviews
    - Annual Summary Report Reviews
- Planned Annual Maintenance Activities and Schedules
- Revisions to DAS Documents (PA)

Saltstone Disposal Facility Overview

As shown in Figure 1.0-1, the development and review of the SDF disposal documentation has been ongoing for many years. The *Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*, and the supporting Basis Document, were issued by DOE in January 2006. [DOE_01-17-2006, DOE-WD-2005-001] Issuance of these documents was supported by a Vault 4 SA and the SDF Performance Objective Demonstration Document. [WSRC-TR-2005-00074, CBU-PIT-2005-00146] The 2009 SDF PA, Revision 0, which introduced a new 150-foot diameter Saltstone Disposal Unit (SDU) design, was issued in October 2009. [SRR-CWDA-2009-00017] Three SAs utilizing new technical information, including another SDU design revision, were issued against the 2009 SDF PA. The first SA (the FY2013 SDF SA) was issued in October 2013 and approved in December 2013. [SRR-CWDA-2013-00062, WDPD-14-08] The second SA (the FY2014 SDF SA) was issued in September 2014 and approved in October 2014. [SRR-CWDA-2014-00006, WDPD-15-05] The FY2014 SA evaluated the performance of the current 375-foot diameter SDU design. The FY2016 SDF SA was issued in October 2016 and approved by DOE in November 2016. [SRR-CWDA-2016-00072, WDPD-17-05] The FY2016 SDF SA re-evaluated the performance of the current 375-foot diameter SDU design to reflect observed field conditions (SDU 6), to incorporate lessons learned (SDUs 7 through 12), and to incorporate new physical locations for SDUs. A full PA revision (SRR-CWDA-2019-00001) was issued in May 2020 and replaced the 2009 SDF PA and its associated SAs.

Figure 1.0-1 also provides an overview of primary documentation issued in support of the U.S. Nuclear Regulatory Commission (NRC) consultation and monitoring role for SDF under NDAA Section 3116. Issuance of the current revision to the DOE DAS for SDF, along with DOE approval of the SDF PA, occurred in June 2020. [WDPD-20-32]

Since July 2020, the NRC has been reviewing the 2019 SDF PA as part of the NRC's monitoring role under Section 3116(b) of the *Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005* (NDAA Section 3116).

The NRC provided a set of Requests for Supplemental Information (RSIs) in October 2020 (ML20254A003). These RSIs requested that additional models be developed to better enhance the understanding of combined uncertainties related to the long-term performance and potential degradation of various components and features associated with the SDF closure system. Due to the sequential nature of the RSIs, wherein some RSIs had to be responded to as prerequisites to other RSIs, the preparation of the responses to the RSIs was performed sequentially, resulting in multiple documents being prepared from March to August 2021, which are summarized in *Summary of RSI Response Documents for the SDF PA*, SRR-CWDA-2021-00068.

In addition, as part of their review, the NRC has issued two letters as of the end of FY21 with Requests for Additional Information (RAIs). [ML21040A492, ML21133A296] The first letter had twelve RAIs as well as six Clarifying Comments (CCs). Those RAIs and CCs were addressed in SRR-CWDA-2021-00047, *Comment Response Matrix for the First Set of U.S. Nuclear Regulatory Commission Staff Requests for Additional Information on the Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site,* Revision 1, issued in July 2021.

The NRC issued the second letter in June 2021 and that letter included an additional sixteen RAIs and fourteen CCs. On August 18, 2021, an initial round of responses to this second set of NRC RAIs and CCs was issued via SRR-CWDA-2021-00072, *Comment Response Matrix for the Second Set of U.S. Nuclear Regulatory Commission Staff Requests for Additional Information on the Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site,* Revision 0. SRR-CWDA-2021-00072 was subsequently revised to include the complete set of RAI and CC responses and Revision 1 was issued in November 2021.

In FY2020, an SA was initiated to evaluate the following new information relative to potential impacts on the long-term performance of the SDF:

1. An improved normative analysis was developed to better determine the chemical and mineralogical constituents for concrete used in constructing SDUs and for the cementitious waste form known as saltstone.
2. Modeling properties have been developed to evaluate the performance of two proposed cementitious materials (SDU Concrete Mix 3B and Cement Free Saltstone) which are currently being considered for deployment.
3. An equivalent set of normative analyses for two new cementitious materials (SDU Concrete Mix 3B Concrete and Cement Free Saltstone) was also developed.
4. The normative analyses were used to update cementitious degradation rates for existing cementitious materials and for the new cementitious materials.

The primary driver for evaluating this new information is to determine the potential impacts from using the two proposed cementitious materials (SDU Concrete Mix 3B Concrete and Cement Free Saltstone). The FY2020 SDF SA (SRR-CWDA-2020-00064) was issued in 1QFY2021. The FY2020 SDF SA evaluated the performance of SDU Concrete Mix 3B and Cement Free saltstone relative to the 2019 SDF PA.

The DOE-SR approved the FY2020 SDF SA (WDPD-21-40) and minor edits were incorporated as Revision 1 to address observations that were identified during the DOE-SR review. Revision 1 of the FY2020 SDF SA, was issued in April 2021.

<u>F-Area and H-Area Tank Farms Overview</u>

As shown in Figure 1.0-2, Tank Farm closure document development has also been ongoing for many years.

The current FTF PA, Revision 1, was issued in March 2010. [SRS-REG-2007-00002] Issuance of the *Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site* (DOE-WD-2012-001) and supporting Basis Document for FTF occurred in March 2012. [DOE/SRS-WD-2012-001] In March 2012, DOE also approved the FTF Tier 1 Closure Plan including its referenced FTF PA, Revision 1. [DOE_03-28-2012, SRR-CWDA-2010-00147] Along with approval of the FTF Tier 1 Closure Plan, DOE approved the Tanks 18 and 19 Tier 2 Closure Plan, including the SA specific to Tanks 18 and 19. [WDPD-12-39, SRR-CWDA-2011-00015, SRR-CWDA-2010-00124] An SA for Tanks 5 and 6 was prepared in support of operational closure of Tanks 5 and 6 and Revision 1 of the SA was issued in January 2013. [SRR-CWDA-2012-00106] DOE approved the Tanks 5 and 6 Tier 2 Closure Plan, including the Tanks 5 and 6 SA, in May 2013. [WDPD-13-56, SRR-CWDA-2013-00014]

The FTF F-Area Diversion Box (FDB)-5 and FDB-6 Special Analysis (SRR-CWDA-2020-00055, *FDB-5 and FDB-6 Special Analysis for the Performance Assessment for the F-Tank Farm at the Savannah River Site*) was issued in 2021. This SA describes the approaches used to assign inventories at closure for FDB-5 and FDB-6 for use in FTF transport modeling. The FDB-5 and FDB-6 SA reports that the results and conclusions presented in the FTF PA and supporting SAs are not impacted by new information regarding the final residual inventories that are planned to be grouted in-place in FDB-5 and FDB-6.

The current HTF PA, Revision 1, was issued in November 2012. [SRR-CWDA-2010-00128] Issuance of the *Section 3116 Determination for Closure of H-Tank Farm at the Savannah River Site* (DOE-WD-2014-001) and supporting Basis Document for HTF occurred in December 2014. [DOE/SRS-WD-2014-001] In December 2014, following issuance of the HTF Section 3116 Waste Determination (WD), DOE approved the HTF Tier 1 Closure Plan including its referenced HTF PA, Revision 1. [DOE-OS-2015-04-27-01, SRR-CWDA-2014-00040]

An SA for Tank 16 was prepared in support of operational closure of Tank 16 and Revision 1 of the SA was issued in February 2015. [SRR-CWDA-2014-00106] DOE approved the Tank 16 Tier 2 Closure Plan, including the Tank 16 SA, in May 2015. [WDPD-15-42, SRR-CWDA-2015-00009] An SA for Tank 12 was prepared in support of operational closure of Tank 12 and Revision 0 of the SA was issued in August 2015. [SRR-CWDA-2015-00073] DOE approved the Tank 12 Tier 2 Closure Plan, including the Tank 12 SA, in September 2015. [SRR-CWDA-2015-00119, WDPD-16-17] An SA specific to the HTF Type I and Type II Tanks was prepared and issued in

August 2016 (SRR-CWDA-2016-00078) and received DOE approval in June 2017. [WDPD-17-34] This SA updated the radiological and chemical inventories for the Type I and Type II tanks in the HTF (incorporating lessons learned from the final waste tank characterization results to date) and includes an extensive series of sensitivity analyses that provide additional information that can inform decisions regarding HTF Type I and Type II tank closure operations.

A revision of the HTF PA was initiated in FY2020 and is schedule to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure). Unless otherwise noted in the HTF PA, the revision will include the following items at a minimum:

- Analyses and results contained in all SAs that have been completed to date;
- Analyses and results of all UWMQEs completed to date;
- Consideration of new information generated through research and development;
- Changes in site future land use plans or closure plans;
- Changes to PA guidance documents requirements; and
- Modeling improvements as identified in the Quality Assurance report for the HTF PA (SRR-CWDA-2012-00070).

A document which outlines the activities and data needed to revise the FTF and HTF PAs (SRR-CWDA-2019-00104, *Strategy for Updating the SRS Tank Farm Performance Assessments*) was issued in December 2019. An extensive update of the HTF compliance case PORFLOW model was completed in FY2021.

Figure 1.0-2 also provides an overview of primary documentation issued in support of the NRC consultation and monitoring role for FTF and HTF under NDAA Section 3116.

Figure 1.0-1: Disposal Document Activities for Saltstone Disposal Facility

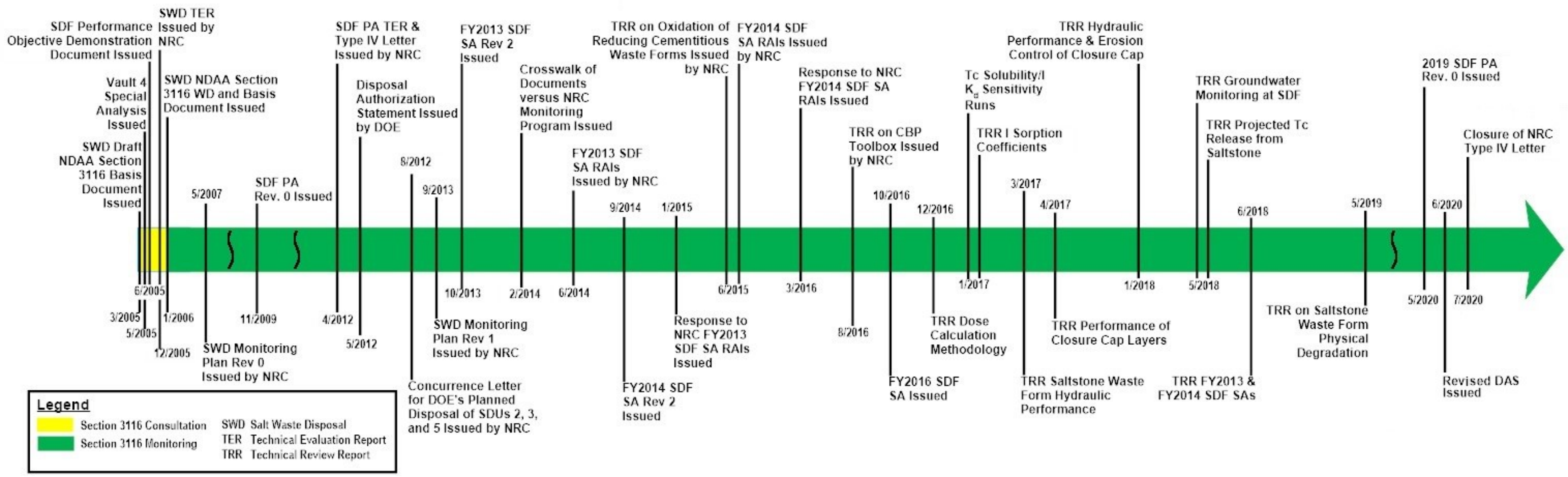
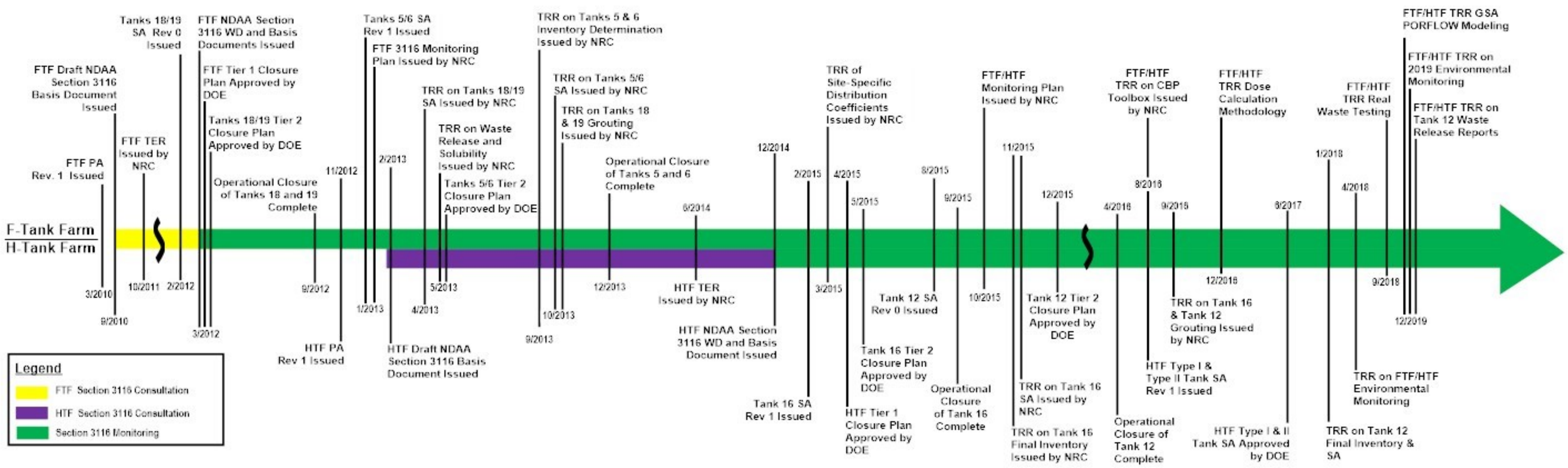


Figure 1.0-2: Closure Document Development Activities for the Tank Farms



2.0 SALTSTONE DISPOSAL FACILITY

Monitoring is an essential part of ensuring a facility is performing as outlined in the PA and in ensuring compliance with performance objectives/measures.

2.1 Saltstone Disposal Facility Monitoring

The SDF PA Monitoring Plan has been developed to meet the requirements for monitoring Low-Level Waste (LLW) disposal facilities according to DOE Order 435.1 (DOE O 435.1) and its associated manual and implementation guidance. This SDF PA Monitoring Plan considers actual performance versus projected performance for the SDF at the SRS as they relate to the requirements of the current DAS for the SDF. [WDPD-20-32] The SDF PA Monitoring Plan is intended to detect changing trends in performance in order to apply a graded approach to corrective actions prior to exceeding any performance objectives.

The SDF Monitoring Plan includes guidance for:

- Ensuring compliance with the current DAS issued for the SDF,
- Providing a general description of the location of the facility and the relevant aspects of the environmental setting for the facility,
- Describing the SDF and associated waste form,
- Identifying pertinent documents that govern or monitor the SDF,
- Monitoring approaches, including media to be monitored; types, locations, and frequencies of sampling; and analytical information, and
- Data evaluation, management, and reporting.

As part of this PA maintenance program, the SDF PA Monitoring Plan is evaluated annually, or as conditions at the facility change (e.g., the installation of new groundwater monitoring wells) and an update to the SDF PA Monitoring Plan, if required, will be submitted for DOE approval as necessary. The latest version of the SDF PA Monitoring Plan is SRR-CWDA-2020-00006, updated in August 2020. Additional information on the SDF PA Monitoring Plan is provided in Section 2.3.7.

2.2 Saltstone Disposal Facility Performance Assessment Testing & Research Activities

This section contains the PA-related testing and research activities that are being performed as (1) part of the ongoing maintenance activities aimed at reducing uncertainty in the SDF PA and SA models, or (2) verification sampling and analysis of material properties used in the PA (i.e., verification of emplaced saltstone properties and properties of saltstone cured under temperature and humidity conditions that reflect the actual disposal environment). As ongoing research provides new information or reduces uncertainty, this information will be evaluated (via the UWMQ [Section 2.3.1] or SA process [Section 2.4.3]) against the information used as a basis for modeling.

Resources have been and continue to be prioritized to support research activities related to measuring and/or modeling key parameters of the saltstone waste form and the disposal units (Figure 2.2-1). Figure 2.2-2 depicts how testing and research activities and ongoing testing of the saltstone waste form are being selected using an integrated, systematic approach.

Figure 2.2-1: Saltstone Research, Development, and Testing Program Elements

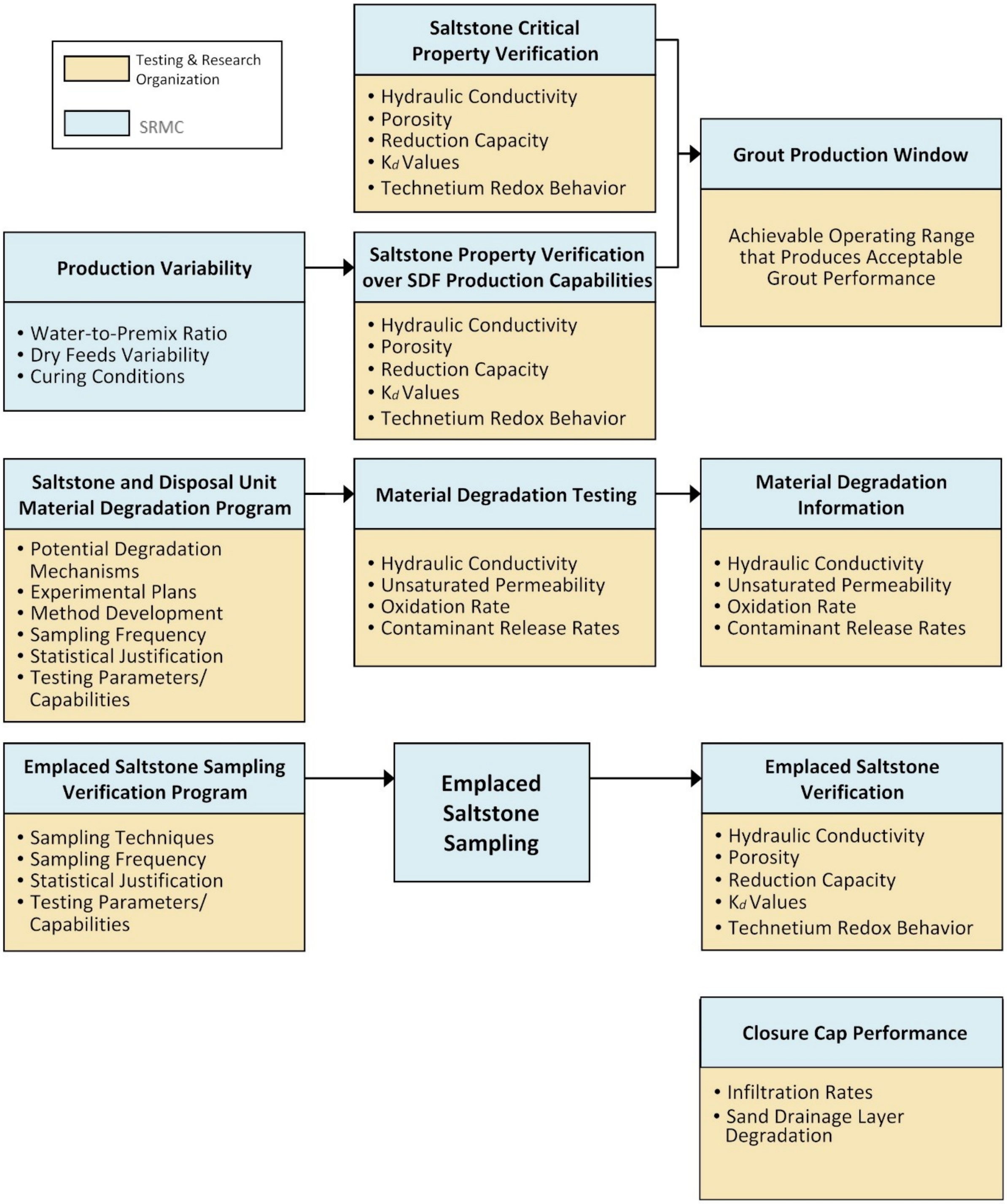
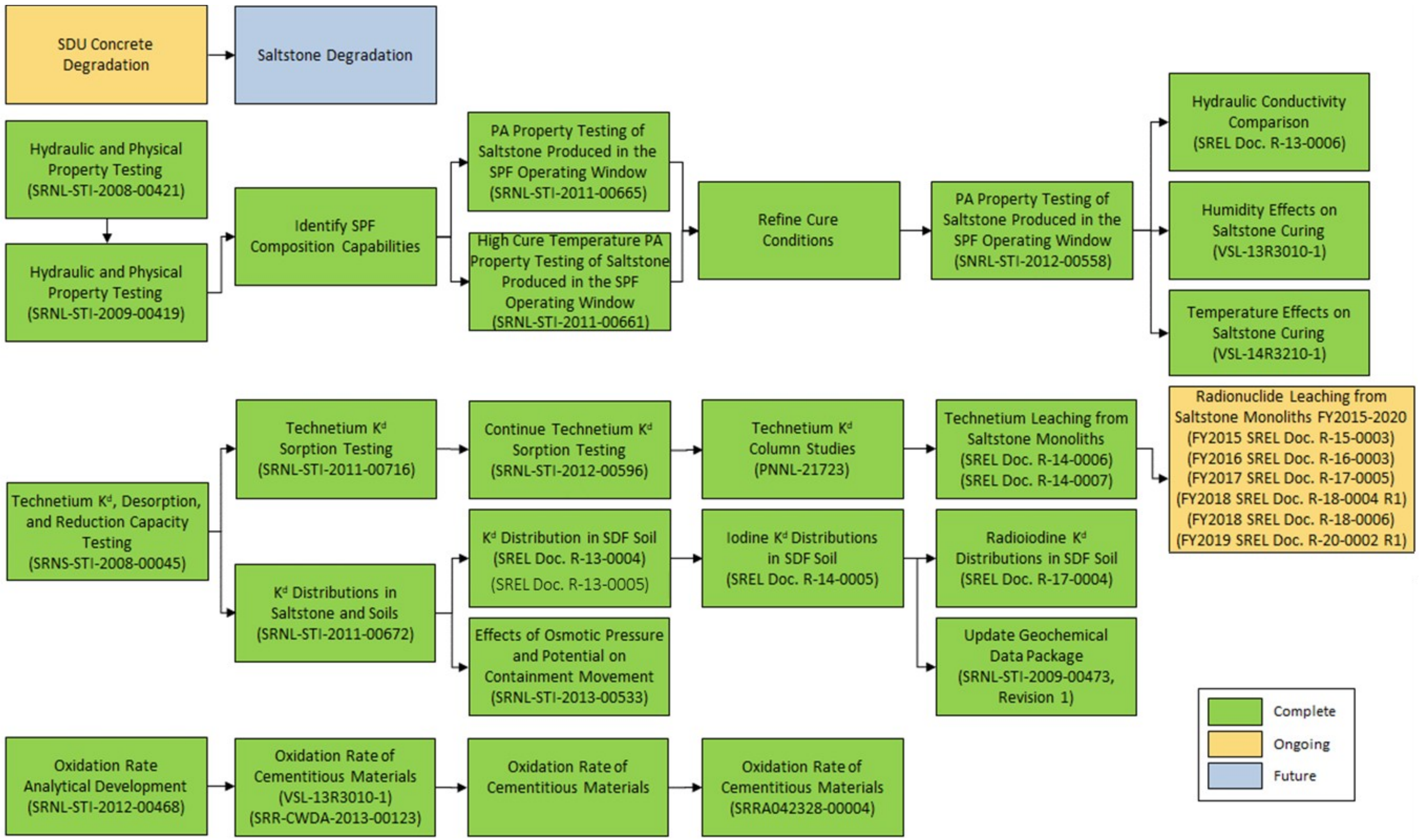


Figure 2.2-2: Critical Property Testing Strategy



Funding estimates have been made for each ongoing or anticipated activity. While actual work performed is always dependent on current funding and priorities, Table 2.5-1 provides a general idea of the work expected to be performed over the next several years.

In September 2013, the NRC revised their NDAA Section 3116 monitoring plan for SDF, with a monitoring plan supplement issued in 2019 [ML19150A295]. This NRC SDF Monitoring Plan provides expectations for closing Technical Evaluation Report (TER) issues. Note that the monitoring factors in the NRC SDF Monitoring Plan cover both the NRC concerns from the 2012 NRC TER and the previous Open Issues that had not been closed from an earlier version (Revision 0) of their NRC SDF Monitoring Plan. [ML13100A113] Appendix B of this FY2022 update provides a summary of monitoring factors in the context of testing and research activities related to the SDF.

2.2.1 Contaminant Leaching Characteristics from Saltstone Monolith

Description: The purpose of this study is to characterize the leaching behavior of saltstone samples spiked with Tc-99 and I-129 in addition to saltstone cores retrieved from SDU Cell 2A. Test methods to be employed include a standardized semi-dynamic leaching test, U.S. Environmental Protection Agency (EPA) Method 1315, *Mass Transfer Rates of Constituents in Monolithic or Compacted Granular Materials Using a Semi-Dynamic Tank Leaching Procedure*, and a dynamic leaching test that was developed as part of this scope. [EPA_Method_1315] The dynamic leaching method (DLM) uses a flexible-wall permeameter apparatus that is more commonly used for measuring the saturated hydraulic conductivity (SHC) of saltstone. The intent is to force leachate through the interior of the saltstone monolith to mimic the eventual ingress of water into saltstone and subsequent pore volume exchange to establish the dynamic leaching behavior of saltstone contaminants. This task provides empirical leaching (diffusion and solubility) data for Tc-99, I-129, and potentially other saltstone contaminants that are used as direct inputs to the SDF PA models. In addition, the development of a dynamic leaching test provides new information regarding the leaching of saltstone associated with multiple pore volume exchanges. Table 2.2-1 summarizes the saltstone samples that have been prepared and tested to date. Table 2.2-2 provides a summary of the EPA Method 1315 data.

Expected Benefit: This task provides empirical leaching (diffusion and solubility) data for Tc-99, I-129, and potentially other saltstone contaminants that can be used as direct inputs to the saltstone PA models. In addition, the development of a dynamic leaching test provides new information regarding the leaching of saltstone associated with multiple pore volume exchanges.

FY2014: Contaminant mass transfer for I- and Re- spiked monoliths was evaluated using EPA Method 1315. [EPA_Method_1315]

Table 2.2-1: Contaminant Leaching Study Summary

FY Report	Batch Sample [a]	GGBFS Reduction Capacity (μeq/g) [f]	Saltwaste Solution Simulant [g]	Spike	EPA 1315	EPA 1315 Notes	DLM	DLM Notes	DLM Status as of FY2021
SREL-R-14-0006, FY2014	H45:45:10 [b]	861	ARP-MCU	I-127, Re	Yes	1-month cure (x1); 3-month cure (x1)	Yes	5 short-term experiments to develop DLM method.	Removed
SREL-R-15-0003, FY2015	H45:45:10 [b]	861	ARP-MCU	I-127, Re	Yes	3-month cure (x1); 6-month cure (x1)	No	N/A	N/A
SREL-R-15-0003, FY2015	H45:45:10	713	ARP-MCU	Tc-99	Yes	3-month cure (x1); 6-month cure (x1)	Yes	6-month cure (x1)	Removed
SREL-R-16-0003, FY2016	H45:45:10	713	ARP-MCU	Tc-99	Yes	3-month cure	No	N/A	N/A
SREL-R-16-0003, FY2016	L45:45:10	1,600	ARP-MCU	Tc-99	Yes	3-month cure (x1); 6-month cure (x2)	No	N/A	N/A
SREL-R-16-0003, FY2016	SDU 2A - Sample A [c]	Not Measured	Tank 50 Actual	N/A	Yes	21-month cure (x1)	Yes	21-month cure (x1)	Running
SREL-R-16-0003, FY2016	SDU 2A - Sample B [d]	Not Measured	Tank 50 Actual	N/A	Yes	21-month cure (x1)	Yes	21-month cure (x1)	Removed
SREL-R-16-0003, FY2016	SDU 2A - Sample C [e]	Not Measured	Tank 50 Actual	N/A	Yes	21-month cure (x1)	No	N/A	N/A
SRRA099188-000005, FY2018	H45:45:10	713	ARP-MCU	I-129	Yes	1.5-month cure (x1)	No	N/A	N/A
SRRA099188-000005, FY2018	L45:45:10	Not Measured	ARP-MCU	I-129	Yes	1.5-month cure (x1)	Yes	6-month cure (x1); 13-month cure (x1)	Removed
SRRA099188-000005, FY2018	L45:45:10	Not Measured	ARP-MCU	Tc-99	No	N/A	Yes	3-month cure (x2)	Removed
SRRA099188-000010, FY2019	L45:45:10	870	SWPF	Tc-99, I-129	Yes	9-month cure (x1)	Yes	10-month cure (x1); 11-month cure (x1)	Running
SRRA099188-000010, FY2019	L60:40	870	SWPF	Tc-99, I-129	Yes	9-month cure (x1)	Yes	10-month cure (x2)	Running

(a) SDU 2A samples with a 45:45:10 designation were prepared using dry-feed material ratio of 45 wt% ground granulated blast furnace slag (GGBFS), 45 wt% FA, and 10 wt% OPC. Samples with a 60:40 designation, prepared using a dry-feed material ratio of 60 wt% GGBFS and 40 wt% FA. All samples prepared using water-to-dry-feed mass ratio of 0.6. SDU samples starting with an "H" were made using Holcim Grade 100/120 GGBFS, samples starting with an "L" were made using Lehigh Grade 100/120 GGBFS.
(b) FY2015 samples are from the same batch as the FY2014 samples, just cured for longer. FY2014 report provided EPA 1315 data for the 1-month and 3-month cured samples but no Effective Diffusivity (De). De coefficient for the 3-month and 6-month cured Re/I spiked saltstone samples is provided in the FY2015 report.
(c) Taken from core SDU2A-0931-C-1-U-2 (see Attachment 2 in SRR-CWDA-2015-00066).
(d) Taken from core SDU2A-0931-C-1-U-5 (see Attachment 2 in SRR-CWDA-2015-00066).
(e) Taken from core SDU2A-0931-C-2-U-2 (see Attachment 2 in SRR-CWDA-2015-00066).
(f) Reduction capacity measured using the Ce(IV) method of Angus and Glasser (1985).
(g) The composition of the saltwaste solution simulants can be found in Table 2 of SRRA099188-000010 (SREL DOC No. R-20-0002). The SDU 2A core samples were made with actual salt waste from Tank 50.
ARP – Actinide Removal Process; FA – Fly Ash, MCU – Modular Caustic Side-Solvent Extraction Unit; OPC – Ordinary Portland Cement, SWPF – Salt Waste Processing Facility

Table 2.2-2: Effective Diffusivities (De) & Leachability Index (LI) for EPA 1315 Experiments

FY Report	Batch Sample [a]	Curing Duration (months)	Tc-99		Re		NO_3		Iodine [c]	
			D_e (cm^2/s)	LI [d]	D_e (cm^2/s)	LI [d]	D_e (cm^2/s)	LI [d]	D_e (cm^2/s)	LI [d]
SREL-R-15-0003, FY2015	H45/45/10 [b]	3	2.40E-10	9.9	3.00E-08	7.6	4.40E-08	7.6	2.90E-08	7.7
SREL-R-15-0003, FY2015	H45/45/10 [b]	6	2.80E-10	9.7	3.30E-08	7.6	1.60E-08	7.9	3.00E-08	7.7
SREL-R-16-0003, FY2016	H45/45/10	3	3.00E-10	9.6	N/A	N/A	3.70E-07	6.7	N/A	N/A
SREL-R-16-0003, FY2016	L45/45/10	3	2.60E-11	10.6	N/A	N/A	4.80E-08	7.5	N/A	N/A
SREL-R-16-0003, FY2016	L45/45/10	6	5.70E-12	11.3	N/A	N/A	6.60E-08	7.2	N/A	N/A
SREL-R-16-0003, FY2016	L45/45/10	6	3.80E-11	10.4	N/A	N/A	2.10E-07	6.7	N/A	N/A
SREL-R-16-0003, FY2016	SDU 2A - Sample A	21	6.40E-11	10.2	N/A	N/A	1.30E-08	8	1.00E-08	8
SREL-R-16-0003, FY2016	SDU 2A - Sample B	21	5.80E-11	10.3	N/A	N/A	4.40E-09	8.5	2.50E-09	8.6
SREL-R-16-0003, FY2016	SDU 2A - Sample C	21	5.20E-11	10.3	N/A	N/A	5.50E-09	8.5	5.50E-09	8.4
SRRA099188-000005, FY2018	H45/45/10	1.5	N/A	N/A	N/A	N/A	9.50E-08	7	2.80E-08	7.6
SRRA099188-000005, FY2018	L45/45/10	1.5	N/A	N/A	N/A	N/A	8.20E-09	8.1	1.40E-08	8
SRRA099188-000010, FY2019	L45/45/10	9	5.30E-11[e]	10.4	N/A	N/A	9.20E-09[e]	8.2	3.30E-09[e]	8.8
SRRA099188-000010, FY2019	L60/40	9	5.70E-11[e]	10.5	N/A	N/A	7.40E-09[e]	8.2	4.40E-09[e]	8.5

(a) Refer to Table 2.3-1 for additional information on batch samples.

(b) Two different batches of H45/45/10 saltstone were used in EPA 1315 tests, one spiked with Re/I-127, and the other spiked with Tc-99 (see Table 2.3-1). For convenience the data from these experiments has been consolidated into one row.

(c) For all SDU 2A samples and lab prepared saltstone samples made after FY2015, I-129 was used as the spike. Prior to that time, I-127 was used.

d LI = $-\log_{10}(D_e)$

e The diffusivities and LI values reported in Table 6 of SRRA099188-000010 reflect the average of all incremental sampling intervals, hence the LI value reported in the table will not necessarily coincide with the negative log of the reported De value. In other words, the De and LI value was calculated at each sampling interval and the average of these values is presented in this table.

<u>FY2015:</u> EPA Method 1315 was used to evaluate the leaching characteristics of Tc-spiked saltstone samples cured for three and six months. The leaching rate of Tc-99 was observed to decrease over the course of testing but exhibited no clear response to either curing duration (3 or 6 months) or test atmosphere (oxic, anoxic, and anoxic reducing).

Dynamic leaching tests utilizing the method developed using Re-spiked samples in FY2014 were conducted on Tc-spiked samples in FY2015. Like the EPA measurements, technetium, iodine, and rhenium were spiked at levels equivalent to those measured in Tank 50 waste. [SREL Doc. R-15-0003]

FY2016: EPA Method 1315 testing continued in FY2016 on Tc-99 spiked saltstone samples. Tc-99 leaching rates appeared to be sensitive to curing duration and the reduction capacity of the ground granulated blast furnace slag (GGBFS) used in making the grout. Due to supply cessation of a historically utilized GGBFS, an alternate blast furnace slag (BFS) source was sought and approved for use in processing future saltstone batches at SRS. Longer curing times and higher reduction capacity for the as-received GGBFS resulted in lower effective diffusivities.

FY2017: At the end of FY2017, four samples had been evaluated on this revised DLM system and while the desired flow rates were set between 0.2 and 1.5 mL/day all samples were operating at rates at or below 0.1 mL/day. As such it was not possible to determine residence time effects on leachate chemistry with that experimental set up. These samples had less than a pore volume exchanged and as such it was too early to make any determinations with respect to sample-to-sample similarities or differences.

FY2018: In FY2018, EPA 1315 leachates collected from two I-129 spiked saltstone simulants were analyzed to obtain effective diffusivities for iodine in saltstone. The two saltstone simulants utilized the same dry feed composition, salt solution simulant, and curing time (1.5 months) but differed regarding the GGBFS source used (Lehigh versus Holcim). The resulting effective diffusivities for iodine from this work were comparable to previous EPA 1315 tests conducted in FY2015 on saltstone simulants cured for 3 months and 6 months. These effective diffusivities are noticeably higher than those measured from actual SDU 2A cores which were cured in SDU 2A for approximately 20 months prior to sampling.

FY2019: Four new DLM experiments were started in FY2019. The experiments employed saltstone simulants spiked with both Tc-99 and I-129 and prepared using Lehigh GGBFS to better understand what impact the new slag has on the saltstone hydraulic (i.e., SHC) and transport (i.e., release rates) properties. [SRR-CWDA-2020-00008]

- In February of 2019, four new DLM experiments began.
    - These new DLM experiments were designed to better understand what impact the down-selected 60:40 cement-free formulation (SRR-CWDA-2019-00003) would have on the saltstone hydraulic (i.e., SHC) and transport (i.e., release rates) properties.
    - Results to date suggest that the 60:40 cement-free formulation is comparable in performance, from a PA perspective, to the historically used 45:45:10 saltstone.

FY2020: Efforts in FY2020 were hindered by the Covid-19 pandemic and additional research projects ongoing at the Savannah River Ecology Laboratory (SREL) (e.g., aqueous and solid phase analysis of waste tank grouts (SRRA151648-000003), mercury leaching from saltstone (SRRA099188-000011)). The end result was that planned activities for FY2020 (i.e., monitoring and analysis of ongoing DLM experiments, saltstone degradation analysis, and studies analyzing curing time effects on saltstone properties) were suspended until a future date.

FY2021: In FY2021, X-Ray Diffraction (XRD) spectroscopy and X-Ray Fluorescence (XRF) spectroscopy analyses on pre- and post- DLM saltstone cores was initiated to better understand how saltstone's chemical and phase composition evolve over time.

In addition, in FY2021 work began to develop a detailed XRD user manual (with practical examples) for alternate sample preparation techniques, phase ID, and quantification of cementitious samples using XRD and associated software.

FY2022: Plans for FY2022 focus on collecting empirical data capturing saltstone's weathering process and are presented in SRR-CWDA-2021-00087. In particular, analysis of pre- and post-DLM saltstone cores using XRF spectroscopy and powder XRD spectroscopy will be conducted to better understand how saltstone's chemical and phase composition evolve over time. A technical report detailing the results of this testing will be issued in FY2022.

In addition, work will continue on development of an XRD user manual initiated in FY2021.

Deliverable: Annual Technical Reports

Expected Completion Date: FY2022

Responsibility: SRMC Waste Disposal Authority (WDA), (SREL)

Estimated Cost: FY2022 $150K, FY2023 $150K, FY2024 $150K, FY2025 through FY2026 $0K

2.2.2 Ongoing Studies

PA models rely on a number of input parameters to make informed predictions about a system's behavior over long periods of time. It is therefore desirable to reduce uncertainty in these parameters whenever possible. The 2019 SDF PA (SRR-CWDA-2019-00001) suggests that the parameters most important with respect to SDF performance are: infiltration (i.e., High Density Polyethylene [HDPE] and closure cap performance), the hydraulic conductivity of saltstone, water ingestion rate of the receptor, technetium solubility, and saltstone oxidation. Several of the maintenance activities discussed below are intended to reduce uncertainty around some of these more critical parameters.

WDA has identified multiple areas of interest in regard to research and development activities to be conducted by SREL during FY2022 detailed in SRR-CWDA-2021-00087.

Additional maintenance activities presented in this section focus on meeting information needs relevant to these other aspects of system performance. Various programs discussed below include:

- Long-term behavior of radionuclides in lysimeters
- Cementitious materials degradation due to radiation exposure
- Closure cap performance

2.2.2.1 Long-Term Radiological Lysimeter Program

Description: Understanding the long-term behavior of radionuclides in soil and cementitious materials is essential to models that project this behavior over thousands of years. The objective of this task is to measure the release from radioactive sources emplaced in lysimeters that are exposed to the outside environment. To this end, a multi-year study is being performed at the Radionuclide Field Lysimeter Experiment Facility (RadFLEx) to evaluate radionuclide fate and transport from sources emplaced in lysimeters that are exposed to the outside environment. The study will provide additional information about long-term geochemical and transport phenomena that will be used to support the waste release and transport models used in the SDF and Tank Farm PAs.

Measurements target solubility and distribution coefficient (K_d) values in soil and cementitious materials, and colloidal transport of various radionuclides. The total exposure time (in some cases) is anticipated to be as long as 10 years. Releases are determined from the lysimeter leachates collected and analyzed regularly (i.e., monthly or quarterly) in addition to solid phase analysis (i.e., destructive analysis) of select lysimeters after specified environmental exposure times. Lysimeter effluent testing in conjunction with solid phase analysis of the lysimeter cores and source material provides researchers with a robust data set specific to the SRS that can provide less ambiguous assignment of transport mechanisms and bolster confidence in PA modeling assumptions. The radionuclide treatments studied at RadFLEx consist of: 1) an anion group (Tc-99, I-127, and I-129), 2) a cationic gamma group (Co-60, Ba-133, Cs-137, and Eu-152), 3) neptunium (Np-237), 4) plutonium (Pu-239, Pu-240, and Pu-241), and 5) radium (Ra-226).

Radionuclide sources are prepared in the laboratory in two physical forms: 1) filter "pita pockets" and 2) cementitious pucks. For the filter pita pockets, a liquid radionuclide source is spiked onto a 47mm glass fiber filter and then covered with a second glass fiber filter. The filters are then stitched together using Teflon thread with the radionuclide source sandwiched between the two. Since the glass fiber filters are chemically inert and have limited physical interference, the filter pita pocket sources are representative of soil contamination. Cementitious pucks (1.25 inches diameter, 0.5 inches thick) are prepared in the laboratory both with and without GGBFS. Radionuclide sources are spiked into the salt solution simulant used in making the cementitious pucks.

To date, lysimeter experiments performed at RadFLEx have proven fruitful, yielding both qualitative (improved mechanistic understanding of the fate and transport of certain radionuclides) and quantitative (sorption coefficients) results. In particular:

- Np breakthrough for both Np(IV) and Np(V) sources has been observed in lysimeter effluent. Np(V) release is two to four orders of magnitude higher than that observed for Np(IV). This data supports the idea that Np(V) mobility is controlled primarily by sorption of the radionuclide to the surrounding environment while Np(IV) release is solubility controlled.
- The concentration of Pu in lysimeter effluents is on the order of E-15 to E-13 mol/L, close to the solubility limits for Pu(IV) hydroxide phases. This data strongly supports the idea that Pu migration is solubility limited.
    - The concentration of Pu in lysimeter effluents is below the detection limit for the standard Inductively Coupled Plasma - Mass Spectrometry (ICP-MS) measurement and a low-level radioanalytical technique was used to perform these measurements.
- The spatial distribution of Pu in two field lysimeters that were removed and dissected for analysis, the first with a colloidal PuO_2(s) source and the second with an emplaced $Pu(V)NH_4(CO_3)$(s) source, both demonstrated greater downward migration than previously observed for $PuCl_3$, $Pu(NO_3)_4$, and $Pu(C_2O_4)_2$ bearing lysimeters. Researchers

have proposed multiple working hypotheses to explain the enhanced transport observed for the PuO_2(s) and Pu(V)$NH_4(CO_3)$(s) lysimeters.

- Working Hypothesis #1: Transport of Pu as PuO_2(s) colloids. The Pu(V)$NH_4(CO_3)$(s) source transforms to a PuO_2(s) phase similar to the one found in Lysimeter 44 (colloidal PuO_2(s) source, SRRA021685-000008). The Pu colloids allow for enhanced transport of the radionuclide.
- Working Hypothesis #2: Transport is due to differing solubility values in the Pu source material. Evidence from the literature strongly suggests that the oxidized Pu present in Pu(V)$NH_4(CO_3)$(s) will rapidly reduce to Pu(+IV), perhaps as a PuO_2(s) phase similar to that found in Lysimeter 44 (colloidal PuO_2(s) source, SRRA021685-000008). Some of the Pu(+IV) present in the PuO_2(s) phase oxidizes over time to the more mobile Pu(+V) oxidation state and is transported a short distance through the soil prior to being re-reduced and once again forming a PuO_2(s) phase. The plutonium continues to undergo cycles of re-oxidation followed by re-reduction thereby allowing it to slowly traverse down the lysimeter column. This mechanism is analogous to the one proposed for mobilization of Np observed in the NpO_2(s) lysimeter (Lysimeter 32, SRRA021685-000011).

- Desorption experiments using Pu contaminated soils retrieved from the PuO_2(s) and Pu(V)$NH_4(CO_3)$(s) lysimeters provided conditional desorption distribution coefficients of log K = 4.4 ± 0.3 mL/g and log K = 3.2 ± 0.2 mL/g, respectively. There was no apparent difference between unfiltered and ultra-filtered samples during the desorption experiments indicating that either 1) colloids are not present in these samples as hypothesized or 2) colloids sorb strongly to the soil and do not desorb.

Desorption experiments for gamma-emitting radionuclides (Co-60, Ba-133, Cs-137, and Eu-152) sorbed to SRS sediment (Lysimeter 26 at RadFLEx) generated conditional sorption coefficients (29 mL/g, 29 mL/g, 2,200 mL/g, and 4,300 mL/g, respectively) that can be utilized in PA modeling. [SRRA021685-000012] In addition, the study revealed the potential for aging effects on sorption, with both Cs-137 and Eu-152 demonstrating increased affinity for SRS sediment with time. With the exception of cobalt (K_d of 29 mL/g measured vs. 40 mL/g modeled in SDF PA), the sorption coefficients determined from this study are favorable (i.e., higher) compared to the values currently used in PA modeling. Given this fact and Co-60's negligible contribution to the overall dose predicted in the PA (Table 5.5-2 of SRR-CWDA-2019-00001), the findings of this experimental work should only improve the dose results presented in the 2019 SDF PA. [SRR-CWDA-2019-00001].

Expected Benefit: This task is expected to provide actual site-specific K_d values in soil and cementitious materials and colloidal transport measurements for various radionuclides. It will provide additional information about long-term geochemical and transport phenomena that will be used to support the waste release and transport models used in the SDF, FTF, and HTF PAs.

FY2012: Completed the installation of the lysimeter and initiation of the sample collection program. [SRNL-STI-2012-00603]

FY2013: The concentrations of radionuclides and stable iodine were measured in the effluents from the field lysimeters. [SRR-CWDA-2013-00121]

FY2014: The concentrations of radionuclides (leached from either filter "pita pockets" or cementitious monoliths) were measured in the effluents from the field lysimeters. [SRRA021685]

FY2015: Key findings with respect to plutonium and cobalt transport are essentially the same as FY2014. Similarly, lysimeters 29 and 30 had measurable effluent concentrations of Np-237 corresponding to 1.56% and 13.1% of the initial activity added to the source. This was consistent with the higher mobility of pentavalent Np(V), which is the source lysimeters 29 and 30. No breakthrough was apparent for lysimeters 31 and 32 which contained neptunium in the less mobile tetravalent state (Np(IV)). [SRRA021685-000007]

FY2016: Key observations for FY2016 are as follows [SRRA021685-000008]:

- The concentration of Pu in lysimeter effluents were on the order of E-15 to E-13 mol/L. This was below the detection limit for the standard ICP-MS measurement and a low-level radioanalytical technique was used to perform these measurements.
- Lysimeters containing pentavalent Np(V) sources had measurable breakthrough corresponding to 2.5% and 18.6% of the initial activity added to the source. The variability in these numbers was hypothesized to be caused by heterogeneous flow of water through the lysimeter. During work in FY2016, Np was also observed in the effluent of lysimeter 32, which contains a relatively insoluble NpO_2 source. The observation of Np in the effluent from this lysimeter implies that the NpO_2 was becoming oxidized and releasing Np(V) which can transport through the lysimeter with a relatively low K_d.
- Similar to previous years, Co-60 was measured in the effluent of all lysimeters containing gamma emitting radionuclides. However, the concentrations were much lower than previous sampling events. The majority of the Co-60 was released within the first two years of the experiment and concentrations are now close to detection limits. For all lysimeters containing the gamma suite of radionuclides, the concentration of Co-60 in the lysimeter effluent was lowest for those with a filter pita pocket source.
- There was a high degree of variability in the amount of water flowing through each lysimeter. It was hypothesized this was due to heterogeneous flow of water through the soil and variations in the localized climate (i.e., wind and rain patterns) above the four-inch diameter lysimeter opening.

FY2017: Two reports were issued in September 2017.

The first report (SRRA021685-000008) documented concentrations measured in field lysimeter effluents during FY2017. The trends/findings concerning Np(V) and Np(IV) release, Co-60 effluent concentrations, and heterogeneous flow reported in FY2016 continued in FY2017.

The second report (SRRA021685-000009) documented the detailed solid phase analysis of a field lysimeter with an emplaced colloidal PuO_2(s) source.

FY2018: Two reports were issued in September 2018.

The first report (SRRA021685-000011) documented concentrations measured in field lysimeter effluents from the fourth quarter of FY2017 and the second quarter of FY2018. The trends/findings concerning Np(IV) and Np(V) release, Co-60 effluent concentrations, and heterogeneous flow reported in FY2016 and FY2017 continued in FY2018 with the one caveat being that Co-60 was only present in measurable concentrations in Lysimeter 4 and 5's effluent. (Note that these two lysimeters possess a cementitious puck source without GGBFS).

The second report (SRRA021685-000010) documented the detailed solid phase analysis of a field lysimeter (Lysimeter 41) with an emplaced $Pu(V)NH_4(CO_3)(s)$ source.

FY2019: In FY2019, new radionuclide sources were prepared for deployment lysimeters (installed in FY2020). Lysimeter effluent continued to be collected and analyzed during FY2019 and desorption experiments for gamma-emitting radionuclides (Co-60, Ba-133, Cs-137, and Eu-152) sorbed to SRS sediment were initiated.

FY2020: In FY2020, fifteen new lysimeters, containing plutonium, neptunium, iodine, or radium sources were installed at RadFLEx (see highlighted rows in Table 2.2-3). Effluent samples were collected at least quarterly from the field lysimeters and transported to Clemson University for analysis. Monthly sampling and analysis were performed for lysimeters where radionuclides have previously been detected in the leachate (i.e., Lysimeter 30 and Lysimeter 32 which utilize a Np(V) and a Np(IV) source, respectively).

Two reports were issued in FY2020.

The first report (SRRA021685-000013) documented concentrations measured in field lysimeter effluents from the third quarter of FY2018 through the fourth quarter of FY2019. The second report (SRRA021685-000012) documented desorption experiments for gamma-emitting radionuclides sorbed to SRS sediment. The study used sediment taken from a previously removed lysimeter (Lysimeter 26 at RADFLEx) and generated conditional sorption coefficients (i.e., K_d values) for Co-60, Ba-133, Cs-137, and Eu-152 of 29 mL/g, 29 mL/g, 2,200 mL/g, and 4,300 mL/g, respectively, that can be utilized in future PA modeling. In addition, the study revealed the potential for aging effects on sorption, with both Cs-137 and Eu-152 demonstrating increased affinity for SRS sediment with time. With the exception of cobalt (K_d of 29 mL/g measured vs. 40 mL/g modeled in FY2019 SDF PA), the sorption coefficients determined from this study are favorable (i.e., higher) compared to the values currently used in PA modeling. Given this fact and Co-60's negligible contribution to the overall dose predicted in the PA (Table 5.5-2 of SRR-CWDA-2019-00001), the findings of this experimental work should only improve the dose results presented in the 2019 SDF PA. [SRR-CWDA-2019-00001]

Table 2.2-3: Radionuclide Field Lysimeter Experiment (RadFLEx) Lysimeters

Description	Lysimeter	Description	Lysimeter
Empty	1-3	Pu(IV)-oxalate, grass	13/9
Empty	2-3	Pu(V)NH4 (CO3)/OM, 2 yr	14-2
Cement Control	3	Saltstone Control	15
Cement gamma suite	4	Saltstone gamma suite	16
Cement gamma suite	5	Saltstone gamma suite	17
Cement gamma Suite	6	Saltstone gamma suite	18
Cement Tc & I (capped)	7	Saltstone Tc & I (capped)	19
$Np(IV)O_2$, 2 yr	8-2	Pu(V)NH4 (CO3)/OM, 4 yr	20-2
Ra-226/Sand	9-2	Pu(V)NH4 (CO3)/OM, 10 yr	21-3
Pu(IV)-oxalate, grass	10	Pu(V)NH4(CO3)/OM	22
Pu(IV)-oxalate, grass	11	Pu(V)NH4(CO3)/OM	23
Grass control	12	Instrumented control	24
Sediment Control	25	Instrumented Control	37
Ra-226	26-2	Pu(V)NH4 (CO3)/Sand, 2 yr	38-3
gamma suite	27	Pu(IV)oxalate	39
gamma suite	28	Pu(IV)oxalate	40
$Np(IV)O_2$, 6 yr	29-2	Pu(V)NH4 (CO3)/Sand, 4 yr	41-3
Np(V)nitrate	30	Pu(V)NH4(CO3)	42
Np(V)-nitrate, 2 yr	31-2	Pu(V)NH4(CO3)	43
$Np(IV)O_2$	32	Pu(V)NH4 (CO3)/Sand, 10 yr	44-3
Np(V)-nitrate, 6 yr	33-2	Pu colloids	45
Pu(III)oxalate	34	Pu colloids	46
Pu(III)oxalate	35	I-129 Cement	47-2
Ra-226	36	I-129 Cement	48-2

FY2021: In FY2021, effluent continued to be collected and analyzed for RadFLEx's active lysimeters (including the 15 new lysimeters installed in FY2020). Additionally, a technical memo (SRRA175647-000002) detailing different analytical techniques for measuring radium and iodine in lysimeter effluent, was issued by Clemson University in support of the RadFLEx project. The memo discusses the detection limits, ease, and cost associated with each analytical method allowing the Liquid Waste Organization (LWO) to make an informed decision regarding what analytical method best suits the needs of the research both scientifically and financially.

FY2022: For FY2022, nine RadFLEx lysimeters will undergo retrieval and solid phase analysis. Four gamma suite lysimeters (lysimeters containing a Ba 137, Eu-152, Co-60, and Cs 137 source) are to undergo non-destructive analysis. The five remaining lysimeters, all possessing a Pu source, will undergo destructive analysis (i.e., soil dissection, soil digestion, and analytical measurements on the resulting digestate). Solid phase analysis of these nine lysimeters will generate high pedigree PA data and justification for selection of geochemical conceptual models.

Deliverable: Annual Leachate Report

Expected Completion Date: FY2030

Responsibility: SRMC WDA (Savannah River National Lab [SRNL] and Clemson)

Estimated Cost: FY2022 through FY2026 $110K/yr

2.2.2.2 Studies Related to Cementitious Materials Degradation Due to Radiation Damage

Description: Saltstone is a cementitious waste form. As such, damage to cementitious materials from radiolytic mechanisms must be understood. A literature search will be conducted to gain a better understanding of the potential degradation of cementitious materials exposed to radiation.

Expected Benefit: This activity is expected to produce a baseline of knowledge concerning cementitious degradation due to radiolytic mechanisms over long periods to inform degradation assumptions. The data provided from this effort will also inform the HTF and FTF modeling.

FY2022: A technical report documenting the results of the literature search will be issued in FY2022.

Deliverable: Technical Report

Expected Completion Date: FY2022

Responsibility: SRMC WDA

Estimated Cost: FY2022 $7K, FY2023 through FY2025 $0/yr

2.2.2.3 Closure Cap Long-Term Performance

Description: This task involved research and development regarding the long-term performance of the closure cap as performed by the University of Virginia. The work is intended to derive analysis results to replace the current engineered closure cap baseline for the SDF from the design defined in SRR-CWDA-2018-00087 (which assumes the material properties as documented in WSRC-STI-2008-00244). Particular emphasis will be directed towards the following scope:

- Establishing infiltration rates through the bottom of the engineered closure cap system over time that can be utilized as an upper boundary condition to vadose zone flow and transport modeling.

- Determining uncertainty ranges in the infiltration rates that can be utilized in alternate infiltration scenarios for PA modeling.

- Providing recommendations for any improvements to the methods currently employed to degrade the performance of the sand drainage layer above the SDUs.

- Comparison to alternate calculation methods/codes or to measured/literature values to provide model support for baseline analysis.

Expected Benefit: This effort will validate assumptions in the PAs concerning the rate of closure cap infiltration as well as the behavior of the drainage layer above each SDF disposal unit.

FY2018: A Closure Cap document (SRRA107772-000009, *Predicting Long-Term Percolation from the SDF Closure Cap*) was issued in FY2018. This report updated the inputs and assumptions from the 2008 estimates (WSRC-STI-2008-00244) and developed a revised model using WinUNSAT-H (a variably saturated flow code that has been used extensively over the past two decades for predicting the hydrology of covers for waste containment systems). During report development, it was determined that a number of assumptions used to develop the 2008 estimates had no supporting bases and therefore had utilized very conservative assumptions. These assumptions were re-evaluated, and more realistic assumptions were developed based on field observations, recent laboratory analyses, and subject matter expertise. Justifications for the revised assumptions, and the updated modeling inputs were documented in SRRA107772-000009. The resulting infiltration (or percolation) estimates was used in the SDF PA modeling for the 2019 SDF PA revision. Updating the inputs and assumptions from the 2008 estimates provides lower infiltration rates used in the 2019 SDF PA revision.

FY2021: Closure cap analyses to address NRC RSIs (ML20254A003) include additional literature reviews and modeling to better characterize and evaluate uncertainties associated with the long-term performance of the closure cap. To support this work updates to the probable maximum precipitation (PMP) estimate and erosion rates are also being evaluated. The resulting infiltration (or percolation) estimates will be used in the upcoming FTF and HTF PA revisions (See Section 3.4).

The FTF and HTF closure caps are primarily intended to provide physical stabilization of the site, minimize infiltration, and provide a deterrent to intrusion. The layers and materials of the current closure cap design are based on the *FTF Closure Cap Concept and Infiltration Estimates* (WSRC-STI-2007-00184). The design was updated to apply to the HTF via *H-Area Tank Farm Closure Cap and Infiltration* (SRNL-ESB-2008-00023). The geometry and the layout of the closure caps were further updated (SRR-CWDA-2019-00080; SRR-CWDA-2019-00081) to incorporate an increased slope at the surface (i.e., 4% slope instead of 1.5% slope) to meet closure requirements specified in the regulation *SWM: Solid Waste Landfills and Structural Fill* (SCDHEC R.61-107.19). FTF and HTF closure cap performance over time was analyzed in SRRA162682-000002, *Predicting Long-Term Percolation From the HTF and FTF Closure Caps, Report No. GENV-20-09.* The Tank Farm closure cap designs are preliminary; however, they provide sufficient information for planning purposes, evaluating the closure cap configuration relative to its constructability and functionality, and for estimating infiltration rates over time through modeling.

SRR-CWDA-2021-00043, *Erosion Analysis for the H-Tank Farm and F-Tank Farm Facilities*, has been issued building upon the FTF and HTF closure caps designs and the previously issued SDF analysis, SRR-CWDA-2021-00035, *Erosion Analysis for the Saltstone Disposal Facility*. The analysis utilizes the Revised Universal Soil Loss Equation (RUSLE) to determine the average annual rate of soil loss due to erosion. SRR-CWDA-2021-00076, *Evaluation of the Uncertainties Associated with the F-Area and H-Area Tank Farm Closure Caps and Long-Term Infiltration Rates* was issued in September 2021 and provides a range of infiltration rates for use in the PA models.

FY2022: No Closure Cap design activities planned in FY2022.

Deliverable: Technical Report for Tank Farm Closure Cap, Section 3.2.3

Completion Date: FY2021

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $0/yr

2.2.3 To Be Determined Out-Year Testing

Description: For FY2023 and beyond, testing has not been finalized. Future testing will be determined based on information needs identified in the SDF PA revision (discussed in Section 2.2.1).

Responsibility: SRMC WDA

Estimated Cost: FY2023 through FY2026 $0/yr

2.3 Saltstone Disposal Facility Performance Assessment Planned Review, Analysis, and Schedules

DOE M 435.1-1 requires the ongoing maintenance of all PAs. This maintenance includes a series of activities that must be performed on an annual basis. This section describes the activities required every year in support of the SDF PA. All cost estimates are assumed bounding so no increases due to escalation are applied.

2.3.1 Maintain Saltstone Disposal Facility Performance Assessment Control through Unreviewed Waste Management Question Process

Description: A formal system to evaluate disposal practice changes and proposed actions is in place for the SRS LW Facilities and is known as the UWMQ process. For SDF, the UWMQ process consists of providing UWMQEs of proposed activities or new information to ensure that the assumptions, results, and conclusions of the current PA, any current SAs, the 3116 Waste Determination, and the CA remain valid, and the changes are within the bounds of the DAS.

If identified through the UWMQ process that a proposed activity or new information is outside the bounds of the current analyses, new SAs are prepared to update the technical baseline. UWMQEs and SAs will continue to be required throughout the life of the facility. For planning purposes, the estimated cost assumes that 12 UWMQEs will be prepared in FY2022 (assumptions remaining at 12 for each out-year). The estimated cost does not reflect the cost of any emergent SDF SAs. Any planned PAs/SAs for SDF are captured in Section 2.4.

One UWMQE was performed in FY2021 for the SDF. The UWMQE was entitled *Evaluation of the Assumed 40,000 gallons of Saltstone Produced with Noncompliant Slag* (SRR-UWMQE-2021-00001). On January 21, 2021, new information was discovered that the slag in the dry feed silos at the Saltstone Production Facility (SPF) did not meet procurement specifications. Specifically, the slag provided by the vendor was actually a mixture of materials: slag (50% to 70%), cement (16% to 39%), and limestone (8% to 11%) (SRR-UWMQE-2021-00001). Prior to identification of this noncompliance, approximately 36,000 gallons of saltstone grout had been produced with the noncompliant slag and was disposed of into SDU 6 (X-CLC-Z-00092). For added conservatism, this UWMQE assumes a volume of 40,000 gallons of saltstone grout was produced with the noncompliant slag and disposed of into SDU 6 (X-CLC-Z-00092).

Deliverable: Provide UWMQEs and UWMQ procedure support, as needed to support SDF operations

Expected Completion Date: Ongoing

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $85K/yr

2.3.2 Prepare Annual Update to Performance Assessment Maintenance Program

Description: The purpose of the LW PA Maintenance Program is to support the continued adequacy of the current PA and SAs and to increase confidence in the results. Every year the annual LW PA Maintenance Program FY update is prepared and provided to DOE. Plan preparation will include review of outstanding PA and SA comments and recommendations (noted in Sections 2.2.1 and 2.2.2). The update outlines planned work for each FY. The cost of preparing the update will be shared between SDF, FTF, and HTF. See the activities described in Section 3.1.2 for FTF and HTF.

Deliverable: Issue a FY LW PA Maintenance Program Annual Update

Expected Completion Date: 2Q-3QFY (issued annually)

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $15K/yr

2.3.3 Provide General Technical Support on Saltstone Disposal Facility Performance Assessment Issues

Description: This task is to provide general technical and programmatic support on SDF PA and SA issues, NRC 3116 monitoring activities, and other regulatory issues that affect SDF operations. Activities include testing and research activity support, general project and operations support, supporting NRC on-site observation visits and technical reviews, responding to NRC RSIs, RAIs, and development of resolution path forward for NRC open items. Research activity support includes monitoring of research done by outside agencies (e.g., academic research, work conducted for Hanford) as well as research performed on-site (e.g., SRNL, SREL). These activities also include support on interactions with South Carolina Department of Health and Environmental Control (SCDHEC), SRS Citizens Advisory Board (CAB), the LFRG, National Academy of Sciences, and other regulatory and stakeholder bodies.

Since July 2020, the NRC has been reviewing the 2019 SDF PA as part of the NRC's monitoring role under Section 3116(b) of the *Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005* (NDAA Section 3116).

The NRC provided a set of RSIs in October 2020 (ML20254A003). These RSIs requested that additional models be developed to better enhance the understanding of combined uncertainties related to the long-term performance and potential degradation of various components and features associated with the SDF closure system. Due to the sequential nature of the RSIs, wherein some RSIs had to be responded to as prerequisites to other RSIs, the preparation of the responses to the RSIs was performed sequentially, resulting in multiple documents being prepared from March to August 2021, which are summarized in *Summary of RSI Response Documents for the SDF PA*, SRR-CWDA-2021-00068.

In addition, as part of their review, the NRC has issued two letters as of the end of FY21 with RAIs. [ML21040A492, ML21133A296] The first letter had twelve RAIs as well as six CCs. Those RAIs and CCs were addressed in SRR-CWDA-2021-00047, *Comment Response Matrix for the First Set of U.S. Nuclear Regulatory Commission Staff Requests for Additional Information on the Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site,* issued in July 2021.

The NRC issued the second letter in June 2021 and that letter included an additional sixteen RAIs and fourteen CCs. On August 18, 2021, an initial round of responses to this second set of NRC RAIs and CCs was issued via SRR-CWDA-2021-00072, *Comment Response Matrix for the Second Set of U.S. Nuclear Regulatory Commission Staff Requests for Additional Information on the Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site,* Revision 0. SRR-CWDA-2021-00072 was subsequently revised to include the complete set of RAI and CC responses and Revision 1 was issued in November 2021.

Deliverable: Provide ongoing technical support on regulatory and policy issues/activities affecting SDF operations

Expected Completion Date: Ongoing

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $575K/yr

2.3.4 Develop and Maintain Performance Assessment Model Archive and Revision Control

Description: This task established software and hardware resources for archiving development and final PA modeling files to a read-only storage medium. In FY2014, capital infrastructure improvements were enacted on the site network, allowing for faster communication between SRNL's high performance computing network and SRMC WDA servers. This improvement increased the rate for file transfers between the two systems. SDF modeling files (for both PORFLOW and GoldSim) were copied to electronic storage devices. The storage devices are maintained onsite by SRMC WDA, within a cipher-locked facility. The properties of the electronic files were set to read-only. Copies of files can be provided upon request. As needed, additional storage devices will be purchased to provide sufficient disk space for maintaining a record of all related model files.

Deliverable: Establish process (completed in FY2014) and maintain after implementation

Expected Completion Date: Ongoing

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $5K/yr

2.3.5 Conduct Annual Saltstone Disposal Facility Performance Assessment Validation

Description: The purpose of the LW PA Maintenance Program is to confirm the continued adequacy of the SDF PA and to increase confidence in the results of that PA. A requirement of the maintenance program is to conduct an annual review of the disposal facility activities. The annual PA review is conducted in a systematic manner that incorporates the following considerations:

1. Radionuclide inventories, waste volumes, and waste types disposed throughout the year
2. Testing and research activities performed during the year
3. Results of PA monitoring conducted in accordance with the SDF PA Monitoring Plan for the SDF

The above factors are reviewed annually to confirm the adequacy of the current facility PA, and to evaluate the need to conduct SAs or prepare a revision to the PA. The results of the review are documented in an annual summary report for the current SDF PA and submitted to DOE.

Deliverable: Issue a FY PA annual summary report

Expected Completion Date: 2QFY (issued annually)

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $15K/yr

2.3.6 Maintain Saltstone Disposal Facility Performance Assessment Closure Plan

Description: The closure plan that complies with DOE M 435.1-1 for SDF must be maintained and modified as needed to reflect facility changes. The SDF closure plan is reviewed annually to determine if a revision is required.

An update of the SDF Closure Plan (SRR-CWDA-2020-00005) was issued in August 2020 based on issuance of the SDF PA (SRR-CWDA-2019-00001) in May 2020.

Deliverable: Review closure plan annually and revise as necessary

Expected Completion Date: Reviewed annually

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $5K/yr

2.3.7 Maintain Saltstone Disposal Facility Performance Assessment Monitoring Plan

Description: The SDF PA Monitoring Plan that complies with DOE M 435.1-1 must be maintained and modified as needed to reflect facility changes. The SDF PA Monitoring Plan is reviewed annually to determine if a revision is required.

An update of the SDF PA Monitoring Plan (SRR-CWDA-2020-00006) was issued in August 2020 based on issuance of the SDF PA (SRR-CWDA-2019-00001) in March 2020 to capture changes in the recently revised 2019 SDF PA and to incorporate ongoing activities as required by the DAS. [WDPD-20-32].

Deliverable: Review the SDF PA Monitoring Plan annually and revise as necessary

Expected Completion Date: Review annually

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $5K/yr

2.3.8 Status of DAS Conditions/Limits

In FY2021 there were three DAS conditions in effect for SDF (per WDPD-20-32):

1. Changes to SDF Waste Acceptance Criteria shall be conservatively based on the Performance Assessment Retreating Closure Cap case analysis and any increase of I-129 concentrations shall be limited by a factor of 2. All Waste Acceptance Criteria (WAC) changes must be reviewed and approved by the Site LFRG member prior to implementation.
2. A Closure PA, including final closure cap design and appropriate erosion analysis, shall be developed and submitted to the LFRG for review and approval prior to closure cap construction.
3. Within 365 days of the DAS issuance, SRS shall submit to DOE Headquarters revised technical basis documents (monitoring plan, maintenance plan, WAC, etc.) for review or a justification provided as to why the existing documents are consistent with the PA.

Condition 3 pertains to implementation of the 2019 SDF PA. Conditions 1 and 2 were applied in response to one Secondary Issue, SDF-S06-PA12-02 (LFRG_03-02-2020), which is the only remaining open issue.

Conditions 1 and 3 were closed in FY2020 with the issuance of the technical basis documents.

2.3.9 LFRG Key and Secondary Issues

The LFRG review of the 2019 SDF PA initially identified 2 Key Issues and 11 Secondary Issues; with the exception of SDF-S06-PA12-02, all of the other Key Issues and Secondary Issues were addressed and closed prior to issuing the 2019 SDF PA. The remaining open issue, SDF-S06-PA12-02: Preliminary Cap Design Does Not Include Adequate Erosion Analysis, will be closed once an adequate erosion analysis has been completed for the proposed closure cap, and any potential impacts from future erosion are evaluated.

2.4 Saltstone Disposal Facility Performance Assessment Development/Revisions

The 2019 SDF PA provides the technical basis and results to be used in subsequent documents to demonstrate compliance with pertinent requirements of DOE M 435.1-1 and associated references and Title 10 Code of Federal Regulations (CFR) Part 61, Subpart C as required by NDAA Section 3116. The revised 2019 SDF PA (SRR-CWDA-2019-00001) was issued in March 2020 and issuance of an updated DAS was received in June 2020. [WDPD-20-32]

2.4.1 Prepare Out-Year Saltstone Disposal Facility Performance Assessment Revisions

Description: The initial SDF PA was issued and implemented in 2009. In FY2018, work was begun to update and revise the SDF PA. The revised 2019 SDF PA (SRR-CWDA-2019-00001) was issued in March 2020 and issuance of an updated DAS was received in June 2020. [WDPD-20-32] The SDF PA (SRR-CWDA-2019-00001) includes the following:

- Analyses and results contained in all SAs that have been completed to date;
- Analyses and results of all UWMQEs completed to date;
- Consideration of new information generated through applied research, including updated information about the material properties of saltstone and the transport behavior of I-129 and Tc-99 (from DLM testing);
- Updates to disposal unit design;
- Revised infiltration rates based on updated closure cap modeling from expert elicitation;
- Revised cementitious degradation rates based on updated material properties and recommended approaches informed by expert elicitation;
- Incorporation of an updated General Separations Area Flow Model using calibration targets from wells in Z Area;
- Changes in site future land use plans or closure plans; and
- Changes to PA guidance documents requirements.

No future PA revisions are scheduled at this time.

Deliverable: PA LFRG review draft issued – Complete
PA Revision 0 issuance – Complete

Expected Completion Date: FY2019 (PA LFRG review draft) – Summer 2019 - Complete
FY2020 (PA Revision 0) – March 2020 - Complete

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $0/yr

2.4.2 Saltstone Disposal Facility Performance Assessment Maintenance Activities

The LFRG performed a review of the revised 2019 SDF PA (SRR-CWDA-2019-00001, Revision B). The Review Team evaluated the SRS SDF PA and associated WAC and Change Control procedure against the requirements in DOE Manual 435.1-1, Radioactive Waste

Management, and the guidance provided in the DAS and Tank Closure Documentation Technical Standard (DOE-STD-5002-2017).

WDA has committed to performing several maintenance activities in support of resolving Secondary Issue SDF-S06-PA12-02 [Lack of Cap Design Including Proper Erosion Analysis] and additional Observations identified as part of the LFRG review of the SDF PA (LFRG_03-02-2020):

- Update the PMP event value
    - Document the development of the value via technical report.
- Use updated PMP value to perform an erosion/stability analysis based on the current closure cap design.
    - Erosion analysis should consider the most "plausible" erosion conditions and closure cap evolution
    - Erosion analysis should consider head-cut erosion/gully or channel formation
    - Erosion analysis should consider potential impacts from "clogged" drainage layers
    - Based on the erosion/stability analyses, consider if the current design requires any changes and implement the changes.
    - Document analyses via technical report.
- If the erosion analysis indicates that significant erosion is probable, develop a more appropriate set of infiltration rates for Compliance Case, Realistic Case, and Pessimistic Case conditions.
    - Document development of new erosion rates via technical report.
- Perform a literature review to develop a better understanding of diffusion in partially saturated media (soils)
    - Document the literature review and enhanced understanding via a technical report.
    - Based on enhanced understanding of diffusion in partially saturated media, consider whether changes need to be implemented in the PA models
- Review the SDF GoldSim Model to:
    - Identify parameters related to features or processes that may perform better than expected (or better than modeled)
    - Identify time-dependent events that could impact model results (e.g., possible step changes)
    - Determine if parameters or conditions could be modeled differently within the probabilistic simulations in ways that could provide insights related to "superior performance" affects

    - For example, if the SDUs are better barrier to release, then suddenly fail in some way, how might that impact results?
  - Document changes to the SDF GoldSim Model via memo and Changed Model Check form.
- Analyze historical well data at or near SRS to quantify the temporal and spatial probabilities of drilling
  - Document analysis via technical report.
  - Use the analysis to develop appropriate stochastic model inputs for probabilistic simulation with respect to Inadvertent Human Intruder (IHI) events.
- Based on the above actions, revise models and re-run Compliance Case, Realistic Case, and Pessimistic Case (for both MOP and IHI results) and rerun the Probabilistic realizations and analyses. Document all new modeling and model analyses via UWMQE or SA, as appropriate.

Deliverable: Incorporate LFRG issue resolutions into PA models – FY2022

Expected Completion Date: FY2022

Responsibility: SRMC WDA

Estimated Cost: FY2022 $50K, FY2023 through FY2026 $0/yr

2.4.3 Saltstone Disposal Facility Special Analyses

In FY2020, an SA was initiated to evaluate the following new information relative to potential impacts on the long-term performance of the SDF:

1. An improved normative analysis was developed to better determine the chemical and mineralogical constituents for concrete used in constructing SDUs and for the cementitious waste form known as saltstone.
2. Modeling properties have been developed to evaluate the performance of two proposed cementitious materials (SDU Concrete Mix 3B and Cement Free Saltstone) which are currently being considered for deployment.
3. An equivalent set of normative analyses for two new cementitious materials (SDU Concrete Mix 3B Concrete and Cement Free Saltstone) was also developed.
4. The normative analyses were used to update cementitious degradation rates for existing cementitious materials and for the new cementitious materials.

The primary driver for evaluating this new information is to determine the potential impacts from using the two proposed cementitious materials (SDU Concrete Mix 3B Concrete and Cement Free Saltstone). The FY2020 SDF SA (SRR-CWDA-2020-00064) was issued in 1QFY2021. The FY2020 SDF SA evaluated the performance of SDU Concrete Mix 3B and Cement Free saltstone relative to the 2019 SDF PA.

The DOE-SR approved the FY2020 SDF SA (WDPD-21-40) and minor edits were incorporated as Revision 1 to address observations that were identified during the DOE-SR review. Revision 1 of the FY2020 SDF SA, was issued in May 2021.

No additional new SAs are scheduled to be initiated in FY2022.

Deliverable: Technical Report – FY2020 SDF SA (SRR-CWDA-2020-00064)

Expected Completion Date: Complete

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $0/yr

2.5 Summary Table for the SDF PA Maintenance Program

Table 2.5-1 summarizes the estimated expenditures by activity and FY. Table A.1-1 contains a summary of the combined estimated expenditures for all the LW facility PA maintenance activities. This Implementation Plan reflects the PA related activities in the annual operating plan for the current FY and the projected out-year activities for estimation purposes.

Table 2.5-1: Summary for the Saltstone Disposal Facility Performance Assessment Maintenance Program ($K)

Section	Maintenance Activity	FY22	FY23	FY24	FY25	FY26
2.2.1	Contaminant Leaching Characteristics from Saltstone Monolith	150	150	150	0	0
2.2.2.1	Long-Term Radiological Lysimeter Program	55	55	55	55	55
2.2.2.2	Studies Related to Concrete Degradation Due to Radiation Damage	7	0	0	0	0
2.2.2.3	Closure Cap Drainage Layer Long-Term Performance	0	0	0	0	0
2.2.4	To Be Determined Out-Year Testing	0	0	0	0	0
	Testing and Research Total	212	205	205	55	55
2.3.1	Maintain SDF PA Control Through UWMQ Process	85	85	85	85	85
2.3.2	Prepare Annual Update to PA Maintenance Program	15	15	15	15	15
2.3.3	Provide General Technical Support on SDF PA Issues	575	575	575	575	575
2.3.4	Develop and Maintain PA Model Revision Archive and Revision Control	5	5	5	5	5
2.3.5	Conduct Annual SDF PA Validation	15	15	15	15	15
2.3.6	Maintain SDF Closure Plan	5	5	5	5	5
2.3.7	Maintain SDF PA Monitoring Plan	5	5	5	5	5
	Annual Tasks Total	705	705	705	705	705
2.4.1	Prepare Out-Year SDF PA Revisions	0	0	0	0	0
2.4.2	SDF PA Maintenance Activities	50	0	0	0	0
2.4.3	SDF Special Analyses	0	0	0	0	0
	PA Development/Revisions Total	50	0	0	0	0
	SDF PA COMPILED TOTAL	**917**	**910**	**910**	**760**	**760**

3.0 F-AREA AND H-AREA TANK FARMS

3.1 Tank Farm Facilities Monitoring

As required by the *Consolidated General Closure Plan for F-Area and H-Area Waste Tank Systems* (SRR-CWDA-2017-00015), groundwater sampling will be conducted during the interim period from the time individual waste tanks and ancillary equipment are removed from service, through post-closure groundwater monitoring as defined in final Record of Decision (ROD) documents for the FTF and HTF Operable Units (OUs). In December 2012, the EPA and SCDHEC approved new Sampling and Analysis Plans (SAPs) for both FTF and HTF. The approved *F-Area Tank Farm Groundwater Sampling and Analysis Plan (*SRNS-RP-2012-00287*)* and the *H-Area Tank Farm Groundwater Monitoring Plan and Sampling and Analysis Plan (*SRNS-RP-2012-00146*)* provide specific details of the groundwater monitoring programs.

Monitoring is performed by SRNS with the latest groundwater monitoring results for the Tank Farms contained in the report, *2021 Annual Groundwater Monitoring Report for the F- and H-Area Radioactive Liquid Waste Tank Farms*, SRNS-RP-2022-00076 issued in March 2022.

3.2 Tank Farm Performance Assessment Testing & Research Activities

This section of the LW PA Maintenance Program contains PA-related testing and research activities identified as part of the ongoing maintenance of the FTF and HTF PAs. The PA testing and research discussion within this section is intended to address combined testing and research activities for both FTF and HTF. No testing and research activities unique to a specific Tank Farm have been identified at this time.

Issuance of the FTF PA and the *Basis for Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site* (DOE/SRS-WD-2012-001) occurred in FY2012. In the *U.S. Nuclear Regulatory Commission Planned Monitoring Activities for F-Area Tank Farm at the Savannah River Site* (ML12345A322), the NRC made recommendations, with respect to the various monitoring factors identified by the NRC, for DOE to consider during maintenance and monitoring of the FTF PA (documented in Appendix A of ML12345A322). Subsequent to issuance of the FTF Monitoring Plan, the NRC issued an HTF TER. The recommendations included in the HTF TER and associated transmittal letter (provided subsequent to the FTF Monitoring Plan) were considered by DOE within the *Nuclear Regulatory Commission's H-Tank Farm Technical Evaluation Report's Recommendations – Department of Energy's Activity Summary Matrix*. [SRR-CWDA-2014-00080]

The NRC revised the NRC issued Monitoring Plan for FTF to include both FTF and HTF in 2015. The revised plan addresses the key monitoring areas for both tank farms. [ML15238A761] In the context of testing and research activities related to the FTF and HTF, the revised Monitoring Plan includes recommendations from the initial NRC FTF Monitoring Plan (ML12345A322) and any NRC TRRs issued subsequent to the NRC Monitoring Plan (see Appendix C). These recommendations will require further evaluation to determine how and when they should be addressed. The NRC recommendations are provided in Appendix C of this LW PA Maintenance Program Implementation Plan in the context of testing and research activities related to the FTF and HTF. In addition, Appendix C also contains NRC recommendations captured from NRC TRRs.

3.2.1 Tank Residual Characterization

These tasks involve measurements and methods that will improve upon current knowledge of materials remaining in the waste tanks at operational closure. Some maintenance activities established under the SDF maintenance program (Section 2.0) may also inform the FTF PA and HTF PA such as those concerning cementitious degradation, soil parameters, and fracture formation.

3.2.1.1 Waste Release Studies

Description: Through the NDAA Section 3116(a) consultation process, the NRC observed that uncertainties associated with the FTF PA doses might prevent DOE from meeting the 10 CFR Part 61, Subpart C performance objectives, particularly with regard to plutonium-related modeling assumptions. The NRC staff's primary concern was that the timing of the FTF PA peak dose could be shifted into their period of performance (10,000 years) if certain assumptions were incorrect. This peak dose is principally associated with the residual Pu-239 inventory in Tank 18. The NRC's TER recommends that DOE provide additional model support to further reduce the uncertainty surrounding PA assumptions that, if found to be significantly non-conservative, could result in this peak dose shifting into a 10,000-year performance period. [ML112371715]

FY2013: An experimental plan was developed in FY2013 to provide additional information regarding the residual waste solubility assumptions used in the FTF and HTF PA waste release models (WRMs). This task was to be performed in two parts, the first part being development of the test plan and methods and the second part being conducting the actual waste testing with simulants and tank samples. The first part was completed in FY2013. [SRNL-RP-2013-00203]

FY2014: The overall objective of the task is to provide additional information regarding the residual waste solubility assumptions used in the FTF and HTF PA WRMs by developing a series of analytic methods to be used to test the solubility of plutonium, neptunium, uranium, and technetium under various simulated waste tank chemistry conditions using actual waste tank residuals. Waste release testing using simulants was initiated and the results were documented in *Determining the Release of Radionuclides from Tank Waste Residual Solids*. [SRNL-STI-2014-00456]

FY2015: Waste release testing was performed in FY2015 in the areas of pore water development (including testing to understand and control stabilities of Oxidized Region II and Oxidized Region III) and surrogates solid testing (zero-head space and open-head space with O_2 and CO_2 present for Oxidized Region II and Oxidized Region III). The results of this testing were documented in an FY2015 testing report (*Determining the Release of Radionuclides from Tank Waste Residual Solids: FY2015 Report,* SRNL-STI-2015-00446) in anticipation of actual waste testing in FY2016.

FY2016: Testing of actual waste (i.e., Tank 18 residuals) was performed in FY2016 using the methodologies developed to date. The solubilities of Pu, Np, U, and Tc were tested under simulated waste tank chemistry conditions using Tank 18 residual waste samples, with the results documented in *Determining the Release of Radionuclides from Tank Waste Residual Solids: FY2016 Report* (SRNL-STI-2016-00432).

FY2017: Based on the successful testing of Tank 18 residuals in FY2016, the decision was made to test the residual solids from Tank 12. Tank 12 was an acid-cleaned tank versus the mechanical-only cleaning conducted on Tank 18 thus providing additional waste release data for comparison. In addition, Tank 12 is the tank which drives currently calculated doses in HTF modeling. Since I-129 is the radionuclide that drives the calculated dose peak, iodine was also analyzed in addition to Pu, Np, U and Tc as done for Tank 18. In FY2017 the Technical Task Request was generated by SRR, *Waste Release Testing Program* (G-TTR-H-00014), and the Task Technical and Quality Assurance Plan (TTQAP) was generated by SRNL, *Task Technical and Quality Assurance Plan for Tank 12 Waste Residual Radionuclide Release Testing* (SRNL-RP-2017-00411). The scope defined by the TTQAP in FY2017 included procurement of test equipment and initial chemical preparation of the Tank 12 solids. New equipment procurement was necessary as the equipment used for Tank 18 testing had been discarded during the SRNL High-Level Caves renovations.

FY2018: The remaining scope of the TTQAP was completed in FY2018. Testing of a Tank 12H residual waste sample was performed in FY2018 using the same basic methodology used for the Tank 18F residual waste testing, with some minor changes made to incorporate lessons learned. The test setup modifications and the initial Tank 12H waste release testing results are documented in *Determining the Release of Radionuclides from Tank 12H Waste Residual Solids Following Tank Closure* (SRNL-STI-2018-00484).

FY2019: SRNL-STI-2018-00484, Revision 1 (*Determining the Release of Radionuclides from Tank 12H Waste Residual Solids Following Tank Closure*) was issued in FY2019. This revision captured the final Tank 12H waste release testing results and addressed outstanding comments against the waste release testing reports. An evaluation of the testing results, in particular the I-129 results, were documented in a revision to *Evaluation of Waste Release Testing Results against the Tank Farm Performance Assessment Waste Release Model* (SRR-CWDA-2016-00086). The measured solubilities for the tested elements are consistent for the residuals from both Tanks 18F and 12H, with the Tank 12H solubilities tending to be less soluble. The updated experimental results (including 12H testing) continue to indicate there may be some variance between the actual waste solubilities and the WRM assigned solubilities. The results indicate that I-129 in the Tank 12H residual waste sample is relatively insoluble, under both reduced and oxidized conditions, compared to the WRM which conservatively assumed no solubility control for iodine. If the Tank 12 derived iodine solubility values were used in the PA model, the HTF peak dose within 10,000 years would decrease significantly. The new waste release data can be integrated into the next revision to the FTF and HTF PAs.

FY2020: No real waste testing was performed in FY2020.

FY2021: The Waste Tank Chemistry Dynamics Testing in Section 3.2.1.2 provide additional inputs for the Tank Farm WRM, and was incorporated into an updated WRM (SRR-CWDA-2021-00042, *Recommended Solubilities for Tank Closure Performance Assessment*) in FY2021.

FY2022: No real waste testing planned in FY2022.

Deliverable: Test Plan (SRNL-RP-2013-00203) – Complete
Residual Solids Technical Report (SRNL-STI-2014-00456) – Complete

Residual Solids Technical Report (SRNL-STI-2015-00446) – Complete
Waste Testing Technical Report (SRNL-STI-2016-00432) – Complete
Tank 12 Waste Testing Technical Report (SRNL-STI-2018-00484) – Complete
Waste Testing Evaluation (SRR-CWDA-2016-00086, Rev. 1) – Complete

Expected Completion Date: FY2013 (Test Plan) – Complete
FY2014 (Residual Solids Report) – Complete
FY2015 (Residual Solids Report) – Complete
FY2016 (Waste Testing Reports) – Complete
FY2017 (Test Plan) – Complete
FY2018 (Waste Testing Report, Rev.0) – Complete
FY2019 (Waste Testing Report, Rev.1) – Complete

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $0K/yr

3.2.1.2 Waste Tank Chemistry Dynamics Testing

Description: The FTF and HTF PA Integrated Conceptual Models (ICMs) simulate radiological and chemical contaminant release from the waste tanks. An independent conceptual WRM was used to simulate stabilized contaminant release from the grouted waste tanks based on various chemical conditions in the waste tank which control solubility and thereby affect the timing and rate of release of contaminates from the residual waste layer (designated as the contamination zone (CZ) in the Tank Farm PA modeling). The current Tank Farm WRM is described in detail in *Evolution of Chemical Conditions and Estimated Solubility Controls on Radionuclides in the Residual Waste Layer during Post-Closure Aging of High-Level Waste Tanks* (SRNL-STI-2012-00404).

The WRM has not been updated since 2012 and does not incorporate solubility test data obtained from Tank 12 and Tank 18 real waste testing (documented in SRR-CWDA-2016-00086). Incorporating this data into the WRM would help to reduce the overall PA uncertainty, especially with respect to the radionuclides that drive peak doses (e.g., I-129, Pu-239). In addition, there are several NRC Monitoring Factors (MFs) regarding WRM chemistry dynamics that are best addressed through update of the WRM (the MFs are documented in Appendix C). The issues touched on in the MFs are areas where additional empirical data would be useful in reducing WRM uncertainty. It would be prudent to address the other WRM areas of concern (such as those raised in the NRC MFs) when the real waste test data is incorporated. To achieve this, it is proposed that testing be performed on various grout formulations to provide additional information regarding: 1) the impact of infiltrating ground water on grout pore water chemistry (e.g., pH and Eh) through time, 2) the ranges of tank grout pore water measure of acidity or alkalinity of a solution (pH) and measure of reduction (or oxidation) potential (Eh) to be expected in waste tanks, initially and through time following many pore volume flushes, and 3) the mineralogy of tank fill grouts, initially and through time following many pore volume flushes.

Another objective is to assess the performance of alternative tank grout formulas and ground water chemistries relative to baseline assumptions, to provide for flexibility within the WRM. This WRM flexibility would help for account for potential variability within the infiltrating water chemistry (i.e., infiltrating fresh rainwater versus infiltrating ground water from an aquifer above the tank bottom) and could also potentially be used to allow for operating flexibility in the future (e.g., use of Controlled Low Strength Material (CLSM) versus the current grout formula).

The testing will involve placing tank fill grout in test columns which are subject to pore water exposure for a set time frame. Infiltrating water and grout will interact with the net effect being that both the infiltrating water and grout chemistries are expected to evolve over the duration of the test. Multiple grout test columns will be used for testing. Some of the grout configurations involve sealed systems while others allow the infiltrate water to flow through the grout column. The infiltrate water will be placed in different columns with various grout forms and formulations with the column sealed for the duration of the test. For the other grout configurations, the infiltrate water will be run through the columns with the column output monitored during the duration of the test. Data will be obtained over time regarding infiltrating water chemistry and grout minerology evolutions. Empirical data on infiltrating water and grout evolution could be used to supplement and/or replace inputs used in the Geochemist's Workbench (GWB) simulation and better define the tank chemistry conditions after closure. The tank chemistry conditions could be used to refine the WRM and to better bound the waste release conditions. An improved WRM would reduce the uncertainty in the FTF and HTF PA models.

<u>FY2019:</u> A detailed test plan, outlining the final scope and goals for the water chemistry and grout minerology testing, was issued in FY2019 as well as starting testing. Testing will be completed and a Technical Report outlining the results will be issued in FY2020. The proposed scope for the testing is outlined in the following.

Request for quote went out March 2019 on a Statement of Work (SOW) for Aqueous and Solid Phase Characterization of Potential Tank Fill Materials. WDA performed a technical evaluation of the three vendor quotes received on this SOW and the University of Georgia Research Foundation was selected to perform this work in April 2019. An SREL Test Plan was issued in FY2019.

The three grout formulations used in the batch and column tests completed a 90-day cure and most of the paste samples were size-reduced to at least the granularity of coarse sand and mixed in clean quartz sand in the proportion of the production grout mixes. Batch tests performed under oxic (bench-top) and anoxic (glove box) exposure conditions were initiated with approximately one-half of the sample material. SREL performed mockups of additional column tests to calibrate probes and troubleshoot the overall apparatus. Column tests using both oxic and anoxic infiltrates started in October 2019. The pH and Eh was monitored in the batch and column tests for at least 20 weeks. The results of the testing are presented the report, *Aqueous and Solid Phase Characterization of Potential Tank Fill Materials*, SREL-R-21-0001, issued in August 2020.

A memorandum entitled *Application of Characterization of the Aqueous and Solid Phase Chemistry of Closure Grouts*, SRR-CWDA-2020-00061, was issued by WDA in August 2020 summarizing the results of the testing.

A report related to Waste Tank Chemistry Dynamics Testing (ML19105B156, *Tank Grout Water-Conditioning Tests—Status Report*) was issued in FY2019 and a follow-up report, ML20126G298 was issued in FY2020, both by the Center for Nuclear Waste Regulatory Analyses under contract for the U.S. Nuclear Regulatory Commission. Grout water conditioning tests performed during FY2018 and early FY2019 investigated the effects of the reducing tank grout in consuming Dissolved Oxygen (DO) and on the pH and Eh of simulated SRS ground water, as well as the effect of grout surface area on these three parameters. The DO consumption test demonstrated that reducing grout could consume DO from the SRS water, a pre-requisite for producing reducing conditions in water contacting the grout.

WDA has completed a review of both these report and found the test results to be consistent with the current Tank Farm PA modeling approaches and supportive of the proposed Waste Tank Chemistry Dynamics Testing.

<u>FY2020:</u> In August 2020, SREL issued the technical report, *Aqueous and Solid Phase Characterization of Potential Tank Fill Material*, SREL-R-21-0001. SREL conducted a series of batch and column studies to address uncertainty in the realistic pH and Eh ranges associated with the grouted waste tank systems, including an evaluation of three candidate Tank Closure Grout (TCG) paste formulations.

The observed results generally agreed with previous laboratory tests aimed at defining achievable Eh and pH conditions in tank waste grouted systems. The pH results were predominantly consistent with both the values derived from geochemical modeling and more recent laboratory testing.

<u>FY2021:</u> In FY2021, WDA updated the WRM (SRR-CWDA-2021-00042, *Recommended Solubilities for Tank Closure Performance Assessment*) to capture refined equilibrium chemistry. SRR-CWDA-2021-00042 includes comprehensive update of solubilities recommended for elements in the residual waste layer based on 1) new and updated aqueous solutions; 2) current thermodynamic databases including the international Nuclear Energy Agency database; and 3) experimental studies. This report utilizes a consulting report from Dr. Miles Denham entitled *Recommended Updates to Solubility Controls for Modeling Leaching of Technetium, Uranium, Neptunium, Plutonium, and Iodine from the Residual Waste Layer of Closed Savannah River Site High-Level Waste Tanks* (IEI 2024-002). The recommendations contained in IEI 2024-002 are based on an updated Nuclear Energy Agency (NEA) thermodynamic database published in 2020, and insights gained from review of laboratory experiments involving real tank waste samples conducted over the past decade.

<u>FY2022:</u> No Waste Tank Chemistry Dynamics Testing planned in FY2022.

<u>Deliverables</u>: WDA Waste Release Model update (SRR-CWDA-2021-00042, *Recommended Solubilities for Tank Closure Performance Assessment*)

<u>Expected Completion Date:</u> FY2019 (Test Plan) – Complete

FY2020 Test Technical Report (SREL-R-21-0001) - Complete

WDA Memorandum (SRR-CWDA-2020-00061) – Complete

WDA Waste Release Model update (SRR-CWDA-2021-00042)

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $0/yr

3.2.2 CLSM Testing

Description: A key step in closing a radioactive liquid waste tank at the Savannah River Site is filling void spaces in the emptied and cleaned tank with grout. The fill grout stabilizes the structure, serves as a barrier to inadvertent intrusion, limits moisture contact with residual waste, chemically conditions the waste (e.g., high pH, low Eh) generally hindering radionuclide release, and inhibits corrosion of impermeable steel liners maintaining containment of the residual waste. Several different grout mixes have been used since 1997 as the bulk fill material for waste tank closure, with additional mixes used for specialized purposes, such as filling cooling coils. The various grouts all have different attributes and features that make them better or worse with respect to the bulk fill grout function.

FY2020: Grout testing was performed in FY2020 in order to:

- Identify the grout attributes affecting performance as a liquid waste tank bulk fill material (e.g., slump flow, bleed water, etc.),
- Define performance metrics and associated requirements and goals,
- Identify additional CLSM characterization needed to support Tank Farm PA revisions,
- Assess the pros and cons of the reference sample LP#8-16 and candidate CLSM mixes on an attribute-by-attribute basis, and
- Recommend next steps toward selecting a bulk fill grout for the next tank closure.

Results of the CLSM testing is contained in *Test Report- CLSM Proposed TCG Hydraulic Conductivity Test; Subcontract No. 0000441257, Delivery Order No.4; Specification K-SPC-G-00013, Rev. 15; Wood E&IS Project No. 6162-19-1253.04* (Wood E&IS 2020) issued in May 2020.

An evaluation memo of the results of the CLSM Test Report entitled *Characterization and Assessment of CLSM Grouts for Potential Use in Waste Tank Operational Closures*, SRR-CWDA-2020-00045 was issued by WDA in June 2020.

FY2021: For FY2021, SREL performed three tasks evaluating Zero-Bleed CLSM; 1) calculating saturated hydraulic conductivity, 2) measure diffusion of Na+ and NO3- from solution into the monolith, and 3) obtain Moisture Characteristic Curves (MCCs) for Zero-Bleed CLSM. A report was issued in FY2021 documenting the results of this CLSM testing. [SRRA099188-000015].

FY2022: For FY2022, no additional effort is proposed for testing CLSM.

Deliverables: Test Technical Report and WDA Evaluation

Expected Completion Date: Test Technical Report (Wood E&IS 2020) - Complete
WDA Evaluation (SRR-CWDA-2020-00045) – Complete
SREL - CLSM Characterization: Data Report (SRRA099188-000015) – Complete

Responsibility: SRMC WDA (SREL)

Estimated Cost: FY2022 through FY2026 $0/yr.

3.2.3 Tank Farm Closure Cap Design

Description: The Tank Farm Closure Cap Concepts used in the FTF PA (SRS-REG-2007-00002, Rev. 1) and HTF PA (SRR-CWDA-2010-00128, Rev. 1) are being updated. The general Tank Farm Closure Cap Concepts used in the PAs are currently detailed in reports WSRC-STI-2007-00184 (FTF) and SRNL-ESB-2008-00023 (HTF). The Tank Farm closure cap designs set forth in these documents will be used in the updated designs except with a nominal 4% closure cap slope (i.e., the closure cap assumptions regarding cap component dimensions, facility locations, and topography are not changed). The change from a 2% to 4% slope was made in compliance with SCDHEC requirements (SCDHEC requires the closure cap to have at least a 3% but not greater than 5% surface slope, graded to promote positive drainage). In addition, lessons learned from a Closure Cap degradation document (*Predicting Long-Term Percolation from the SDF Closure Cap*, SRRA107772-000009) issued in 2018 will be incorporated into the updated Tank Farm Closure Cap Concepts. This SDF Closure Cap degradation document captured research that provided improved insights related to HDPE/ Geosynthetic Clay Liner (GCL) degradation. As a result of this, infiltration through the closure cap is expected to be lower, resulting in very different flow fields in the vadose zone, relative to previous modeling efforts.

In FY2020, updated predictions were prepared for the percolation rate emanating from the base of the engineered closure cap anticipated for closure of the FTF and HTF at the SRS. [SRRA162682-000002] Simulations were conducted with meteorological conditions representing wet conditions in the current climate and two climate change scenarios corresponding to wet and very wet conditions. Predictions were made for conditions where the drainage layer and composite barrier continue to function as intended, and where degradation of the drainage layer and composite barrier occur due to clogging of the drainage layer, oxidation of the geomembrane, or severe gully erosion that penetrates down to the composite barrier. [SRRA162682-000002]

FY2021: The FTF and HTF closure caps are primarily intended to provide physical stabilization of the site, minimize infiltration, and provide a deterrent to intrusion. The layers and materials of the current closure cap design are based on the *FTF Closure Cap Concept and Infiltration Estimates* (WSRC-STI-2007-00184). The design was updated to apply to the HTF via *H-Area Tank Farm Closure Cap and Infiltration* (SRNL-ESB-2008-00023). The geometry and the layout of the closure caps were further updated (SRR-CWDA-2019-00080; SRR-CWDA-2019-00081) to incorporate an increased slope at the surface (i.e., 4% slope instead of

1.5% slope) to meet closure requirements specified in the regulation *SWM: Solid Waste Landfills and Structural Fill* (SCDHEC R.61-107.19). FTF and HTF closure cap performance over time was analyzed in SRRA162682-000002, *Predicting Long-Term Percolation From the HTF and FTF Closure Caps, Report No. GENV-20-09.* The Tank Farm closure cap designs are preliminary; however, they provide sufficient information for planning purposes, evaluating the closure cap configuration relative to its constructability and functionality, and for estimating infiltration rates over time through modeling.

SRR-CWDA-2021-00043, *Erosion Analysis for the H-Tank Farm and F-Tank Farm Facilities*, has been issued building upon the FTF and HTF closure caps designs and the previously issued SDF analysis, SRR-CWDA-2021-00035, *Erosion Analysis for the Saltstone Disposal Facility*. The analysis utilizes the RUSLE to determine the average annual rate of soil loss due to erosion. SRR-CWDA-2021-00076, *Evaluation of the Uncertainties Associated with the F-Area and H-Area Tank Farm Closure Caps and Long-Term Infiltration Rates* was issued in September 2021 and provides a range of infiltration rates for use in the PA models.

Deliverables: FTF and HTF Closure Cap Documents

FY2022: No Closure Cap design activities planned in FY2022.

Responsibility: SRMC WDA

Expected Completion Date:

Erosion Analysis – Complete

Closure Cap Erosion Analysis (SRR-CWDA-2021-00043) – Complete

Closure Cap Uncertainty Analysis (SRR-CWDA-2021-00076) – Complete

Estimated Cost: FY2022 $50K, FY2023 through FY2026 $0/yr.

3.2.4 To Be Determined Out-Year Testing

Description: For FY2023 and beyond, testing has not been finalized.

Responsibility: SRMC WDA

Expected Completion Date: Ongoing

Estimated Cost: FY2023 through FY2026 $0/yr.

3.3 Tank Farm Performance Assessment Planned Review, Analysis, and Schedules

DOE M 435.1-1 requires the ongoing maintenance of all PAs. This maintenance involves a series of activities that must be performed on an ongoing or annual basis. The activities in this section

3.3.1 Maintain Tank Farm Performance Assessment Control through Unreviewed Waste Management Question Process

Description: Similar to the process set up for evaluating disposal related questions in SDF, a UWMQ process was established for waste tank closure activities. The UWMQ process consists of providing UWMQEs of proposed activities or new information to ensure that the assumptions, results, and conclusions of the approved PA, CA, and SAs remain valid.

If identified through the UWMQ process that a proposed activity or new information is outside the bounds of the approved NDAA Section 3116 Basis Document, PA, CA, or SAs, new SAs are prepared to update the technical baseline. UWMQEs and SAs will continue to be required throughout the life of the facility. For planning purposes, the estimated cost assumes that four UWMQEs will be prepared each year in the out-years. The estimated cost does not reflect the cost of any emergent Tank Farm PA or SA revisions. Currently planned PA and SA revisions are captured in Section 3.2.

FY2020: No UWMQEs were completed for the Tank Farms in FY2021.

Deliverable: Provide UWMQEs and UWMQ procedure support, as needed to support closure of FTF and HTF.

Expected Completion Date: Ongoing

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $170K/yr

3.3.2 Prepare Annual Update to Performance Assessment Maintenance Program

Description: The purpose of the LW PA Maintenance Program is to confirm the continued adequacy of the current PA and SAs, and to increase confidence in the results. Every year the annual LW PA Maintenance Program FY Implementation Plan is prepared and provided to DOE-SR. Plan preparation will include review of outstanding PA and SA comments and recommendations (noted in Sections 3.2.1 and 3.2.2). The Implementation Plan will outline planned work for each FY. The cost of preparing the Implementation Plan will be shared between SDF and the Tank Farms. See Section 2.3.2 for SDF maintenance activities.

Deliverable: Issue a FY update to the LW PA Maintenance Program

Expected Completion Date: 2Q-3QFY (issued annually)

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $30K/yr

3.3.3 Provide General Technical Support on Tank Farm Performance Assessment Issues

Description: This task is to provide general technical and programmatic support on Tank Farm PA and SA issues, NRC activities, and other regulatory issues that affect waste tank closure. Activities include testing and research activity support, general project support, review of annual groundwater monitoring data, supporting NRC on-site observation visits and technical reviews, and development of resolution path forward for NRC open items. Tier 2 Closure Plans are developed for each waste tank prior to closure activities and include reviews of actual tank residual impacts on long-term conditions. Research activity support includes monitoring of research done by outside agencies (e.g., academic research, Hanford activities) as well as research performed on-site (e.g., SRNL, SREL). These activities also include support on interactions with SCDHEC, SRS CAB, LFRG, National Academy of Sciences, and other regulatory and stakeholder bodies.

Deliverable: Provide ongoing technical support on regulatory and policy issues/activities affecting waste tank closure activities.

Expected Completion Date: Ongoing

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $370K/yr

3.3.4 Develop and Maintain Performance Assessment Model Archive and Revision Control

Description: This task established software and hardware resources for archiving development and final PA modeling files to a read-only storage medium. In FY2014, capital infrastructure improvements were enacted on the site network, allowing for faster communication between SRNL's high performance computing network and SRMC WDA servers. This improvement increased the rate for file transfers between the two systems. FTF and HTF modeling files (for both PORFLOW and GoldSim) were copied to electronic storage devices. The storage devices are maintained onsite by SRMC WDA, within a cipher-locked facility. The properties of the electronic files were set to read-only. Copies of files can be provided upon request. As needed, additional storage devices will be purchased to provide sufficient disk space for maintaining a record of all related model files.

Deliverable: Establish process (completed in FY2014) and maintain after implementation

Expected Completion Date: Ongoing

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $10K/yr

3.3.5 LFRG Key and Secondary Issues

There are currently no open LFRG Key or Secondary issues associated with the Tank Farm PAs.

3.4 Tank Farm Performance Assessment Development/Revisions

The FTF and HTF PAs provide the technical basis and results to be used in subsequent documents to demonstrate compliance with performance objectives of *Radioactive Waste Management Manual, Licensing Requirements for Land Disposal of Radioactive Waste*, as required by NDAA Section 3116, *Federal Facility Agreement for the Savannah River Site* (FFA), *Standards for Wastewater Facility Construction*, and *Proper Closeout of Wastewater Treatment Facilities*. [DOE M 435.1-1, 10 CFR 61, WSRC-OS-94-42, SCDHEC R.61-67, SCDHEC R.61-82]

3.4.1 Prepare Out-Year F-Area Tank Farm Performance Assessment Revisions

Description: In March 2012, following issuance of the Section 3116 Determination for FTF Closure (DOE-WD-2012-001), DOE approved the Tier 1 Closure Plan for FTF (SRR-CWDA-2010-00147) including its referenced FTF PA, Revision 1 (Tier 1 authorization letter, DOE_03-28-2012, was received March 28, 2012). The FTF PA, Revision 1, has been issued and implemented. A future revision of the FTF PA will be scheduled as required and agreed upon by DOE. Unless otherwise noted in the FTF PA, the future FTF PA revision will include the following items at a minimum:

- Updated modeling to make the PA more consistent with the more current modeling approaches (i.e., at a minimum, consistent with the HTF PA);
- Analyses and results contained in all SAs that have been completed to date;
- Analyses and results of all UWMQEs completed to date;
- Consideration of new information generated through research and development;
- Changes in site future land use plans or closure plans; and
- Changes to PA guidance documents requirements.

Future FTF PA revisions will also consider the following:

- LFRG items from the PA review team report (LFRG_08-13-2008);
- Comment Responses to SCDHEC and EPA on Revision 1 of the FTF PA (SRR-CWDA-2011-00164, SRR-CWDA-2011-00175);
- Responses to RAIs posed by the NRC (SRR-CWDA-2011-00054);
- NRC recommendations in the *U.S. Nuclear Regulatory Commission Plan for Monitoring Disposal Actions Taken by the U.S. Department of Energy at the Savannah River Site F-Area and H-Area Tank Farm Facilities in Accordance with the National Defense Authorization Act for Fiscal Year 2005* (ML15238A761), as discussed in detail in Section 3.3; and
- Information generated to support other PAs and SAs.
- Incorporation of applicable Technical Review Reports (TRRs) from the NRC.

Furthermore, the future FTF PA revisions shall be in alignment with the most current revision of the LW System Plan.

A document which outlines the activities and data needed to revise the F-Tank Farm and the H-Tank Farm PAs (SRR-CWDA-2019-00104, *Strategy for Updating the SRS Tank Farm Performance Assessments*) was issued in December 2019.

Deliverable: Issue PA revision

Expected Completion Date: FY2024

Responsibility: SRMC WDA

Estimated Cost: FY2022 $150K, FY2023 $300K, FY2024 $400K, FY2025 $0, FY2026 $0

3.4.2 Prepare Out-Year H-Area Tank Farm Performance Assessment Revisions

Description: The HTF PA was submitted for DOE review in November 2010. Revision 1 of the HTF PA, incorporating FTF PA lessons learned and comments on HTF PA Revision 0, was dated November 2012. DOE's Draft NDAA Section 3116 Basis Document for HTF was prepared in FY2013 and was provided, along with the HTF PA Revision 1, to the NRC to initiate HTF NDAA Section 3116 Consultation in FY2013. Final HTF PA approval and implementation was achieved in FY2015.

A revision of the HTF PA was initiated in FY2020 and is schedule to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure). Unless otherwise noted in the HTF PA, the revision will include the following items at a minimum:

- Analyses and results contained in all SAs that have been completed to date;
- Analyses and results of all UWMQEs completed to date;
- Consideration of new information generated through research and development;
- Changes in site future land use plans or closure plans;
- Changes to PA guidance documents requirements; and
- Modeling improvements as identified in the Quality Assurance report for the HTF PA (SRR-CWDA-2012-00070).

In late FY2020, as part of the HTF and future FTF PAs, a report entitled *Features, Events, and Processes for the F-Area and H-Area Tank Farm Performance Assessments*, was initiated. The information presented within the report informs an upcoming revision to the PAs. As part of a PA, models are used to simulate the release and transport of radionuclides and chemical contaminants from post-closure facilities and to estimate exposure and consequence to potential receptors. Due to the complex nature of PA models, a structured methodology is necessary to ensure that relevant components are adequately addressed during model development. Therefore, PA models must be developed within defined boundaries and with appropriate consideration of relevant (site-specific) features, events, and processes (FEPs), as derived from a complete set of FEPs. The FEPs report was issued in March 2021.

The HTF PA revision will also consider the following:

- Comment Responses to SCDHEC and EPA on Revision 0 of the HTF PA (SRR-CWDA-2011-00135, SRR-CWDA-2012-00166);
- NRC recommendations from the *Technical Evaluation Report for H-Area Tank Farm Facility, Savannah River Site, South Carolina* (ML14094A496) and addressed within the *Nuclear Regulatory Commission's H-Tank Farm Technical Evaluation Report's Recommendations – Department of Energy's Activity Summary Matrix* (SRR-CWDA-2014-00080);
- NRC recommendations in the *U.S. Nuclear Regulatory Commission Plan for Monitoring Disposal Actions Taken by the U.S. Department of Energy at the Savannah River Site F-Area and H-Area Tank Farm Facilities in Accordance with the National Defense Authorization Act for Fiscal Year 2005* (ML15238A761), as discussed in detail in Section 3.3; and
- Information generated to support other PAs and SAs.
- Incorporation of applicable TRRs from the NRC.

A document which outlines the activities and data needed to revise the F-Tank Farm and the H-Tank Farm PAs (SRR-CWDA-2019-00104, *Strategy for Updating the SRS Tank Farm Performance Assessments*) was issued in December 2019. An extensive update of the HTF compliance case PORFLOW model was completed in FY2021. Key PA reports and studies issued in 2021 in support of the updated HTF PA are summarized in Table 3.4-1. Using the issued reports shown in Table 1, WDA has documented which parameters from the completed modeling reports will be used in the different HTF PA modeling cases/sensitivity analyses and has updated the HTF PORFLOW compliance case model to be able to use those parameters and incorporate any physical changes (e.g., add new ancillary structures or model the tank liner in multiple segments). The HTF PORFLOW model update involved defining the elements/configurations that must be included in the model and how the various cases are differentiated.

Table 3.4-1 - HTF PA Modeling Reports Issued in 2021

Document Number	Document Topic
SRR-CWDA-2021-00004	SRR-CWDA-2021-00004, *Conceptual Model Development for the H-Area Tank Farm Facility Performance Assessment*, was issued in March 2021. The purpose of the HTF PA Conceptual Model Report is to document: 1) the methods used in the development of the conceptual models for the new HTF PA; 2) a description of the recommended modeling scenarios and conceptual models; and 3) a discussion of how all the relevant FEPs relate to the conceptual models, either through explicit modeling descriptions or through other approaches.
SRNL-STI-2021-00017	SRNL issued SRNL-STI-2021-00017 *Geochemical Data Package for Performance Assessment Calculations Related to the Savannah River Site* in 2021. This report documents updates to solute K_d and solubility limit recommendations for soils and cementitious materials.
SRR-CWDA-2021-00025	SRR-CWDA-2021-00025, *Tank Farm Closure Inventory For use in Performance Assessment Modeling* was issued in March 2021. This document presents the assigned inventories of radiological and chemical constituents in the residual material in both the HTF and FTF waste tanks and ancillary equipment at the presumed time of closure to support PA modeling.
SRR-CWDA-2021-00034 SREL Doc.: R-21-0001	SRR-CWDA-2021-00034, *Chemical and Physical Evolution of Tank Closure Cementitious Materials* was issued in April 2021. This study analyzes the chemical evolution of tank concrete and fill grout due to long-term environmental exposure to vadose zone soil moisture and groundwater. The predicted mineral composition, pH, and Eh variations through time are key inputs to solubility analysis in the Waste Release Model and transport property transitions in the Vadose Zone Transport Model. The study also forecasts the physical degradation of concrete and grout over time due to decalcification, carbonation, and reinforcing bar corrosion. This report utilized the results of grout studies documented in SREL Doc.: R-21-0001, *Aqueous and Solid Phase Characterization of Potential Tank Fill Materials.*
SRNL-STI-2021-00187	SRNL issued a technical report on steel tank liner and concrete reinforcing bar corrosion *entitled Corrosion of Steel in Evolving Concrete Environments* (SRNL-STI-2021-00187). This study was coordinated with Chemical and Physical Evolution of Tank Closure Cementitious Materials (SRR-CWDA-2021-00034) and provides failure times for the key steel components within closed waste storage tanks based on consideration of multiple potential modes of corrosion (anoxic, chloride-induced, carbonation-induced, etc.).

SRR-CWDA-2021-00042 IEI 2024-002	SRR-CWDA-2021-00042, *Recommended Solubilities for Tank Closure Performance Assessment*, was issued in May 2021. This report includes comprehensive update of solubilities recommended for elements in the residual waste layer based on 1) new and updated aqueous solutions; 2) current thermodynamic databases including the international Nuclear Energy Agency database; and 3) experimental studies. This report utilizes a consulting report from Dr. Miles Denham entitled Recommended Updates to Solubility Controls for Modeling Leaching of Technetium, Uranium, Neptunium, Plutonium, and Iodine from the Residual Waste Layer of Closed Savannah River Site High-Level Waste Tanks (IEI 2024-002). The recommendations contained in IEI 2024-002 are based on an updated NEA thermodynamic database published in 2020, and insights gained from review of laboratory experiments involving real tank waste samples conducted over the past decade.
SRR-CWDA-2021-00043	SRR-CWDA-2021-00043, *Erosion Analysis for the H-Tank Farm and F-Tank Farm Facilities*, has been issued building upon the previously issued SDF analysis, SRR-CWDA-2021-00035, *Erosion Analysis for the Saltstone Disposal Facility*. The analysis utilizes the RUSLE to determine the average annual rate of soil loss due to erosion.
SRR-CWDA-2021-00045	SRR-CWDA-2021-00045, *Air Pathway Release Model for the F-Area and H-Area Tank Farm Facility Performance Assessments* was issued in May 2021. This technical report documents the development and benchmarking of Air Pathway Release (APR) models created for HTF and FTF using GoldSim simulation software. APR models for HTF and FTF are designed to evaluate the air-phase transport of potentially volatile radionuclides present in the Tank Farm's residual waste. The radionuclides partitioned into the air phase may be released to the accessible environment (the atmosphere) via diffusion through the waste tank grout, the tank's roof, and the closure cap barriers.
SRR-CWDA-2021-00076	SRR-CWDA-2021-00076, *Evaluation of the Uncertainties Associated with the F-Area and H-Area Tank Farm Closure Caps and Long-Term Infiltration Rates* was issued in September 2021. This report provides a range of infiltration rates for use in the PA models.
SRR-CWDA-2021-00078	SRR-CWDA-2021-00078, *Saturated Hydraulic Conductivities for F-Area and H-Area Tank Farm Cementitious Materials* was issued in September 2021. This report evaluates available data related to the initial saturated hydraulic conductivity of Tank Farm cementitious materials and selects a set of appropriate values for use in PA modeling.
SRR-CWDA-2013-00058, Rev 3	SRR-CWDA-2013-00058, *Dose Calculation Methodology for Liquid Waste Performance Assessments at the Savannah River Site*, Revision 3 was issued in January 2022. This document updates the dose calculation methodologies in support of the HTF PA. As part of this update, a thorough review of the references has been performed. Since the last HTF PA was issued, a number of key references for the dose calculations have been revised and this new information needs to be incorporated into the HTF PA dose calculator.

HTF Porflow Simulations performed in 2021 were limited to the Compliance Case within the Central Scenario. Subsequent PORFLOW model updates will be completed in 2022 to cover the remaining Central Scenario cases, several alternate modeling cases, and sensitivity analysis (as needed) as discussed in SRR-CWDA-2021-00004, *Conceptual Model Development for the H-Area Tank Farm Facility Performance Assessment*. The HTF Goldsim Model will be also be updated in FY2022.

Deliverable: Issue supporting input documents and HTF PA revision

Expected Completion Date: Supporting Documents and Input Documents - FY2021; HTF PA Models Updated – FY2022 HTF PA Revision – FY2023

Responsibility: SRMC WDA

Estimated Cost: FY2022 $400K, FY2023 $300K, FY2024 though FY2026 $0/yr

3.4.3 Tank Farm Special Analyses

Description: SAs are performed to evaluate the significance of new information or new analytical methods to the results and associated conclusions of a PA. As waste tanks and ancillary equipment are cleaned, final residual inventories will be used to update the PA fate and transport modeling, allowing for evaluation of the difference between the projected and final waste tank inventories to determine if the results and conclusions of the PA and supporting SAs remain valid.

FY2020: In FY2020, an SA was initiated to support operational closure of F-Area Diversion Box (FDB)-5 and FDB-6, which are no longer needed in support of FTF operations. This reanalysis allows for evaluation of the difference between the projected and final FTF inventories to determine if the results of the FTF PA transport modeling, and the conclusions reached based on the FTF PA information, remain valid.

This SA will describe the approaches used to assign inventories at closure for FDB-5 and FDB-6 for use in FTF transport modeling. The analytes used for the inventory determination are the same 60 radionuclides and 18 chemicals used for ancillary equipment inventory assignment in the FTF PA. The methodology used to assign the FDB-5 and FDB-6 inventories is similar to the approach used in the FTF PA to determine the FTF piping systems residual inventory. Using this approach results in there being several conservatisms inherent in the final FDB-5 and FDB-6 inventories. Camera inspection confirmed that the FDB-5 and FDB-6 vault and sump walls are clean with a minimal accumulation of material on the vault floor of only FDB-6, as would be expected in FDBs cleaned by flushing. To account for any uncertainty associated with volume determination through visual inspection, the radiological and chemical inventory assigned to FDB-5 and FDB-6 conservatively assumed a non-negligible accumulation of residue on the FDB surfaces (jumper internals and floors) most likely to have collected material after flushing.

FY2021: The FTF FDB-5 and FDB-6 Special Analysis (SRR-CWDA-2020-00055, *FDB-5 and FDB-6 Special Analysis for the Performance Assessment for the F-Tank Farm at the Savannah River Site*) was issued in February 2021. The FDB-5 and FDB-6 SA reports that the results and conclusions presented in the FTF PA and supporting SAs are not impacted by new information regarding the final residual inventories that are planned to be grouted in-place in FDB-5 and FDB-6.

Deliverable: Technical Report – SRR-CWDA-2020-00055

Completion Date: FY2021

Responsibility: SRMC WDA

Estimated Cost: FY2022 through FY2026 $0/yr

3.5 Summary Table for the Tank Farm PA Maintenance Program

Table 3.5-1 summarizes the estimated expenditures by activity and FY. Table A.1-1 contains a summary of the combined estimated expenditures for all the LW facility PA maintenance activities. This Implementation Plan reflects the PA related activities in the annual operating plan for the current FY and the projected out-year activities for estimation purposes.

Table 3.5-1: Summary for the Tank Farm Performance Assessment Maintenance Program ($K)

Section	Maintenance Activity	FY22	FY23	FY24	FY25	FY26
2.2.2.1	Long-Term Radiological Lysimeter Program	55	55	55	55	55
3.2.1.1	Waste Release Studies	0	0	0	0	0
3.2.1.2	Waste Tank Chemistry Dynamics Testing	0	0	0	0	0
3.2.2	CLSM Testing	0	0	0	0	0
3.2.3	Closure Cap Design	50	0	0	0	0
3.2.4	To Be Determined Out-Year Testing	0	0	0	0	0
	Testing and Research Total	105	55	55	55	55
3.3.1	Maintain Tank Farm PA Control Through UWMQ Process	170	170	170	170	170
3.3.2	Prepare Annual PA Maintenance Program Implementation Plan	30	30	30	30	30
3.3.3	Provide General Technical Support on Tank Farm PA Issues	370	370	370	370	370
3.3.4	Develop and Maintain PA Model Revision Archive and Revision Control	10	10	10	10	10
	Annual Tasks Total	580	580	580	580	580
3.4.1	Prepare Out-Year FTF PA Revisions	150	300	400	0	0
3.4.2	Prepare Out-Year HTF PA Revisions	400	300	0	0	0
3.4.3	Tank Farm Special Analyses	0	0	0	0	0
	PA Development/Revisions Total	550	600	400	0	0
	TANK FARM PA COMPILED TOTAL	**1,235**	**1,235**	**1,035**	**635**	**635**

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APPENDIX A

Summary Table for the Liquid Waste Facilities Performance Assessment Maintenance Program FY2022

A.1 Summary Table for the LW PA Maintenance Program

Table A.1-1 contains a summary of the combined estimated expenditures for all the LW facility PA maintenance activities, summarized from Tables 2.5-1 and 3.5-1. This Maintenance Program reflects the PA related activities in the annual operating plan for the current FY and the projected out-year activities for estimation purposes.

Table A.1-1: Summary for the Liquid Waste Performance Assessment Maintenance Program ($K)

LW PA Maintenance Program	FY22	FY23	FY24	FY25	FY26
SDF PA Maintenance Program Totals	**917**	**910**	**910**	**760**	**760**
Tank Farm PA Maintenance Program Totals	**1,235**	**1,235**	**1,035**	**635**	**635**
COMPILED TOTAL	2,152	2,145	1,945	1,395	1,395

APPENDIX B

U.S. Nuclear Regulatory Commission Monitoring Factors for Saltstone Disposal Facility

Appendix B: U.S. Nuclear Regulatory Commission Monitoring Items for the Saltstone Disposal Facility

Factors are colored by current NRC priority and a symbol is included with each Monitoring Factor (MF) number to ensure clarity. Changes from previous year are indicated by red text. A legend containing a description of the NRC ranking is provided at the end of the table. [ML13100A113]

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
Monitoring Activity (MA 1) – Inventory				
1.01 *§*	**Inventory in Disposal Structures**	NRC expects to close MF 1.01 after DOE has completed waste disposal at the SDF and determined the final inventory in each disposal structure.	**Section 2.3.5 - Conduct Saltstone Disposal Facility Performance Assessment Validation** Contaminant inventories are determined based on sample analysis and to ensure compliance with the Saltstone WAC. The SDF inventory will be updated based on the results of quarterly sample results and transfer volumes. Annual review reports including updated actual inventory will be provided to the NRC.	DOE will continue to revise inventory estimates as part of waste disposal activities.
1.02 ‡	**Methods Used to Assess Inventory**	NRC expects to close MF 1.02 after DOE has completed waste disposal at the SDF and determined the final inventory in each disposal structure.	**Section 2.3.5 - Conduct Saltstone Disposal Facility Performance Assessment Validation** Contaminant inventories are determined based on sample analysis and to ensure compliance with the Saltstone WAC. The SDF inventory will be updated based on the results of quarterly sample results and transfer volumes. Annual review reports including updated actual inventory will be provided to the NRC.	Final inventory will be determined prior to SDF closure. PA Maintenance Plans indicate that a "future revision of the SDF PA will be scheduled as required." This activity was performed as part of the 2019 SDF PA and included revised assessments of inventories to use in modeling. In FY2017 estimates of total Tc-99 and I-129 inventories were completed (SRR-CWDA-2015-00123, SRR-CWDA-2015-00077). Supernate from five tanks estimated to contain a significant fraction of the total Tc and I inventories were analyzed in FY2018 and the previous reports were revised to incorporate the new data.

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
MA 2 – Infiltration and Erosion Control				
2.01 ‡	**Hydraulic Performance of Closure Cap**	NRC expects to close MF 2.01 after NRC determines that the hydraulic performance of the as-built closure cap is adequate. Given the importance of construction activities on the performance of the cap, MF 2.01 will not be closed prior to construction of the cap.	**Section 2.2.2.3 - Closure Cap Long-Term Performance** Research will validate assumptions in the modeling concerning the rate of pluggage of the closure cap drainage layer as well as the drainage layer above each SDU. **Section 2.3.3 - Provide General Technical Support on Saltstone Disposal Facility Performance Assessment Issues** To address RSIs from the NRC, literature reviews are currently underway to better evaluate uncertainties associated with the hydraulic performance of the closure cap.	Research began in FY2017 and concluded in FY2018 to validate PA assumptions concerning the rate of closure cap infiltration as well as the drainage layer behavior. DOE incorporated updated closure cap modeling into the 2019 SDF PA, including sensitivity cases to evaluate risks associated with the preliminary closure cap design. DOE will revise closure cap modeling assumptions and support once a final closure design has been determined. In FY2018, the NRC recommended increasing the priority of MF 2.01 (Hydraulic Performance of Closure Cap) from Low to Medium priority. (ML18002A545, ML18107A161)
2.02 †	**Erosion Control of the SDF Engineered Surface Cover and Adjacent Area**	NRC expects to close MF 2.02 after NRC determines that the physical stability of the final closure cap is adequate. Given the importance of construction activities on the performance of the cap, MF 2.02 will not be closed prior to construction of the cap.	**Section 2.3.3 - Provide General Technical Support on Saltstone Disposal Facility Performance Assessment Issues** To address RSIs from the NRC, literature reviews are currently underway to better evaluate uncertainties associated with the hydraulic performance of the closure cap, including an evaluation of the potential for erosion in areas adjacent to the SDF closure cap.	DOE will revise closure cap modeling assumptions and support once a final closure design has been determined. DOE incorporated updated closure cap modeling into the 2019 SDF PA, including sensitivity cases to evaluate risks associated with the potential erosion. In FY2018, the NRC recommended modifying MF 2.02 to clarify that areas adjacent to the future SDF closure cap will be under the NRC monitoring activities at the SDF. (ML18002A545, ML18107A161)

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
MA 3 – Waste Form Hydraulic Performance				
3.01 ±	**Hydraulic Conductivity of Field-Emplaced Saltstone**	NRC expects to close MF 3.01 after NRC determines that model support for the SHC of field-emplaced saltstone is sufficient.	**Section 2.2.1 - Contaminant Leaching Characteristics from Saltstone Monolith** Laboratory prepared and process room samples will have physical properties testing performed to determine the hydraulic conductivity, K_d, bulk cured density, porosity, and microstructure/ phase analysis. Future testing will compare these properties to those measured from emplaced core sampling.	Saltstone testing of measured hydraulic conductivities is ongoing. A variety of laboratory testing has completed, including one in which samples were cured under conditions similar to those expected for field-emplaced saltstone. The results were incorporated into the FY2014 SDF SA. Multiple cores were extracted via a wet core drilling process in FY2015 approximately 20 months after the saltstone of interest was processed in the SPF and subsequently emplaced in SDU Cell 2A. The physical property data for SDU-emplaced and laboratory-prepared samples is summarized in the SDU Cell 2A Core Sampling Report (SRR-CWDA-2016-00051), with values for SDF model inputs provided in the report where applicable. Based on these results, NRC closed this monitoring factor in June 2017 per ML17097A351.

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
3.02 ±	**Variability of Field-Emplaced Saltstone**	NRC expects to close MF 3.02 after NRC determines that saltstone production, placement, and curing conditions that significantly affect saltstone hydraulic properties are well controlled.	**Section 2.2 – Saltstone Disposal Facility Performance Assessment Testing & Research Activities** Previous testing and research activities were carried out to define the operating conditions (e.g., water-to-premix ratio, dry feeds variability, and the curing temperature) required to meet or exceed PA expectations of saltstone performance. **Section 2.2.1 - Contaminant Leaching Characteristics from Saltstone Monolith** Laboratory prepared and process room samples will have physical properties testing performed to determine the hydraulic conductivity, K_d, bulk cured density, porosity, and microstructure/ phase analysis. Future testing will compare these properties to those measured from emplaced core sampling.	Saltstone testing of measured hydraulic conductivities is ongoing. A variety of laboratory testing has completed, including one in which samples were cured under conditions similar to those expected for field-emplaced saltstone. The results were incorporated into the FY2014 SDF SA. Variability of saltstone hydraulic conductivities was evaluated in the FY2014 SDF SA through the use of parametric flow cases that applied average, upper bounding, and lower bounding values. Multiple cores were extracted via a wet core drilling process in FY2015 approximately 20 months after the saltstone of interest was processed in the SPF and subsequently emplaced in SDU Cell 2A. The physical property data for SDU-emplaced and laboratory-prepared samples is summarized in the SDU Cell 2A Core Sampling Report (SRR-CWDA-2016-00051), with values for SDF model inputs provided in the report where applicable. Based on these results, NRC closed this monitoring factor in June 2017 per ML17097A351.

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
3.03 ±	**Applicability of Laboratory Data to Field-Emplaced Saltstone**	NRC expects to close MF 3.03 after NRC determines that representing the hydraulic properties of field-emplaced saltstone with the hydraulic properties of laboratory-produced samples is adequate. That assessment should account for the range of expected disposal conditions of field-emplaced saltstone as well as effects of scale. Alternately, MF 3.03 may be closed if NRC determines that DOE bases the hydraulic properties of saltstone on the properties of an appropriate range of samples of field-emplaced saltstone, rather than on measurements of laboratory-produced samples.	**Section 2.2.1 - Contaminant Leaching Characteristics from Saltstone Monolith** Laboratory prepared and process room samples will have physical properties testing performed to determine the hydraulic conductivity, K_d, bulk cured density, porosity, and microstructure/ phase analysis. Future testing will compare these properties to those measured from emplaced core sampling.	The saltstone sampling and analysis plan established a strategy for studies to reduce PA uncertainty in the area of SHC, and for correlating grout properties between laboratory-prepared samples and core-drilled samples from actual emplaced grout. A variety of laboratory testing has completed, including one in which samples were cured under conditions similar to those expected for field-emplaced saltstone. The results were incorporated into the FY2014 SDF SA. Multiple cores were extracted via a wet core drilling process in FY2015 approximately 20 months after the saltstone of interest was processed in the SPF and subsequently emplaced in SDU Cell 2A. The physical property data for SDU-emplaced and laboratory-prepared samples is summarized in the SDU Cell 2A Core Sampling Report (SRR-CWDA-2016-00051), with values for SDF model inputs provided in the report where applicable. Based on these results, NRC narrowed the scope of this monitoring factor in June 2017 per ML17097A351 to the understanding of changes in hydraulic conductivity in the short term between laboratory-prepared and field-emplaced saltstone.
3.04 ±	**Effect of Curing Temperature on Saltstone Hydraulic Properties**	NRC expects to close MF 3.04 after NRC determines that projected SDF performance is based on estimates of the hydraulic properties of saltstone (e.g., hydraulic conductivity and diffusivity) that are well-supported. That support should account for the range of curing conditions (i.e., temperatures values, humidity values) experienced by field-emplaced saltstone.	**Section 2.2 – Saltstone Disposal Facility Performance Assessment Testing & Research Activities** Previous testing and research activities were carried out to define the operating conditions (e.g., water-to-premix ratio, dry feeds variability, and the curing temperature) required to meet or exceed PA expectations of performance.	Saltstone testing of measured hydraulic conductivities is ongoing. A variety of laboratory testing has completed, including one in which samples were cured under conditions similar to those expected for field-emplaced saltstone. The results were incorporated into the FY2014 SDF SA. The physical property data for SDU-emplaced and laboratory-prepared samples is summarized in the SDU Cell 2A Core Sampling Report (SRR-CWDA-2016-00051). Based on the test results, NRC closed this monitoring factor in June 2017 per ML17097A351.

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
MA 4 – Waste Form Physical Degradation				
4.01 ±	**Waste Form Matrix Degradation**	NRC expects to close MF 4.01 after NRC determines that support for modeled changes in the SHC and diffusivity during the performance period is sufficient.	**Section 2.2.2.2 - Studies Related to Cementitious Materials Degradation Due to Radiation Damage** A literature search will be conducted to gain a better understanding of the potential degradation of cementitious materials exposed to radiation. and **Section 2.4.1 - Prepare Out-year Saltstone Disposal Facility Performance Assessment Revisions** This section describes future revisions to the PA that will incorporate improvements to conceptual modeling.	The degradation models for concrete and saltstone grout were revised for the FY2014 SDF SA to incorporate greater conservatisms and to modify inputs to implicitly model fractures in the matrix. The 2019 SDF PA incorporated the revised degradation model and updated input values based on recent research and development. The PA also considered variations of the input values to better evaluate risks associated with saltstone degradation.
4.02 ±	**Waste Form Macroscopic Fracturing**	NRC expects to close MF 4.02 after NRC determines that model support for the assumed formation of macroscopic fractures during the performance period is sufficient.	**Section 2.2 – Saltstone Disposal Facility Performance Assessment Testing & Research Activities** Previous testing and research activities were carried out to provide a better understanding of degradation mechanisms and fracturing. [SRNL-STI-2013-00522]	The degradation models for concrete and saltstone grout were revised based on FY2013 test data for the FY2014 SDF SA to incorporate greater conservatisms and to modify inputs to implicitly model fractures in the matrix. The 2019 SDF PA explicitly includes sensitivity cases to examine the potential effects from assumed macroscopic fractures through saltstone and SDU concrete.

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
MA 5 – Waste Form Chemical Degradation				
5.01 ±	**Radionuclide Release from Field-Emplaced Saltstone**	NRC expects to close MF 5.01 after NRC determines that measurements of radionuclide release rates from field-emplaced saltstone used in the PA are reliable.	**Section 2.2.2.1 - Long-Term Radiological Lysimeter Program** This task is expected to provide K_d values in soil and cementitious materials and additional information about long-term geochemical and transport phenomena that will be used to support the waste release and transport models. **Section 2.2.1 - Contaminant Leaching Characteristics from Saltstone Monolith** Laboratory prepared and process room samples will have physical properties testing performed to determine the hydraulic conductivity, K_d, bulk cured density, porosity, and microstructure/phase analysis. Future testing will compare these properties to those measured from emplaced core sampling.	In June of 2015, the NRC issued a TRR titled *Technical Review: Oxidation of Reducing Cementitious Waste Forms, Docket No. PROJ0734*. The TRR is related to MFs 5.01, 5.02, 5.03, and 5.05. [ML15098A031] Studies to better quantify radionuclide release from field-emplaced saltstone have been complete. Multiple cores were extracted via a wet core drilling process in FY2015 approximately 20 months after the saltstone of interest was processed in the SPF and subsequently emplaced in SDU Cell 2A. The physical property data for SDU-emplaced and laboratory-prepared samples is summarized in the SDU Cell 2A Core Sampling Report (SRR-CWDA-2016-00051), with values for SDF model inputs provided in the report where applicable. Ongoing work related to hydraulic conductivity and Tc-99 and I-129 release from field-emplaced saltstone is discussed in Section 2.2.1. The updated 2019 SDF PA incorporated this new information to improve the modeling of Tc-99 and I-129 releases. In FY2018, the NRC recommended no changes to MF 5.01. (ML18095A122)

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
5.02 ‡	**Chemical Reduction of Technetium by Saltstone**	NRC expects to close MF 5.02 after NRC determines that: (1) model support for the chemical reduction of Tc(VII) to Tc(IV) is robust; and (2) this reduced state is maintained under field conditions. NRC expects that DOE will inform NRC what the ranges of those conditions are expected to be during the performance period.	**Section 2.2 – Saltstone Disposal Facility Performance Assessment Testing & Research Activities** Studies to support modeled assumptions for Tc release behavior. **Section 2.2 - Saltstone Disposal Facility Performance Assessment Testing & Research Activities** Measurement of cured saltstone grout samples are expected to validate PA assumptions concerning the movement of oxidation fronts through cementitious materials.	In November of 2013, the NRC issued a TRR titled *Technical Review: Solubility of Technetium Dioxides in Reducing Cementitious Material Leachates, A Thermodynamic Calculation, Docket No. PROJ0734*. The TRR is related to MFs 5.02 and 5.05. [ML13304B159] In June of 2015, the NRC issued a TRR titled *Technical Review: Oxidation of Reducing Cementitious Waste Forms, Docket No. PROJ0734*. The TRR is related to MFs 5.01, 5.02, 5.03, and 5.05. [ML15098A031] A robust suite of tests has been performed and additional tests are planned in order to develop a detailed understanding of Tc behavior with respect to releases via chemical reductions. Based on the most current data available, the FY2014 SDF SA applied a modified approach for modeling Tc release. The physical property data for samples is summarized in the SDU Cell 2A Core Sampling Report (SRR-CWDA-2016-00051) Dynamic leaching and EPA Method 1315 testing were performed in FY2016 and encompassed evaluation of radionuclide-spiked saltstone simulants and actual saltstone cores extracted from SDU Cell 2A. The data from these studies is provided in SREL Doc. R-16-0003. Work continued in FY2017 and FY2018, as documented in SREL Doc. R-17-0005, SREL Doc. R-18-0004, and SREL Doc. R-18-0006. The updated 2019 SDF PA incorporated this new information to improve the modeling of Tc-99 releases. In FY2018, the NRC recommended decreasing the priority of MF 5.02 from High to Medium to reflect the NRC staff reduced concern about technetium (Tc) oxidation by trace concentrations of oxygen. (ML18095A122, ML18219B035)

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
5.03 †	**Reducing Capacity of Saltstone**	NRC expects to close MF 5.03 after NRC determines that information for the initial reducing capacity of saltstone and the expected evolution of redox conditions over time is adequate.	**Section 2.2 - Saltstone Disposal Facility Performance Assessment Testing & Research Activities** Measurement of cured saltstone grout samples are expected to validate PA assumptions concerning the movement of oxidation fronts through cementitious materials.	In June of 2015, the NRC issued a TRR titled *Technical Review: Oxidation of Reducing Cementitious Waste Forms, Docket No. PROJ0734*. The TRR is related to MFs 5.01, 5.02, 5.03, and 5.05. [ML15098A031] A review of measured test data resulted in a revised reduction capacity for saltstone (from 0.822 meq e^-/g to 0.607 meq e^-/g). Pore volume data was revised to apply this more conservative value for the FY2014 SDF SA. In addition, sensitivity models were developed to better understand the effects of varying the initial oxidation conditions in saltstone. These sensitivity models showed that a significant percentage of the saltstone monolith would need to be initially oxidized to significantly alter dose results within 10,000 years. An updated evaluation of the reducing capacity of saltstone has been incorporated into the 2019 SDF PA. The PA also included sensitivity cases to better evaluate the effects associated with reducing capacity uncertainties. The 2019 SDF PA also provides the basis for the assumption that saltstone oxidation prior to closure cap emplacement will be minimal. In FY2018, the NRC recommended decreasing the priority of MF 5.03 from Medium to Low to reflect the NRC staff reduced concern about technetium (Tc) oxidation by trace concentrations of oxygen. (ML18095A122, ML18219B035)

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
5.04 ‡	**Certain Risk-Significant K_d Values for Saltstone**	NRC expects to close MF 5.04 after NRC determines that model support for the sorption coefficients assumed for radium and selenium for saltstone is adequate. MF 5.04 may be closed based on DOE measurements on either field-emplaced or simulated saltstone. NRC could close MF 5.04 (and open a new MF for selenium) if NRC determines that the inventory of Ra-226 and its ancestors is consistent with the revised inventory assumed in Case K under MFs 1.01 and 1.02.	**Section 2.2.2.1 - Long-Term Radiological Lysimeter Program** This task is expected to provide K_d values in soil and cementitious materials and additional information about long-term geochemical and transport phenomena that will be used to support the waste release and transport models.	In January of 2017, the NRC issued a TRR titled *Technical Review: Iodine Sorption Coefficients for Use in Performance Assessments for the Saltstone Disposal Facility, Docket No. PROJ0734*. The TRR is related to MFs 5.04, 6.01, 7.01, 10.04, 10.06, and 10.09. [ML16342C575] Due to the relative importance of K_d values, studies are ongoing to improve estimates for site-specific conditions. Studies focus on radionuclides that are expected to contribute significantly to dose risks. The FY2014 SDF SA applied the latest available values and future modeling will consider all available data. In FY2016, DOE produced a comprehensive report of K_d values, including improved documentation for the rationale for values used in modeling. Responses to the NRC RAIs on the FY2014 SDF SA were documented in FY2016, including additional K_d sensitivity analyses. Results indicated that K_d value variability did not impact the ability to meet performance objectives. The NRC recommended expanding the scope of MF 5.04 (Certain Risk-Significant K_d Values for Saltstone), MF 6.01 (Certain Risk-Significant K_d Values in Disposal Structure Concrete), and MF 7.01 (Certain Risk-Significant K_d Values in Site Sand and Clay) to now include iodine sorption in saltstone, disposal structure concrete, and soils, respectively. (ML18158A172) The 2019 SDF PA incorporates the latest K_d values as recommended in the FY2016 K_d report (SRR-CWDA-2017-00019). The PA also updated the saltstone K_d based on an SREL study of actual I-129 release from saltstone simulant samples.

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
5.05 ‡	**Potential for Short-Term Rinse-Release from Saltstone**	NRC expects to close MF 5.05 after NRC determines that model support for the exclusion of rinse-release phenomenon from the conceptual model assumed in the DOE 2009 SDF PA is adequate. Alternately, MF 5.05 may be closed after NRC determines that the phenomenon is well-understood and the effect on the projected dose is well supported.	**Section 2.2.1 – Contaminant Leaching Characteristics from Saltstone Monolith** Studies to support modeled assumptions for Tc release behavior.	In November of 2013, the NRC issued a TRR titled *Technical Review: Solubility of Technetium Dioxides in Reducing Cementitious Material Leachates, A Thermodynamic Calculation, Docket No. PROJ0734*. The TRR is related to MFs 5.02 and 5.05. [ML13304B159] In June of 2015, the NRC issued a TRR titled *Technical Review: Oxidation of Reducing Cementitious Waste Forms, Docket No. PROJ0734*. The TRR is related to MFs 5.01, 5.02, 5.03, and 5.05. [ML15098A031] A Pacific Northwest Laboratory (PNNL) study found that short-term oxidation of Tc in saltstone can be overcome (i.e., re-reduced) in a fairly short amount of time. In addition, sensitivity models were developed in the FY2014 SDF SA to better understand effects of varying the initial oxidation conditions in saltstone. The physical property data for SDU-emplaced and lab-prepared samples is summarized in the SDU Cell 2A Core Sampling Report (SRR-CWDA-2016-00051), with values for SDF model inputs provided in the report where applicable. Based on these results, NRC narrowed the scope of this monitoring factor in June 2017 per ML17097A351 to the understanding of changes in hydraulic conductivity in the short term between laboratory-prepared and field-emplaced saltstone. In FY2018, the NRC recommended closing MF 5.05. (ML18095A122, ML18219B035)

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
MA 6 – Disposal Structure Performance				
6.01 ‡	**Certain Risk-Significant K_d Values in Disposal Structure Concrete**	NRC expects to close MF 6.01 after NRC determines that DOE information about radium and selenium sorption in disposal structure concrete is appropriate. Ra-226 information could include either material-specific measurements of radium sorption to disposal structure concrete or additional support for the revised lower inventory estimates for Ra-226 and Th-230 that DOE used in Case K. Se-79 information could include additional model support (e.g., results of laboratory experiments) for the appropriate sorption coefficient for selenium in oxidized disposal structure concrete. Alternately for radium and selenium, if the DOE dose projection changes, NRC could determine that the potential dose from radium and selenium is appropriate without sorption in the disposal structure concrete. DOE may provide additional model support (e.g., results of laboratory experiments) to demonstrate that the sorption coefficient for selenium in oxidized disposal structure concrete reflects the sorption of selenate rather than selenite. For either Ra-226 or Se-79, if appropriate information for one of those radionuclides is provided by DOE, but not the other radionuclide, then NRC could close MF 6.01 and open a new MF for the other radionuclide.	**Section 2.2.2.1 - Long-Term Radiological Lysimeter Program** This task is expected to provide K_d values in soil and cementitious materials and additional information about long-term geochemical and transport phenomena that will be used to support the waste release and transport models.	In January of 2017, the NRC issued a TRR titled *Technical Review: Iodine Sorption Coefficients for Use in Performance Assessments for the Saltstone Disposal Facility, Docket No. PROJ0734*. The TRR is related to MFs 5.04, 6.01, 7.01, 10.04, 10.06, and 10.09. [ML16342C575] Due to the importance of K_d values, studies were performed to improve estimates for site-specific conditions with focus on radionuclides that contribute significantly to dose risks. The geochemical data package (SRNL-STI-2009-00473) used to identify a justified set of geochemical data inputs for the various transport modeling at SRS was updated in July 2016 (it was last revised in March 2010). This update incorporated the numerous experiments and geochemical measurements that have been conducted since 2010, resulting in new recommended input values for modeling, integrating recent documented geochemical results, including radionuclide K_d values, solubility values, and cementitious impact factors, and includes a critical evaluation of these values with respect to existing values to assess potential impacts. The 2019 SDF PA incorporates the latest K_d values as recommended in the FY2016 K_d report (SRR-CWDA-2017-00019). The NRC recommended expanding the scope of MF 5.04 (Certain Risk-Significant K_d Values for Saltstone), MF 6.01 (Certain Risk-Significant K_d Values in Disposal Structure Concrete), and MF 7.01 (Certain Risk-Significant K_d Values in Site Sand and Clay) to now include iodine sorption in saltstone, disposal structure concrete, and soils, respectively. (ML18158A172)

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
6.02 ±	**Technetium Sorption in Disposal Structure Concrete**	NRC expects to close MF 6.02 after NRC determines that K_d values for technetium in reduced and oxidized disposal structure concrete are well-supported. <u>Alternately</u>, if the DOE dose projection changes, then NRC could determine that the potential dose from technetium is appropriate without technetium sorption in disposal structure concrete.	**Section 2.2 - Saltstone Disposal Facility Performance Assessment Testing & Research Activities** A summary of already completed studies support modeled assumptions for Tc sorption.	Based upon new information, the FY2014 SDF SA (SRR-CWDA-2014-00006) incorporated a dual dependency model for Tc-99 solute transport (using both the redox state and the solid-phase concentration of Tc-99, via the solubility limit). Additionally, the degradation model for cementitious materials has been revised. Together, these modeling improvements significantly changed the expected transport (and dose results) for Tc-99 within the first 10,000 years after SDF closure. The updated 2019 SDF PA incorporated new information related to the modeling of Tc-99 releases. Specifically, the solubility limit was revised. In FY2018, the NRC recommended closing MF 6.02. (ML18095A122, ML18219B035)

6.03 ‡	**Performance of Disposal Structure Roofs and HDPE/GCL Layers**	NRC expects to close MF 6.03 after NRC determines that model support for the amount of water that DOE expects to be diverted by the lower lateral drainage layer, including support for the hydraulic conductivity of the relevant engineered layers, is sufficient. <ins>Alternately</ins>, NRC could close MF 6.03 if DOE conservatively assumes less diversion around the disposal structures in the PA model.	**Section 2.2.2.2 - Studies Related to Cementitious Materials Degradation Due to Radiation Damage** A literature search will be conducted to gain a better understanding of the potential degradation of cementitious materials exposed to radiation. and **Section 2.2.2.3 - Closure Cap Long-Term Performance** Research will validate assumptions in the PAs concerning the rate of pluggage of the closure cap drainage layer as well as the drainage layer above each SDU. **Section 2.3.3 - Provide General Technical Support on Saltstone Disposal Facility Performance Assessment Issues** To address RSIs from the NRC, literature reviews are currently underway to better evaluate uncertainties associated with the hydraulic performance of the closure cap, including an evaluation of the long-term performance of HDPE and GCL materials.	In April of 2017, the NRC issued a TRR titled *Technical Review: Performance of the High Density Polyethylene Layer, High Density Polyethylene/Geosynthetic Clay Liner Composite Layer, and the Lower Lateral Drainage Layer, Docket No. PROJ0734*. The TRR is related to MFs 6.03 and 10.02. [ML17081A187] Infiltration into saltstone is influenced by closure cap performance and roof degradation. Closure cap performance is addressed in the discussions associated with MFs 2.01 and 2.02. The roof degradation is addressed through the revised degradation analysis for cementitious materials. The flow cases in the FY2014 SDF SA provide additional insights by varying the infiltration rates and the degradation of cementitious materials. Furthermore, the linear degradation rate for cementitious materials results in less diversion of water around the SDUs. Research was begun in FY2017 to improve insights related to SDS concrete and high-density polyethylene/geosynthetic clay liner (HDPE/GCL) degradation. A Closure Cap degradation document (*Predicting Long-Term Percolation from the SDF Closure Cap*, SRRA107772-000009) and SDU concrete degradation document (*Predicting the Hydraulic Conductivity Over Time for Degrading Saltstone Vault Concrete – Task 5*, SRRA110110-000004) were issued in FY2018. The updated 2019 SDF PA revised the modeling of HDPE/GCL materials based on this research. As a result of this, infiltration through the closure cap is expected to be lower, resulting in very different flow fields in the vadose zone, relative to previous modeling efforts. Due to these new flow fields, the amount of infiltrating water that is diverted by the lower lateral drainage layer is expected to be minimal.

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
6.04 ‡	**Disposal Structure Concrete Fracturing**	NRC expects to close MF 6.04 after NRC determines that support for the amount of fracturing of the disposal structure floor and walls expected to occur during the performance period is adequate or if NRC determines that the estimate that DOE uses in the PA model is conservative.	**Sections 2.2 – Saltstone Disposal Facility Performance Assessment Testing & Research Activities** Previous testing and research activities were carried out to provide a better understanding of degradation mechanisms and fracturing. [SRNL-STI-2013-00522] Additional research is being carried out to establish key degradation mechanisms for SDU concrete based on long-term, realistic service conditions and incorporating credible, chronic exposure scenarios.	For the FY2014 SDF SA, the model assumes a linear degradation rate for cementitious materials. This assumption conservatively approximates the hydraulic effects of fracturing. The FY2016 SDF SA (SRR-CWDA-2016-00072) addresses cracks in the SDU roof/floor. Research was begun by Vanderbilt University in FY2017 to improve insights in this area. The intent of the work is to gain an enhanced understanding of mechanisms potentially associated with the degradation of SDU concrete and utilize that information to recommend an alternative degradation profile to the currently utilized, and conservative, linear profile. The 2019 SDF PA explicitly includes sensitivity cases to examine the potential effects from assumed macroscopic fractures through saltstone and SDU concrete. An SDU concrete degradation document (*Predicting the Hydraulic Conductivity Over Time for Degrading Saltstone Vault Concrete – Task 5*, SRRA110110-000004) was issued in FY2018.
6.05 ‡	**Integrity of Non-cementitious Materials**	NRC expects to close MF 6.05 after NRC determines that support for the assumed performance of non-cementitious materials used in the disposal structures is adequate. For example, DOE may perform accelerated testing to estimate long-term performance. <u>Alternately</u>, DOE may be able to use a conservative estimate in the PA model.	N/A	The FY2014 SDF SA and the 2019 SDF PA modeled non-cementitious materials as gravel and demonstrates that joints have a negligible impact on performance, even when modeled with conservative moisture characteristic curves (MCCs).

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
MA 7 – Subsurface Transport				
7.01 ‡	**Certain Risk-Significant K_d Values in Site Sand and Clay**	NRC expects to close MF 7.01 after NRC determines that site-specific measurements for the K_d value for selenium in sand and clay are appropriate. Those measurements should consider the potential effect of the higher pH conditions that are likely to exist downgradient of the SDF. <u>Alternatively</u>, MF 7.01 may be closed if NRC determines that selenium K_d values for SRS sand and clay do not have the potential to significantly affect the dose to an off-site MOP. That determination should consider the uncertainty in other key parameters related to selenium release and transport (i.e., MFs 5.04 and 6.01).	**Section 2.2.2.1 - Long-Term Radiological Lysimeter Program** This task is expected to provide K_d values in soil and cementitious materials and additional information about long-term geochemical and transport phenomena that will be used to support the waste release and transport models.	In December of 2016, the NRC issued a TRR titled *Technical Review of "Dose Calculation Methodology for Liquid Waste Performance Assessments at the Savannah River Site", SRR-CWDA-1013-00058, Rev. 1, July 2014, Docket No. PROJ0734*. The TRR is related to MFs 7.01, 10.07, 10.08 and 10.09. [ML16277A060] In January of 2017, the NRC issued a TRR titled *Technical Review: Iodine Sorption Coefficients for Use in Performance Assessments for the Saltstone Disposal Facility, Docket No. PROJ0734*. The TRR is related to MFs 5.04, 6.01, 7.01, 10.04, 10.06, and 10.09. [ML16342C575] Due to the relative importance of K_d values, studies were performed to improve estimates for site-specific conditions with focus on radionuclides that contribute significantly to dose risks. The FY2014 SDF SA applied the latest available values. The geochemical data package (SRNL-STI-2009-00473) used to identify a justified set of geochemical data inputs for the various transport modeling at SRS was updated July 2016 (it was last revised in March 2010). The 2019 SDF PA incorporates the latest K_d values as recommended in the FY2016 K_d report (SRR-CWDA-2017-00019). The NRC recommended expanding the scope of MF 5.04 (Certain Risk-Significant K_d Values for Saltstone), MF 6.01 (Certain Risk-Significant K_d Values in Disposal Structure Concrete), and MF 7.01 (Certain Risk-Significant K_d Values in Site Sand and Clay) to now include iodine sorption in saltstone, disposal structure concrete, and soils, respectively. (ML18158A172)

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
MA 8 – Environmental Monitoring				
8.01 §	**Leak Detection**	NRC expects to close MF 8.01 after the leak detection system ends operation or after final waste disposal occurs, whichever comes later.	**Section 2.3.3 - Provide General Technical Support on Saltstone Disposal Facility Performance Assessment Issues** Activities include supporting NRC on-site observation visits and technical reviews, general project support, testing and research activity support, and development of resolution path forward for NRC open items.	DOE will provide routine/requested information to NRC as it becomes available. (ML18219B035)
8.02 §	**Groundwater Monitoring**	NRC does not expect to close MF 8.02 because NRC will monitor groundwater data for the duration of NRC monitoring at the SDF.	**Section 2.3.3 - Provide General Technical Support on Saltstone Disposal Facility Performance Assessment Issues** Activities include supporting NRC on-site observation visits and technical reviews, general project support, testing and research activity support, and development of resolution path forward for NRC open items.	DOE will provide routine/requested information to NRC as it becomes available. In FY2018, the NRC recommended not changing either the priority or the status of MF 8.02. (ML18117A494, ML18219B035)

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
8.03 ±	**Identification and Monitoring of Groundwater Plumes in the Z Area**	NRC staff identified the following concerns regarding the groundwater monitoring system in the Z Area: (1) the locations and the number of groundwater monitoring wells in the upper part of the aquifer system in order to detect saltstone disposal structure leaks or any unintentional release to the subsurface relatively early; (2) the locations and the number of groundwater monitoring wells to adequately follow the development of the plume within the Z Area, and (3) the lack of groundwater wells to obtain background concentration values from the Upper Three Runs Aquifer–Lower Aquifer Zone (UTRA-LAZ). The NRC staff expects to close MF 8.03 when the NRC staff determines that the groundwater monitoring system in the Z Area can: (1) identify saltstone contaminants in the groundwater in the SDF at no more than 150 ft [46 m] from a disposal structure; and (2) track the movements of the groundwater plume (e.g., know the horizontal and vertical extent of the plume; be able to follow the approximate path of the peak of the plume).	N/A	In FY2018, the NRC recommended adding the new MF 8.03 (Identification and Monitoring of Groundwater Plumes in the groundwater monitoring well network). (ML18117A494, ML18219B035) The SRS groundwater model (General Separations Area [GSA] Model) has been updated using recent well data and improved modeling techniques (SRNL-STI-2018-00643). This revised GSA Model showed good agreement with known contaminant plumes at the GSA, including the Z Area plume. The 2019 SDF PA uses this updated GSA Model to simulate groundwater flow and transport.
MA 9 – Site Stability				
9.01 ‡	**Settlement Due to Increased Overburden**	NRC expects to close MF 9.01 after NRC determines that the projections of settlement in the recent geotechnical investigations will not adversely affect SDF performance. Alternately, DOE may provide NRC information that allows NRC to determine that the new DOE settlement projections are consistent with the values assumed in the DOE 2009 SDF PA.	N/A	Geotechnical evaluations for current and planned SDUs indicate that settlement will not be significant.

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
9.02 ‡	**Settlement Due to Dissolution of Calcareous Sediment**	NRC expects to close MF 9.02 after NRC assesses a new DOE projection of the likelihood of the formation of sinks during the period of performance at the SDF and any resulting effects on site stability.	N/A	Geotechnical evaluations for current and planned SDUs indicate that settlement will not be significant. The Georgia Institute of Technology (GIT) was contracted by the Department of Energy (DOE) to provide an independent evaluation of the soft zones and their implications at the SRS (K-ESR-G-00023, K-TRT-G-00008, K-ESR-K-00008). These studies suggest that the risk of settlement due to dissolution of calcareous sediment is less likely in the GSA where subsurface clastic materials are more dominant than carbonates, compared to areas in the southeast portion of the SRS where the subsurface carbonates are more dominant than the clastic material. Note that in a geotechnical investigation for the future site of SDU 9 (K-ESR-Z-00010), it was determined that a limited portion of the near-surface soil material beneath the SDU 9 footprint may not provide adequate stability to support the SDU. To mitigate this, the unsuitable material was over-excavated down to approximately 252 feet above mean sea level (msl) and backfilled with structural aggregate fill material back up to an elevation of 262 feet above msl (C-CG-Z-00134). Regardless, to ensure defensibility, the 2019 SDF PA assumed that SDU 9 would be constructed at a lower elevation of 250 feet above msl as the SDF PA models were performed prior to this site preparation work.

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
MA 10 – Performance Assessment Model Revisions				
10.01 ±	**Implement-ation of Conceptual Models**	NRC expects to close MF 10.01 after DOE updates the PA and NRC determines that intermediate model results are consistent with the conceptual models, quality assurance methods used are appropriate, and parameter values and uncertainty ranges are appropriate.	**Section 2.4.1 - Prepare Out-year Saltstone Disposal Facility Performance Assessment Revisions** This section describes future revisions to the PA that will incorporate improvements to conceptual modeling.	The 2019 SDF PA identified multiple conceptual models. These conceptual models were developed to address specific conditions or to ensure that specific FEPs were addressed (as informed by SRR-CWDA-2017-00057 and SRR-CWDA-2018-00006). In many cases, various sensitivity cases were developed to evaluate possible variations of the conceptual models.
10.02 ±	**Defensibility of Conceptual Models**	NRC expects to close MF 10.02 after DOE updates the PA and NRC determines that the conceptual models are appropriate.	**Section 2.4.1 - Prepare Out-year Saltstone Disposal Facility Performance Assessment Revisions** This section describes future revisions to the PA that will incorporate improvements to conceptual modeling.	In April of 2017, the NRC issued a TRR titled *Technical Review: Performance of the High Density Polyethylene Layer, High Density Polyethylene/Geosynthetic Clay Liner Composite Layer, and the Lower Lateral Drainage Layer, Docket No. PROJ0734*. The TRR is related to MFs 6.03 and 10.02. [ML17081A187] The 2019 SDF PA identified multiple conceptual models. These conceptual models were developed to address specific conditions or to ensure that specific FEPs were addressed (as informed by SRR-CWDA-2017-00057 and SRR-CWDA-2018-00006). In many cases, various sensitivity cases were developed to evaluate possible variations of the conceptual models. In FY2018, the NRC recommended not changing either the priority or the status of MF 10.02. (ML18095A122, ML18107A161)
10.03 ‡	**Diffusivity in Degraded Saltstone**	NRC expects to close MF 10.03 after DOE updates the PA and NRC determines that the diffusivity information, including the model of the movement of the oxidation front, is well-supported.	**Section 2.2 - Saltstone Disposal Facility Performance Assessment Testing & Research Activities** Measurement of cured saltstone grout samples are expected to validate PA assumptions concerning the movement of oxidation fronts through cementitious materials.	The 2019 SDF PA incorporates updated effective diffusions coefficients based on studies by SREL. The 2019 SDF PA also provides the basis for the assumption that saltstone oxidation prior to closure cap emplacement will be minimal. This includes observations of SDU 2A cores which showed little to no evidence that the field-emplaced saltstone was being oxidized.

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
10.04 †	**K_d Values for Saltstone**	NRC expects to close MF 10.04 after DOE updates the PA and NRC determines that the K_d values for saltstone for any radionuclides that become risk-significant in the updated PA are well-supported.	**Section 2.2.2.1 - Long-Term Radiological Lysimeter Program** This task is expected to provide K_d values in soil and cementitious materials and additional information about long-term geochemical and transport phenomena that will be used to support the waste release and transport models.	In January of 2017, the NRC issued a TRR titled *Technical Review: Iodine Sorption Coefficients for Use in Performance Assessments for the Saltstone Disposal Facility, Docket No. PROJ0734*. The TRR is related to MFs 5.04, 6.01, 7.01, 10.04, 10.06, and 10.09. [ML16342C575] Due to the relative importance of K_d values, studies were performed to improve estimates for site-specific conditions, with focus on radionuclides that contribute significantly to dose risks. The FY2014 SDF SA applied the latest available values and future modeling will consider all available data. The geochemical data package (SRNL-STI-2009-00473) used to identify a justified set of geochemical data inputs for the various transport modeling at SRS was updated in July 2016 (it was last revised in March 2010). The 2019 SDF PA incorporates the latest K_d values as recommended in the FY2016 K_d report (SRR-CWDA-2017-00019).
10.05 †	**Moisture Characteristic Curves**	NRC expects to close MF 10.05 after DOE updates the PA and NRC determines that the MCCs are well-supported. Alternatively, MF 10.05 may be closed if, in an updated PA, DOE assumes the relative permeability is 1, which means that DOE does not use MCCs in the updated PA.	**Section 2.2 – Saltstone Disposal Facility Performance Assessment Testing & Research Activities** Previous testing and research activities investigated the impact of curing temperature on the moisture retention properties in saltstone. Characteristic curves for high cure temperature samples were compared to those based on saltstone cured at room temperature.	In March of 2017, the NRC issued a TRR titled *Technical Review: Saltstone Waste Form Hydraulic Performance, Docket No. PROJ0734*. The TRR is related to MF 10.05. [ML17018A137, ML19150A295] The FY2014 SDF SA and the 2019 SDF PA applied revised MCCs to incorporate data from the latest studies. The 2019 SDF PA also includes a sensitivity case that assumes the relative permeability is 1, which means that the MCCs were not used. This sensitivity case showed no change in the results relative to the Compliance Case.

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
10.06 †	**K_d Values for Disposal Structure Concrete**	NRC expects to close MF 10.06 after DOE updates the PA and NRC determines that the K_d values for disposal structure concrete for any radionuclides that become risk-significant in the updated PA are well-supported.	**Section 2.2.1 - Contaminant Leaching Characteristics from Saltstone Monolith Emplaced Core Sample** Laboratory prepared and process room samples will have physical properties testing performed to determine the hydraulic conductivity, K_d, bulk cured density, porosity, and microstructure/ phase analysis. Future testing will compare these properties to those measured from emplaced core sampling.	In January of 2017, the NRC issued a TRR titled *Technical Review: Iodine Sorption Coefficients for Use in Performance Assessments for the Saltstone Disposal Facility, Docket No. PROJ0734*. The TRR is related to MFs 5.04, 6.01, 7.01, 10.04, 10.06, and 10.09. [ML16342C575] Due to the relative importance of K_d values, studies were performed to improve estimates for site-specific conditions, with focus on radionuclides that are expected to contribute significantly to dose risks. The FY2014 SDF SA applied the latest available values and future modeling will consider all available data. The geochemical data package (SRNL-STI-2009-00473) used to identify a justified set of geochemical data inputs for the various transport modeling at SRS was updated in July 2016 (it was last revised in March 2010). The 2019 SDF PA incorporates the latest K_d values as recommended in the FY2016 K_d report (SRR-CWDA-2017-00019).

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
10.07 †	**Calculation of Build-Up in Biosphere Soil**	NRC expects to close MF 10.07 after DOE updates the PA and NRC determines that the soil K_d values are well-supported in the soil build-up calculation (i.e., if DOE chose conservative low K_d values in the transport calculation, then the soil K_d values may not be the same K_d values used in the transport calculation).	N/A	In December of 2016, the NRC issued a TRR titled *Technical Review of "Dose Calculation Methodology for Liquid Waste Performance Assessments at the Savannah River Site", SRR-CWDA-2013-00058, Rev. 1, July 2014, Docket No. PROJ0734*. The TRR is related to MFs 7.01, 10.07, 10.08, and 10.09. [ML16277A060] For the FY2014 SDF SA and the 2019 SDF PA, DOE developed a revised dose calculator that incorporated the latest available data related to exposure factors and also included a soil-build up calculation with the most recent K_d values. The dose calculator (SRR-CWDA-2013-00058) was updated again in early FY2019 for use in the SDF PA revision. Additionally, the 2019 SDF PA also includes a number of sensitivity cases to better evaluate risks associated with alternative K_d values for soil build-up calculations.
10.08 ‡	**Consumption Factors and Uncertainty Distributions for Transfer Factors**	NRC expects to close MF 10.08 after DOE updates the PA and NRC determines that the values of consumption factors and uncertainty distributions for transfer factors are well-supported.	**Section 2.2.3 - Prepare Out-year Saltstone Disposal Facility Performance Assessment Revisions** This section describes future revisions to the PA that will incorporate the latest available information with respect to consumption factors, transfer factors, and uncertainty distributions.	In December of 2016, the NRC issued a TRR titled *Technical Review of "Dose Calculation Methodology for Liquid Waste Performance Assessments at the Savannah River Site", SRR-CWDA-2013-00058, Rev. 1, July 2014, Docket No. PROJ0734*. The TRR is related to MFs 7.01, 10.07, 10.08, and 10.09. [ML16277A060] For the 2019 SDF PA the dose calculator (SRR-CWDA-2013-00058) was updated. This update to the dose calculator provided additional support for the consumption factors and removed the unsupported uncertainty distributions associated with the transfer factors.

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
10.09 *†*	**K_d Values for SRS Soil**	NRC expects to close MF 10.09 after DOE updates the PA and NRC determines that the site-specific K_d values for any radionuclides that become risk-significant in the updated PA are well-supported.	**Section 2.2.2.1 - Long-Term Radiological Lysimeter Program** This task is expected to provide K_d values in soil and cementitious materials and additional information about long-term geochemical and transport phenomena that will be used to support the waste release and transport models.	In December of 2016, the NRC issued a TRR titled *Technical Review of "Dose Calculation Methodology for Liquid Waste Performance Assessments at the Savannah River Site", SRR-CWDA-1013-00058, Rev. 1, July 2014, Docket No. PROJ0734*. The TRR is related to MFs 7.01, 10.07, 10.08, and 10.09. [ML16277A060] In January of 2017, the NRC issued a TRR titled *Technical Review: Iodine Sorption Coefficients for Use in Performance Assessments for the Saltstone Disposal Facility, Docket No. PROJ0734*. The TRR is related to MFs 5.04, 6.01, 7.01, 10.04, 10.06, and 10.09. [ML16342C575] Due to the relative importance of K_d values, studies were performed to improve estimates for site-specific conditions, with focus on radionuclides that are expected to contribute significantly to dose risks. The FY2014 SDF SA applied the latest available values and future modeling will consider all available data. The geochemical data package (SRNL-STI-2009-00473) used to identify a justified set of geochemical data inputs for the various transport modeling at SRS was updated in July 2016 (it was last revised in March 2010). The 2019 SDF PA incorporates the latest K_d values as recommended in the FY2016 K_d report (SRR-CWDA-2017-00019).
10.10 *‡*	**Far-Field Model Calibration**	NRC expects to close MF 10.10 after DOE updates the PA and NRC determines that the far-field model calibration, particularly in the area near the SDF, is adequate.	**Section 2.3.3 - Provide General Technical Support on Saltstone Disposal Facility Performance Assessment Issues** To address RSIs from the NRC, additional ground water modeling will be developed to support improved far-field model calibration.	The SRS groundwater model (GSA Model) has been updated using recent well data and improved modeling techniques (SRNL-STI-2018-00643). This revised GSA Model showed good agreement with known contaminant plumes at the GSA, including the Z Area plume. The 2019 SDF PA uses this updated GSA Model to simulate groundwater flow and transport.

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
10.11 ‡	**Far-Field Model Source Loading Approach**	NRC expects to close MF 10.11 after DOE updates the PA and NRC determines that the far-field source loading approach in the model is adequate.	N/A	No new activities have been performed to address this monitoring factor.
10.12 ‡	**Far-Field Model Dispersion**	NRC expects to close MF 10.12 after DOE updates the PA and NRC determines that the grid refinement used in any hydrological model supporting the updated PA does not increase modeled dispersion beyond the expected physical dispersion.	N/A	In response to the RAIs for the FY2013 SDF SA, DOE has performed sensitivity modeling to evaluate the potential impacts from dispersivity variability. A similar sensitivity case was also incorporated into the 2019 SDF PA.
10.13 †	**Impact of Calcareous Zones on Contaminant Flow and Transport**	NRC expects to close MF 10.13 after DOE investigates potential preferential pathways due to subsurface calcareous zones and NRC determines that the DOE representation of any preferential pathways due to calcareous zones is adequate.	N/A	Geotechnical evaluations for current and planned SDUs indicate that subsurface calcareous zone will be minimal or not present in Z Area. Regardless, the 2019 SDF PA includes a sensitivity case to evaluate the potential impacts should preferential flow paths be present.
10.14 ‡	**Scenario Development and Defensibility**	NRC would monitor DOE consideration of plausible alternative scenarios in future PA development because of the potential importance of plausible alternative scenarios to dose projections and continue to monitor the scenario development and defensibility of the central scenario. The NRC expects to close MF 10.14 after the DOE updates the PA and the NRC determines that the evaluated scenarios are appropriate	N/A	In FY2018, the NRC recommended adding the new MF 10.14 (Scenario Development and Defensibility) as Medium priority to reflect the NRC staff distinguishing conceptual model uncertainty from scenario uncertainty. (ML18158A172) The 2019 SDF PA identified multiple conceptual models. These conceptual models were developed to address specific conditions or to ensure that specific FEPs were addressed (as informed by SRR-CWDA-2017-00057 and SRR-CWDA-2018-00006). In many cases, various sensitivity cases were developed to evaluate possible variations of the conceptual models.

MF #[1]	Factor	NRC Expectations[2]	Related PA Maintenance Activities as Described in this Document	Comments
MA 11 – Radiation Protection Program				
11.01 §	**Dose to Individuals During Operations**	NRC expects to close MF 11.01 at the end of the institutional control period.	**Section 2.3.3 - Provide General Technical Support on Saltstone Disposal Facility Performance Assessment Issues** Activities include supporting NRC on-site observation visits and technical reviews, general project support, testing and research activity support, and development of resolution path forward for NRC open items.	DOE will provide routine/requested information to NRC as it becomes available.
11.02 §	**Air Monitoring**	NRC expects to close MF 11.02 at the end of the institutional control period.	**Section 2.3.3 - Provide General Technical Support on Saltstone Disposal Facility Performance Assessment Issues** Activities include supporting NRC on-site observation visits and technical reviews, general project support, testing and research activity support, and development of resolution path forward for NRC open items.	DOE will provide routine/requested information to NRC as it becomes available.

Y = Yes N= No N/A = Not applicable

[1] Monitoring Factors are color-coded based on NRC-determined prioritizations in NRC SDF Monitoring Plan. [ML13100A113]. Symbols are included for clarity.

± **Red = High**	† **Green = Low**
‡ **Yellow = Medium**	§ **Blue = Periodic**
Purple = Closed	

[2] NRC expectations are from the NRC SDF Monitoring Plan. [ML13100A113]. Subsequent to issuance of the NRC SDF Monitoring Plan, NRC has issued various TRRs related to SDF monitoring activities. [ML13304B159, ML15098A031, ML16196A179, ML16277A060, ML16342C575, ML17018A137, ML17081A187, ML18002A545, ML18033A071, ML18095A122, ML18117A494, ML18158A172, ML19031B221]

APPENDIX C

U.S. Nuclear Regulatory Commission Monitoring Items for F-Area Tank Farm and H-Area Tank Farm

Appendix C: U.S. Nuclear Regulatory Commission Monitoring Items for the F-Area Tank Farm and H-Area Tank Farm

Factors are colored by NRC priority and a symbol is included with each MF number to ensure clarity. Changes from previous year are indicated by red text. A legend containing a description of the NRC ranking is provided at the end of the Table.

<table>
<tr><th>MF[1]</th><th>Factor</th><th>NRC Monitoring Activities[2] / Recommendation(s)</th><th>Related PA Maintenance Activities as Described in this Document</th></tr>
<tr><td colspan="4">MA 1 – Inventory</td></tr>
<tr><td rowspan="3">1.1
†</td><td rowspan="3">Final Inventory and Risk Estimates</td><td><u>General NRC Monitoring Activities [ML15238A761]</u>
During the monitoring period, NRC staff will review special analyses typically performed at the time of closure of each tank that provide updated inventories and risk estimates for the entire tank farm that is the subject of the special analysis. NRC staff will assess the degree to which DOE demonstrates the tank farm meets the performance objectives with the new projected radionuclide inventories and will assess other PA updates. As part of the evaluation, NRC staff will assess the degree to which DOE's special analyses evaluate uncertainty in the revised inventory. NRC staff should independently verify whether the change in inventory, or changes to other modeling parameters, are expected to lead to an exceedance of the dose-based performance objectives (i.e., a 0.25 mSv/yr [25 mrem/yr] limit to a MOP under 10 CFR 61.41 or an applied 5 mSv/yr [500 mrem/yr] limit to an intruder under 10 CFR 61.42). NRC staff will review special analyses to ensure intruder risks reported in the tank farm PAs are appropriately assessed and evaluated.

This factor can be closed following NRC review of the last tank or equipment-specific special analysis prepared by DOE for FTF and HTF.</td><td>Section 3.4.3 – Tank Farm SA
Each tank is sampled following waste retrieval operations. For each waste tank an SA will be performed to evaluate the impact of the final residual inventory on the conclusions of the PAs. SAs will be available to the NRC in support of NRC's monitoring role. An SA specific to the HTF Type I and Type II Tanks was prepared and issued in August 2016. [SRR-CWDA-2016-00078] This SA updated the radiological and chemical inventories for the HTF Type I and Type II tanks, incorporating lessons learned from the final waste tank characterization results to date.</td></tr>
<tr><td><u>Recommendation [FTF and HTF TERs – As Tanks Are Cleaned and Sampled]</u>
In the FTF and HTR TERs, NRC staff recommended DOE sample each tank following waste retrieval operations for the purpose of developing a final inventory.
(Duplicate, also applies to MF 1.2)</td><td>Section – N/A
DOE has committed to sampling of each tank following waste retrieval operations. This activity is covered as part of the individual tank project work scope.</td></tr>
<tr><td><u>Recommendation [FTF and HTF TERs – When Developing Highly Radioactive Radionuclide (HRR) List and When Characterizing Residuals]</u>
In the FTF and HTR TERs, NRC staff recommended that DOE continue to evaluate its HRR list and provide sufficient justification for any changes as additional information becomes available. The HRR list should be evaluated especially where it is used to inform decisions, such as the selection of radionuclides characterized in residual waste, selection of treatment technologies, and the screening of radionuclides for the purpose of detailed PA calculations.
(Duplicate, also applies to MF 1.2)</td><td>Section – N/A
Each tank will be sampled following waste retrieval operations and an SA will be performed to evaluate the impact of the final residual inventory on the conclusions of the applicable PA. Development of the final tank residual inventory, including selection of radionuclides to be analyzed, is covered as part of the individual tank project work scope. This recommendation will be considered in development of future inventory determinations and documentation.</td></tr>
</table>

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
1.1 †	**Final Inventory and Risk Estimates**	Recommendation [HTF TER] In the HTF TER, NRC staff recommended DOE revise its annulus inventory assumptions in the HTF PA if plans to clean the annuli of Tanks 9H, 10H, and 14H change.	**Section 3.4.3– Tank Farm SA** Each tank is sampled following waste retrieval operations. An SA will be performed to evaluate the impact of the final residual inventory on the conclusions of the applicable PA. This recommendation will be considered in development of future SAs. An SA specific to the HTF Type I and Type II Tanks was prepared and issued in August 2016. [SRR-CWDA-2016-00078] This SA updated the radiological and chemical inventories for the HTF Type I and Type II tanks, incorporating lessons learned from the final waste tank characterization results to date.
		Recommendation [ML13273A299] DOE should evaluate whether it has appropriately managed inventory uncertainty.	**Section 3.4.3 – Tank Farm SA** Each tank is sampled following waste retrieval operations. An SA will be performed to evaluate the impact of the final residual inventory on the conclusions of the applicable PA. This recommendation will be considered in development of future SAs. Under Monitoring Factor 1.1, the NRC concluded that the Tank 12H SA adequately evaluated deviations in the Tank 12H final inventory compared to forecasted inventories used in earlier PA calculations. [ML17277B235] An SA specific to the HTF Type I and Type II Tanks was prepared and issued in August 2016. [SRR-CWDA-2016-00078] This SA updated the radiological and chemical inventories for the HTF Type I and Type II tanks, incorporating lessons learned from the final waste tank characterization results to date.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		Recommendation [ML13273A299] DOE should provide a stronger technical basis for projected inventory multipliers.	**Section 3.4.3 – Tank Farm SA** Each tank is sampled following waste retrieval operations. An SA will be performed to evaluate the impact of the final residual inventory on the conclusions of the applicable PA. This recommendation will be considered in development of future SAs. An SA specific to the HTF Type I and Type II Tanks was prepared and issued in August 2016. [SRR-CWDA-2016-00078] This SA updated the radiological and chemical inventories for the HTF Type I and Type II tanks, incorporating lessons learned from the final waste tank characterization results to date.
1.2 †	**Residual Waste Sampling**	General NRC Monitoring Activities [ML15238A761] NRC staff will review sampling and analysis plans developed for each tank. NRC's technical review should include, but may not be limited to, the following considerations: • Consideration of intratank waste variability that is important to the sampling design, including the basis for assumptions regarding homogeneity and the number of samples to be collected • Use of floor concentration samples for assigning residual waste inventory for tank walls • DOE's support for assumptions regarding normality of radionuclide concentration when developing deterministic and probabilistic inventory parameters • Sampling of HRRs or basis for removal of HRRs from the list of radionuclides to be sampled In addition to review of sampling and analysis plans, NRC staff also will conduct its own independent assessment to verify the list of HRRs in DOE's assessment is complete. If additional HRRs are identified, NRC staff will meet with DOE to resolve the discrepancies in the list and suggest actions, as appropriate, that DOE could take to ensure that risks are appropriately assessed and managed. NRC staff will review sampling and analysis plans to ensure all HRRs are sampled or a basis for exclusion of an HRR is provided. This MF can be closed when NRC concludes that DOE has provided sufficient information to support its list of HRRs and following review of the last sampling and analysis plan for a tank and following the last planned onsite observation of sampling of a tank (may occur prior to the last tank or ancillary equipment being sampled).	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		Recommendation [FTF and HTF TERs – As Tanks Are Cleaned and Sampled] In the FTF and HTF TERs, NRC staff recommended DOE sample each tank following waste retrieval operations for the purpose of developing a final inventory. (Duplicate, also applies to MF 1.1)	**Section – N/A** DOE has committed to sampling of each tank following waste retrieval operations. This activity is covered as part of the individual tank project work scope.
		Recommendation [FTF TER – As Tanks Are Sampled and SAs are Prepared] In the FTF TER, NRC staff recommended DOE better explain intratank waste variability that influences waste characterization and uncertainty evaluation. NRC's comments were expressed in the context of Tank 18 sampling, but also pertain to future characterization of other tanks. Specifically, NRC commented on (i) lack of explanation regarding differences between past and current sample variability, (ii) potential lack of consideration and explanation of the unexpectedly high tank wall concentrations for Pu-238, and (iii) lack of basis for assumptions regarding normality of sample concentrations and volume estimates when calculating inventory multiplier to be used in the probabilistic analysis.	**Section – N/A** Each tank will be sampled following waste retrieval operations and an SA will be performed to evaluate the impact of the final residual inventory on the conclusions of the applicable PA. Development of the final tank residual inventory is covered as part of the individual tank project work scope. This recommendation will be considered in development of future inventory determinations and documentation.
1.2 †	**Residual Waste Sampling**	Recommendation [FTF and HTF TERs – When Developing HRR List and When Characterizing Residuals] In the TERs for FTF and HTF, NRC staff recommended DOE continue to evaluate its HRR list and provided sufficient justification for any changes as additional information becomes available. The HRR List should be evaluated especially where it is used to inform decisions, such as the selection of radionuclides characterized in residual waste, selection of treatment technologies, and the screening of radionuclides for the purpose of detailed PA calculations. (Duplicate, also applies to MF 1.1)	**Section – N/A** Each tank will be sampled following waste retrieval operations and an SA will be performed to evaluate the impact of the final residual inventory on the conclusions of the applicable PA. Development of the final tank residual inventory, including selection of radionuclides to be analyzed, is covered as part of the individual tank project work scope. This recommendation will be considered in development of future inventory determinations and documentation.
		Recommendation [HTF TER – When Characterizing Residuals] In the HTF TER, the NRC repeated recommendations from the Inventory TRR for Tanks 5F and 6F related to sampling (ML13085A291). These recommendations include: 1. DOE should consider, in its tank sampling design, historical information on tank waste receipts, and information related to the alteration and redistribution of waste due to cleaning operations that may impact horizontal and vertical waste heterogeneity, 2. DOE should evaluate the option to composite samples within segments (or strata) to preserve information about segment (or strata) variance, 3. DOE should evaluate and present information on the relative contributions of various forms of uncertainty in its estimation of mean tank concentrations, 4. DOE should also consider how it can better assure sample representativeness by improving tank sampling designs, collection tools and instructions.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** These recommendations apply to the overall waste tank residual sampling program and are not tank-specific. These recommendations will be evaluated as funding becomes available. Under Monitoring Factor 1.2, the NRC concluded that the DOE methodology used to develop final inventory estimates for high-level waste tanks in the Tank 12H SA was acceptable. [ML17277B235]

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
1.3 †	**Residual Waste Volume**	General NRC Monitoring Activities [ML15238A761] DOE indicates its intent to improve the method of estimating residual volumes in its LW PA Maintenance Programs (e.g., SRR-CWDA-2012-00022 and SRR-CWDA-2014-00108). NRC staff will monitor DOE's progress in this area. NRC staff also will attempt to observe DOE's use of video and photographic records to develop residual waste volumes during an onsite observation. NRC staff will monitor DOE's visual inspection of internal surfaces to ensure no significant inventory is overlooked (e.g., Pu-238 on the walls of Tank 18F). In the Tank 16H Final Inventory TRR (ML15301A830), NRC reiterated that DOE needs to improve documentation of its volume estimation approach, as well as validate methods used to estimate the residual volumes whether through sampling, measurement or through more qualitative methods (e.g., visual evidence). This factor will be closed once NRC staff concludes DOE has taken steps to improve the process by which it estimates residual volumes or shows that DOE has appropriately managed volume uncertainty. This factor may be reopened if NRC staff identifies issues with DOE's approach to developing or considering uncertainty in volumes estimates.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary. With respect to volume estimation (Monitoring Factor 1.3), the NRC found DOE implementation of the tank mapping methodology for Tank 12H adequate for the purpose of developing radionuclide inventories for use in PA calculations, although several areas of potential improvement were noted, particularly related to timing of solids mapping and consideration of uncertainty in volume estimates. Additional technical issues relevant to volume estimation were listed in the Tank 16H inventory TRR (ML15301A830) and were not repeated. [ML17277B235]

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
1.3 †	**Residual Waste Volume**	Recommendation [FTF and HTF TERs – 1 to 5 Years, Next Tank Mapping] In the FTF TER, NRC staff recommended DOE consider improvements to residual material mapping and consideration of uncertainty in volume estimates. In the HTF TER, NRC repeated recommendations related to volume estimations from the Inventory TRR for FTF Tanks 5 and 6. [ML13085A291] NRC expects DOE to address the following technical concerns when estimating residual tank waste volumes in the future: 1. DOE should better understand the accuracy of mapping team height estimates through additional field validation activities for a range of solid material heights. 2. DOE should clearly communicate how it determines the size of areas to be mapped and how it manages uncertainty related to height estimates for discretized areas in its deterministic analysis. Likewise, DOE should clarify how it represents uncertainty in the assignment of high and low end heights to these areas (e.g., does it use a height that is clearly below/above the non-uniform surface of the delineated areas). 3. DOE should consider uncertainty in the volume estimates resulting from the transfer of data from photographic and video evidence to hand contoured maps (and then to Excel spreadsheets with a finer discretization). 4. DOE should be more transparent with respect to its approach to (i) mapping annular volumes including use of a crawler to inspect internal surfaces and (ii) estimating residual waste volumes in ventilation ducts. DOE should consider uncertainty in annulus volume estimates. In lieu of improving the method by which DOE estimates residual waste volume, DOE could manage inventory uncertainty with conservative estimates (i.e., volume estimates that clearly err on the side of higher values).	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary. These recommendations apply to the overall waste tank residual sampling program and are not tank-specific. These recommendations will be evaluated as funding becomes available. **Section – N/A** DOE will stay up to date with advances in volume measurement applications.
1.4 *	**Ancillary Equipment Inventory**	General NRC Monitoring Activities [ML15238A761] DOE indicated, in response to NRC comment (SRR-CWDA-2009-00054), its intent to verify PA assumptions regarding transfer line inventories consistent with Section 8.2, "Further Work," in DOE's PA (SRS-REG-2007-00002). NRC staff will meet with DOE to discuss DOE's schedule for characterization of transfer lines to ensure conclusions regarding the relatively low risk estimates for transfer lines are confirmed. Additionally, transfer line inventories are important for the intruder analysis because DOE assumes an intruder can more easily access the residual inventory in a transfer line than in a tank. NRC staff will monitor DOE's efforts in this area to ensure the assumed transfer line inventories are sufficiently bounding or that increased risk is assessed. This MF can be closed once NRC staff concludes that DOE characterization has confirmed the low risk of ancillary components.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary. **Section 3.4.3 – Tank Farm SA** In FY2021, an SA was issued to support operational closure of FDB-5 and FDB-6, which are no longer needed in support of FTF operations. The FDB-5 and FDB-6 SA reports that the results and conclusions presented in FTF PA and supporting SAs are not impacted by new information regarding the final residual inventories that are planned to be grouted in-place in FDB-5 and FDB-6 and the conclusions reached based on the FTF PA information, remain valid.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
1.4 *	**Ancillary Equipment Inventory**	Recommendation [FTF and HTF TERs – 1 to 5 Years] DOE indicates, in response to NRC comment (SRR-CWDA-2009-00054) its intent to verify PA assumptions regarding transfer line inventories consistent with Section 8.2, "Further Work" in DOE's PA (SRS-REG-2007-00002).	**Section 3.4.3 – Tank Farm SA** In FY2021, an SA was issued to support operational closure of FDB-5 and FDB-6, which are no longer needed in support of FTF operations. The FDB-5 and FDB-6 SA reports that the results and conclusions presented in FTF PA and supporting SAs are not impacted by new information regarding the final residual inventories that are planned to be grouted in-place in FDB-5 and FDB-6 and the conclusions reached based on the FTF PA information, remain valid.
1.5 *	**Waste Removal (As It Pertains to ALARA)**	General NRC Monitoring Activities [ML15238A761] NRC will evaluate removal to the maximum extent practical (MEP) for each cleaned tank to ensure DOE disposal actions are consistent with as low as reasonably achievable (ALARA) criteria. NRC staff will assess DOE compliance with ALARA objectives through review of DOE documentation completed in conjunction with the federal facility agreement closure process. This factor can be closed once all tanks are cleaned and NRC staff has reviewed DOE documentation of removal to the MEP.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [FTF and HTF TERs – As Tanks Are Cleaned] In the FTF TER, NRC staff recommended DOE more fully evaluate costs and benefits of additional HRR removal, including (i) consideration of benefits of additional HRR removal over longer performance periods (and considering uncertainty in the timing of peak doses), (ii) justification for assumptions regarding alternative cleaning technology effectiveness, and (iii) comparison of costs and benefits of additional HRR removal to similar DOE activities. In the HTF TER, NRC staff indicated that DOE provide a clear linkage between the Criterion 2 evaluation and the PA results, including consideration of the long-term risks associated with the HTF facility, and indicated that sufficient detail was not provided in the waste determination to ensure consistent format and appropriate content for future cost-benefit analyses.	**Section – N/A** Development of cost-benefit analyses related to HRR removal are covered as part of the individual tank project work scope. This recommendation will be considered in development of future cost-benefit analyses.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		Recommendation [HTF TER] In the HTF TER, NRC staff indicated that it does not have confidence that DOE has adequately evaluated the risk associated with the projected inventory of the Tank 16H annulus. The NRC staff recommended DOE evaluate a waste release scenario due to groundwater in-leakage into and out of the annular region and contacting the high-solubility waste in the annuli of those tanks.	**Section 3.4.2 – Prepare Out-Year HTF PA Revisions** This recommendation will be considered in the next PA revision. An SA specific to the HTF Type I and Type II Tanks was prepared and issued in August 2016. [SRR-CWDA-2016-00078] This SA updated the radiological and chemical inventories for the HTF Type I and Type II tanks, incorporating lessons learned from the final waste tank characterization results to date. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).
1.5 *	**Waste Removal (As It Pertains to ALARA)**	Recommendation [ML13080A401] In the Cost Benefit Analysis for Tanks 18 and 19, the NRC noted that many additional costs were due to the length of time that had passed between the decision to cease removal activities and the time at which the cost-benefit analysis was performed. DOE does not expect this lapse in time for future cost-benefit analysis for other tanks.	**Section – N/A** Development of cost-benefit analyses related to Highly Radioactive Radionuclide (HRR) removal are covered as part of the individual tank project work scope. This recommendation will be considered in development of future cost-benefit analyses.
		Recommendation [ML13080A401] In the Cost Benefit Analysis for Tanks 18 and 19, the NRC noted issues with the collective dose comparison, which only included 1 person for 50 years, although NRC also noted problems with use of collective dose.	**Section – N/A** Development of cost-benefit analyses related to HRR removal are covered as part of the individual tank project work scope. This recommendation will be considered in development of future cost-benefit analyses.
		Recommendation [ML13080A401] In the Cost Benefit Analysis for Tanks 18 and 19, the NRC staff questioned DOE's criteria that additional waste removal be more cost beneficial than other similar DOE activities.	**Section – N/A** Development of cost-benefit analyses related to HRR removal are covered as part of the individual tank project work scope. This recommendation will be considered in development of future cost-benefit analyses.
		Recommendation [ML13080A401] In the Cost Benefit Analysis for Tanks 18F and 19F, the NRC staff also questioned DOE's separate consideration of cost and benefit uncertainty in its sensitivity analysis (cumulative impact of uncertainty in the costs and benefits was not considered). Additionally, higher removal rates (e.g., 75 percent) could have been evaluated in sensitivity analysis.	**Section – N/A** Development of cost-benefit analyses related to HRR removal are covered as part of the individual tank project work scope. This recommendation will be considered in development of future cost-benefit analyses.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
MA 2 – Waste Release			
2.1 §	**Solubility-Limiting Phases/Limits and Validation**	General NRC Monitoring Activities [ML15238A761] NRC continues to recommend that DOE design and perform waste release experiments using actual tank residual samples as soon as practical. DOE staff should continue to discuss its plans with NRC to ensure experiments are designed to optimize their potential usefulness in supporting the 10 CFR 61.41 compliance demonstrations. This monitoring activity is considered to be the highest priority by NRC staff at this time from both a timing and importance perspective. NRC staff encourages DOE to continue the work that was initiated in FY2014 with respect to obtaining support for the assumed solubility limits of key radionuclides in tank farm waste. Pending results of the waste release experiments, NRC will evaluate the need for additional experiments for other tank waste. This factor can be closed once DOE provides experimental support for the assumed solubilities of key radionuclides relied on for performance. The results of waste release experiments may inform the extent to which additional recommendations would need to be implemented.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Testing of actual waste (i.e., Tank 18 and Tank 12 residuals) was performed in FY2016 and FY2018. The solubilities of I, Pu, Np, U, and Tc were tested under simulated waste tank chemistry conditions using Tank 18 and Tank 12 residual waste samples. Data was collected via measured concentrations (or solubilities) over a multi week testing period under different chemical conditions (pH and E_h were varied). The chemical conditions reflect a range of states such that the test results can be used to better understand the impact of transitory waste tank chemical conditions on solubility. As discussed in *Evaluation of Waste Release Testing Results against the Tank Farm Performance Assessment Waste Release Model* (SRR-CWDA-2016-00086), the experimental results indicate there may be some variance from the actual waste solubilities and the WRM assigned solubilities. For example, Np and I was in all cases more insoluble than assigned in the WRM. The other three elements (Pu, Tc and U) appeared in most instances to be potentially more soluble than was assumed in the WRM. For example, Pu was relatively insoluble when oxidized, but was still more soluble than calculated by the WRM. Even if the experimental results were conservatively accepted into the WRM, the newly assigned solubilities would have a negligible impact on peak doses in 1,000 or 10,000 years.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
2.1 §	**Solubility-Limiting Phases/Limits and Validation**	Recommendation [FTF and HTF TERs – Short-to-immediate term] In the FTF TER, NRC staff recommended DOE perform experiments to verify validity of Geochemist's Workbench calculations used to determine solubility-limiting phases, solubility limits, and chemical transition times. These experiments should study (i) pH and E_h evolution of the grout pore water over time, (ii) controlling solubility-limiting phases, and (iii) static and dynamic leach tests to study the mobility of HRRs, including consideration of alteration of tank residuals following chemical cleaning with reagents, such as oxalic acid. In the HTF TER, NRC staff reiterates its FTF recommendation that DOE conduct waste release experiments to (i) distinguish between releases from high solubility compounds and low solubility compounds via semi-dynamic leach tests and (ii) determine constant concentrations of elements of concern under conditions of exposure to local groundwater and grout leachate via static tests. (Duplicate, also applies to MF 2.2)	**Section 3.2.1.1 – Waste Release Studies** This task focuses on reducing uncertainty surrounding WRM assumptions. The first step is to attempt to determine solubility values based on actual waste samples for key radionuclides. Testing of actual waste (i.e., Tank 18 and Tank 12 residuals) was performed in FY2016 and FY2018. The solubilities of I, Pu, Np, U, and Tc were tested under simulated waste tank chemistry conditions using Tank 18 and Tank 12 residual waste samples, with the results documented in *Evaluation of Waste Release Testing Results against the Tank Farm Performance Assessment Waste Release Model* (SRR-CWDA-2016-00086).
		Recommendation [ML12272A082] DOE should provide additional information to support assumptions regarding longevity of reducing conditions in the contaminated zone. Recent studies (Cantrell and Williams, 2012) suggest that the reducing capacity of the tank grout could be depleted much earlier than assumed in the FTF PA (SRS-REG-2007-00002) and in more recent plutonium solubility modeling performed for Tank 18 (SRNL-STI-2012-00087). Uncertainty in the normative mineralogy assumed in geochemical modeling should be considered under this action. (Duplicate, also applies to MF 2.2)	**Section 3.2.4 – To Be Determined Out-Year Testing** An SA specific to the HTF Type I and Type II Tanks was prepared and issued in August 2016. [SRR-CWDA-2016-00078] This SA updated the radiological and chemical inventories for the HTF Type I and Type II tanks, incorporating lessons learned from the final waste tank characterization results to date. DOE has evaluated potential activities in this area based on the waste release testing experimental work performed in support MF 2.1. Testing is being performed on various grout formulations to provide additional information regarding: 1) the impact of infiltrating ground water on grout pore water chemistry (e.g. pH and Eh) through time, 2) the ranges of tank grout pore water pH and Eh to be expected in waste tanks, initially and through time following many pore volume flushes, and 3) the mineralogy of tank fill grouts, initially and through time following many pore volume flushes.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		Recommendation [ML12272A082] DOE should provide additional support for the assumption that the E_h of infiltrating water will remain below a critical threshold at which plutonium solubility will increase to a risk significant value (e.g., updated geochemical modeling indicates a dramatic increase in plutonium solubility occurs at E_h greater than +0.45 V). Uncertainty in the critical threshold and the E_h of infiltrating groundwater should be considered under this action. (Duplicate, also applies to MF 2.2)	**Section 3.2.4 – To Be Determined Out-Year Testing** DOE has evaluated potential activities in this area based on the waste release testing experimental work performed in support MF 2.1. Testing is being performed on various grout formulations to provide additional information regarding: 1) the impact of infiltrating ground water on grout pore water chemistry (e.g. pH and Eh) through time, 2) the ranges of tank grout pore water pH and Eh to be expected in waste tanks, initially and through time following many pore volume flushes, and 3) the mineralogy of tank fill grouts, initially and through time following many pore volume flushes.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
2.1 §	**Solubility-Limiting Phases/Limits and Validation**	Recommendation [ML18242A259] In the Tank 18F Waste Release Testing TRR, NRC staff concluded that additional waste release testing and updated geochemical modeling are needed for NRC staff to have confidence in the PA results. The NRC staff offered the following additional conclusions and comments related to waste release testing. • Although DOE only used a single sample (FTF-1) for the Tank 18F waste release testing, their rationale (e.g., good characterization, and high concentrations of key radionuclides) is reasonable. In future waste release testing, if testing of multiple samples is impractical, DOE should consider compositing samples to get representative results for the entire tank contents rather than just a small portion of the waste. • DOE should consider the impact of waste treatment methods, grout additives, and other chemical constituents that may increase radionuclide solubility (e.g., oxalates and carbonates) in designing and evaluating the results of future experiments. • In future testing, DOE should consider water rinses with synthetic SRS ground water in addition to grout conditioned ground water to study the impact of grout bypass on waste release results. DOE should also consider evaluating the change in concentration over time for the rinse solutions. • DOE should continue to conduct solid phase analysis of residual waste to inform waste release assumptions for other tanks. • As recommended by an independent peer review group, DOE should consider conducting spectroscopic analyses of plutonium (Pu) and other metals such as iron (Fe) in waste residues. • DOE should analyze all major ions, alkalinity, and appropriate trace components (e.g., Pu, Fe, and sulfide). • DOE should consider the following: (1) comparison of the experimental conditions against those for which the Nuclear Energy Agency's (NEA's) thermodynamic database is based to better understand differences in the modeled and experimental results, and (2) updating the assumed phases and geochemical modeling as warranted. • DOE should consider performing updated geochemical modeling using information gained from characterization of the tanks, and knowledge gained from comparisons of the experimental to previously modeled results.	Testing of actual waste (i.e., Tank 18 and Tank 12 residuals) was performed in FY2016 and FY2018. The solubilities of I, Pu, Np, U, and Tc were tested under simulated waste tank chemistry conditions using Tank 18 and Tank 12 residual waste samples. The NRC conclusions and comments relating to waste release testing were incorporated into the Tank 12 testing to the extent practical and will be addressed further in any future testing. DOE has also evaluated other potential activities in this area based on the waste release testing experimental work performed in support MF 2.1. Testing is being performed on various grout formulations to provide additional information regarding: 1) the impact of infiltrating ground water on grout pore water chemistry (e.g. pH and Eh) through time, 2) the ranges of tank grout pore water pH and Eh to be expected in waste tanks, initially and through time following many pore volume flushes, and 3) the mineralogy of tank fill grouts, initially and through time following many pore volume flushes.

2.1 §	**Solubility-Limiting Phases/Limits and Validation**	Recommendation [ML19298A092] In the Tank 12H Waste Release Testing TRR, NRC stated that DOE should consider the following items to enhance its waste release testing. • NRC staff supports DOE's recommendation to conduct additional leach testing on other tank waste (N-ESR-H-00040). • DOE should consider evaluation of the impact of waste type, waste treatment methods, grout additives, & other chemical constituents that may increase radionuclide solubility (e.g., oxalates & carbonates) in designing/evaluating the results of future experiments. • In future waste release testing, if testing of multiple tank samples is impractical, DOE should develop support for the use of composite samples and discuss the limitations of use of a composite sampling approach. Ideally supporting information for use of a composite leach test sample would include solid phase characterization and aqueous phase concentrations of individual samples to better understand tank waste variability. • As stated in the Tank 18F TRR (ML18242A259), in future testing, DOE should consider water rinses with synthetic SRS groundwater in addition to grout conditioned groundwater to study the impact of grout bypass on waste release results. • DOE should conduct solid phase analysis on tank waste residuals, including Tank 12H. Recommendations were provided in an independent peer review group report (LA-UR-2012-00079) with potential analysis methods. • DOE should analyze all major ions, alkalinity, and appropriate trace components (e.g., Pu, Fe, and sulfide). If possible, an anion/cation balance should be calculated to determine if an important component has been missed. • DOE should consider the following: (1) comparison of the experimental conditions against those for which the NEA's thermodynamic database is based to better understand differences in the modeled and experimental results, and (2) updating the assumed phases and geochemical modeling as warranted. • DOE should consider performing updated geochemical modeling using information gained from characterization of the tanks, and knowledge gained from comparisons of the experimental to previously modeled results. DOE should also consider how the inability to meet the target Eh endpoints assumed in modeling affect the results. • DOE should develop additional model support that calcium carbonate maintains pH in the simulated cement-reacted solutions, both oxidizing and reducing, and how the leaching results might have been affected by this assumption. • DOE should develop additional model support to refer to the results of the experiments (i.e., aqueous phase concentrations) as solubilities. Without a conceptual understanding of controls on radionuclide concentrations in the engineered system, it would be difficult to extrapolate the results to other conditions. • DOE should discuss how the RRII and ORII conditions targeted in the leach testing differ from Conditions C and D assumed in the HTF PA for Tank 12H, and how the use of a higher pH affects the applicability of the experimental results.	Waste release testing is being performed on various grout formulations to provide additional information. The topics addressed in this recommendation will be considered in any future waste release testing and in updates to the Waste Release Modeling.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
2.1 §	**Solubility-Limiting Phases/Limits and Validation**	Recommendation [ML19298A092] In the Tank 12H Waste Release Testing TRR, NRC stated that DOE should consider the following items to continue to address uncertainties in the current PA models and support future PA models. • DOE should perform probabilistic or multi-variate sensitivity analysis considering uncertainty in performance of multiple barriers, including scenarios that evaluate basemat bypass, early hydraulic failure due to water table rise or preferential flow through the system, and consider the impact of higher mobility forms of Pu in the natural system. • DOE should continue to study and develop alternative conceptual models to account for the various oxidation states of Pu in the natural system including models that consider two fractions of Pu (relatively high mobility and low mobility forms) as well as the potential for oxidation and reduction reactions affecting the mobility of Pu in the subsurface along the flow paths away from the tanks to the 1 m and 100 m compliance points.	The topics addressed in this recommendation will be considered in any future PA models.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
2.1 §	**Solubility-Limiting Phases/Limits and Validation**	Recommendation [ML18242A259] In the Tank 18F Waste Release Testing TRR, NRC staff concluded that additional waste release testing and updated geochemical modeling are needed for NRC staff to have confidence in the PA results. The NRC staff offered the following additional conclusions and comments related to waste release testing and PA modeling. • DOE should consider a larger range of uncertainty in key radionuclide solubility due to experimental limitations (e.g., substantial metal losses of uranium during leach testing which compromised the utility of the uranium data collected from the experiments and apparent lack of ability to achieve equilibrium conditions particularly for Pu and Tc). • DOE should perform probabilistic or multi-variate sensitivity analysis considering uncertainty in performance of multiple barriers including scenarios that evaluate basemat bypass, early hydraulic failure due to water table rise or preferential flow through the system, and consider the impact of higher mobility forms of Pu in the natural system. • DOE should explain differences in PORFLOW and GoldSim modeling results (e.g., Pu peak doses of around 5 mSv/yr (500 mrem/yr) in the Tanks 18/19 SA (SRR-CWDA-2010-00124) versus 7 mSv/yr (700 mrem/yr) in SRR-CWDA-2016-00086). • DOE should evaluate the impact of the early, high concentration release of Pu or justify why the rinse sample results are not applicable to alternative conceptual models involving water table rise or preferential flow through the system. • DOE should continue to study and develop models to account for higher mobility forms of Pu in the natural system including models that consider two fractions of Pu (relatively high mobility and low mobility forms) as well as the potential for oxidation and reduction reactions affecting the mobility of Pu in the subsurface along the flow paths away from the tank to the 1 m and 100 m compliance points. DOE should evaluate the impact of transport of key radionuclides from the waste zone up into the tank grout, and if found to be risk-significant, provide additional support for the transport mechanism(s).	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** Future revisions to the FTF PA will be provided to NRC for review in support of NRC's monitoring role. Testing of actual waste (i.e., Tank 18 and Tank 12 residuals) was performed in FY2016 and FY2018. The solubilities of I, Pu, Np, U, and Tc were tested under simulated waste tank chemistry conditions using Tank 18 and Tank 12 residual waste samples. The NRC conclusions and comments relating to waste release testing were incorporated into the Tank 12 testing to the extent practical and will be addressed further in any future testing.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
2.2 ‡	Chemical Transition Times and Validation	General NRC Monitoring Activities [ML15238A761] NRC staff will evaluate the efficacy of DOE's use of two chemical transitions, three chemical states, and no more than three solubilities for each key radionuclide with solubility changes assumed in DOE's PAs to occur at the same time for each key radionuclide for a given tank type. NRC will perform this evaluation through NRC review of literature, DOE-generated geochemical modeling, or through independent geochemical modeling. NRC staff also may observe DOE experiments related to this MF in conjunction with an onsite observation of the FTF or HTF. This factor can be closed when (i) DOE shows that chemical transition times are no longer important to its compliance demonstration (i.e., predicted dose is less than the dose standards for all time) or (ii) DOE provides adequate experimental support for its assumptions regarding chemical transition times.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** DOE has evaluated potential activities in this area based on the waste release testing experimental work performed in support MF 2.1. In August 2020, SREL issued the technical report, *Aqueous and Solid Phase Characterization of Potential Tank Fill Material*, SREL-R-21-0001. SREL conducted a series of batch and column studies to address uncertainty in the realistic pH and Eh ranges associated with the grouted waste tank systems, including an evaluation of three candidate Tank Closure Grout (TCG) paste formulations. The observed results generally agreed with previous laboratory tests aimed at defining achievable Eh and pH conditions in tank waste grouted systems. The pH results were predominantly consistent with both the values derived from geochemical modeling and more recent laboratory testing. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will incorporate these testing results.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		Recommendation [FTF and HTF TERs – Short-to-Immediate Term] In the FTF TER, NRC staff recommended DOE perform experiments to verify validity of Geochemist's Workbench calculations used to determine solubility limiting phases, solubility limits, and chemical transition times. These experiments should study (i) pH and E_h evolution of the grout pore water over time, (ii) controlling solubility limiting phases, and (iii) static and dynamic leach tests to study the mobility of HRRs, including consideration of alteration of tank residuals following chemical cleaning with reagents, such as oxalic acid. In the HTF TER, NRC staff reiterated its FTF recommendation that DOE conduct waste release experiments to (i) distinguish between releases from high solubility compounds and low solubility compounds via semi-dynamic leach tests and (ii) determine constant concentrations of elements of concern under conditions of exposure to local groundwater and grout leachate via static tests. (Duplicate, also applies to MF 2.1)	**Section 3.2.1.1 – Waste Release Studies** DOE has evaluated potential activities in this area based on the waste release testing experimental work performed in support MF 2.1. In August 2020, SREL issued the technical report, *Aqueous and Solid Phase Characterization of Potential Tank Fill Material*, SREL-R-21-0001. SREL conducted a series of batch and column studies to address uncertainty in the realistic pH and Eh ranges associated with the grouted waste tank systems, including an evaluation of three candidate Tank Closure Grout (TCG) paste formulations. The observed results generally agreed with previous laboratory tests aimed at defining achievable Eh and pH conditions in tank waste grouted systems. The pH results were predominantly consistent with both the values derived from geochemical modeling and more recent laboratory testing. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will incorporate these testing results.
		Recommendation [HTF TER – Immediate-Term] The NRC staff recommends DOE include dissolved oxygen concentrations in its modeling that are consistent with measurements of unimpacted groundwater across SRS or collect additional dissolved oxygen measurements within the HTF at locations and elevations that are in closer proximity to the tanks.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** DOE has evaluated potential activities in this area based on the waste release testing experimental work performed in support MF 2.1. No work related to this recommendation is currently being performed.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
2.2 ‡	Chemical Transition Times and Validation	Recommendation [ML12272A082] DOE should provide additional information to support assumptions regarding longevity of reducing conditions in the contaminated zone. Recent studies (PNNL-21723) suggest that the reducing capacity of the tank grout could be depleted much earlier than assumed in the FTF PA (SRS-REG-2007-00002) and in more recent plutonium solubility modeling performed for Tank 18 (SRNL-STI-2012-00087). Uncertainty in the normative mineralogy assumed in geochemical modeling should be considered under this action. (Duplicate, also applies to MF 2.1)	**Section 3.2.4 – To Be Determined Out-Year Testing** DOE has evaluated potential activities in this area based on the waste release testing experimental work performed in support MF 2.1. In August 2020, SREL issued the technical report, *Aqueous and Solid Phase Characterization of Potential Tank Fill Material*, SREL-R-21-0001. SREL conducted a series of batch and column studies to address uncertainty in the realistic pH and Eh ranges associated with the grouted waste tank systems, including an evaluation of three candidate Tank Closure Grout (TCG) paste formulations. The observed results generally agreed with previous laboratory tests aimed at defining achievable Eh and pH conditions in tank waste grouted systems. The pH results were predominantly consistent with both the values derived from geochemical modeling and more recent laboratory testing. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will incorporate these testing results.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		<u>Recommendation [ML12272A082]</u> DOE should provide additional support for the assumption that the E_h of infiltrating water will remain below a critical threshold at which plutonium solubility will increase to a risk significant value (e.g., updated geochemical modeling indicates a dramatic increase in plutonium solubility occurs at E_h greater than +0.45 V). Uncertainty in the critical threshold and the E_h of infiltrating groundwater should be considered under this action. (Duplicate, also applies to MF 2.1)	**Section 3.2.4 – To Be Determined Out-Year Testing** DOE has evaluated potential activities in this area based on the waste release testing experimental work performed in support MF 2.1. In August 2020, SREL issued the technical report, *Aqueous and Solid Phase Characterization of Potential Tank Fill Material*, SREL-R-21-0001. SREL conducted a series of batch and column studies to address uncertainty in the realistic pH and Eh ranges associated with the grouted waste tank systems, including an evaluation of three candidate Tank Closure Grout (TCG) paste formulations. The observed results generally agreed with previous laboratory tests aimed at defining achievable Eh and pH conditions in tank waste grouted systems. The pH results were predominantly consistent with both the values derived from geochemical modeling and more recent laboratory testing. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will incorporate these testing results.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
MA 3 – Cementitious Material Performance			
3.1 ‡	Hydraulic Performance of Concrete Vault and Annulus (As it Relates to Steel Liner Corrosion and Waste Release)	General NRC Monitoring Activities [ML15238A761] NRC staff will review reports, analog studies, and other information used to support DOE's assumption regarding initial conditions and performance of the concrete vaults to protect the steel liner and limit releases of radioactivity from the annulus. For example, NRC staff will review annual tank inspection reports that provide information regarding trenching, scarifying, and cracking of the concrete vaults, as well as information about groundwater intrusion into the tank vaults. NRC staff will review reports related to previous events that led to potential releases or groundwater in-leakage through joints or cracks in the concrete vaults. Analog studies could include review and evaluation of information obtained from West Valley or other analog sites to better understand the potential for and rates of corrosion of high-level waste tanks/components, as well as mitigative design measures. As part of this MF, NRC staff also will consider the potential for earlier steel liner failure than assumed in DOE's PA due to corrosion of steel components (e.g., rebar) in the concrete vaults that are close to the vault surface or that may be physically separated but electrically connected. If DOE performs additional modeling or experiments to study the potential for transport of deleterious species into the tank vaults or the separation of iron dissolution and oxygen reduction and subsequent corrosion of steel liners or tanks, NRC staff will review the documentation or provide input on the design and results of the experiments. Experiments to study steel liner corrosion are expected to be relatively difficult to implement with unknown benefit compared to other experimental investigations recommended in NRC's TERs and discussed in this Monitoring Plan. Therefore, NRC staff does not consider these experiments to be a high priority at this time. Until such time that DOE provides additional support for the estimated lifetimes of the steel liners, NRC staff (i) will assume steel liners will not be effective at mitigating releases for the long time periods DOE relies on the steel liners for performance in the tank farm PAs and (ii) will investigate the support for the performance of other barriers to ensure performance objectives can be met until such support for steel liner performance is provided. NRC staff will perform routine monitoring of DOE's reliance on cementitious materials to ensure tank farm PA assumptions regarding the ability of the tank vaults to serve as a recognizable and durable barrier to intrusion are valid. In the Cementitious Barriers Partnership Toolbox (CBP) TRR (ML16196A179), the NRC identified QA gaps and limitations in the documentation associated with software development and in the technical basis for the conceptual and mathematical models for the CBP Toolbox. This MF will be reviewed in conjunction with MF 3.4 and can be closed following closure of tanks at FTF and HTF.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
3.1 ‡	Hydraulic Performance of Concrete Vault and Annulus (As it Relates to Steel Liner Corrosion and Waste Release)	<u>Recommendation [FTF and HTF TERs – Long-Term Activity with need contingent on other factors]</u> In the FTF and HTF TERs, NRC staff recommended DOE consider uncertainty in initial conditions and performance lifetime of concrete vaults, because they impact uncertainty in the calculated steel liner failure times.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed.
		<u>Recommendation [HTF TER – Short- and Immediate-Term]</u> In the HTF TER, NRC staff indicated that DOE should conduct a more comprehensive analysis of contaminant release from the annular regions of Types I and II tanks. Dose projections from the potential release of the radionuclides in the annuli and sand pads are likely to be very sensitive to several key assumptions, which should be well supported. These assumptions include, but are not limited to, (i) the assumed release scenario; (ii) the chemical composition of the infiltrating water; (iii) the volumetric flow rate through grouted tanks, including shrinkage gaps and cracks; and (iv) the solubility of the annulus and sand pad waste. NRC staff also indicated that if the possibility of rise and fall of the water table in the vicinity of the Types I and II tanks cannot be excluded, DOE should evaluate a scenario where water drains from any gaps in the annulus and sand pad regions. (Also applies to MFs 3.2, 3.3, and 3.5)	**Section 3.2.4 – To Be Determined Out-Year Testing** An SA specific to the HTF Type I and Type II Tanks was prepared and issued in August 2016. [SRR-CWDA-2016-00078] This SA updated the radiological and chemical inventories for the HTF Type I and Type II tanks, incorporating lessons learned from the final waste tank characterization results to date. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will include a more comprehensive analysis of contaminant release from the annular regions of Types I and II tanks.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
3.2 ‡	**Groundwater Conditioning via Reducing Grout**	General NRC Monitoring Activities [ML15238A761] NRC staff will monitor DOE experiments to study the potential for groundwater flow through cracks that may form in the tank grout. NRC staff will monitor DOE experiments or perform its own independent experiments to better understand the nature of flow through the tank grout as it impacts the extent to which infiltrating groundwater interacts with and is conditioned by the tank grout. NRC staff also will review information regarding water table rise to evaluate the likelihood of this alternative conceptual model for waste release. Based on the results of the water table rise investigation, an alternative conceptual model may be proposed for a subset of tanks to assess the impact on the compliance demonstration. Specifically, NRC staff will review historical water table elevation data for wells to assess the likelihood of water table rise above the bottom of the tanks. NRC staff also will review design and construction of any DOE mitigation measures used to ensure that the water table remains below the bottom of the tanks. Under contract with the NRC, Center for Nuclear Waste Regulatory Analyses is conducting experiments to study the extent of groundwater conditioning when flow is primarily through preferential pathways or through a cracked grout specimen. The objectives of these experiments are to understand the extent to which infiltrating water chemistry (primarily pH and E_h) is modified by contact with the tank grout and how the tank grout buffering capacities for pH and E_h may change with contact to infiltrating water. Documentation of results of these experiments are expected in CY2015. NRC will also review documentation provided by DOE to support assumptions regarding the extent of groundwater conditioning for as-emplaced tank grout. NRC staff may conduct the technical review activities in conjunction with an onsite observation to observe any laboratory or field experiments in this area. If results of waste release experiments conducted under MF 2.1 show key radionuclides in waste residuals have sufficiently low solubility when in contact with unconditioned SRS groundwaters, MF 3.2 related to the extent of conditioning (and 2.2 related to the longevity of conditioning) will no longer be needed by DOE to support the compliance demonstration and can be closed. If MF 2.1 results indicate unconditioned flow may lead to unacceptably high doses, then this MF will need to be evaluated by NRC and can be closed after DOE (i) shows matrix flow through the grout will dominate waste release or (ii) provides information to support assumptions regarding the level of groundwater conditioning for degraded (cracked) grout.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary. DOE has evaluated potential activities in this area based on the waste release testing experimental work performed in support MF 2.1. In August 2020, SREL issued the technical report, *Aqueous and Solid Phase Characterization of Potential Tank Fill Material*, SREL-R-21-0001. SREL conducted a series of batch and column studies to address uncertainty in the realistic pH and Eh ranges associated with the grouted waste tank systems, including an evaluation of three candidate Tank Closure Grout (TCG) paste formulations. The observed results generally agreed with previous laboratory tests aimed at defining achievable Eh and pH conditions in tank waste grouted systems. The pH results were predominantly consistent with both the values derived from geochemical modeling and more recent laboratory testing. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will incorporate these testing results.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
3.2 ‡	**Groundwater Conditioning via Reducing Grout**	<u>Recommendation [FTF and HTF TERs – Intermediate- to Long-Term Activity with need contingent on other factors]</u> In the FTF and HTF TERs, NRC staff recommended DOE obtain greater support for its assumption regarding flow through the tank grout (i.e., fracture versus matrix) flow as it impacts the timing of chemical transition or time to release of HRRs at risk-significant solubility. If found to be risk-significant, DOE should consider the appropriateness of using MCCs for matrix materials to simulate fracture flow. In the HTF TER, NRC staff recommended DOE provide more support for the assumption that the engineered system will not interfere with the ability of the overlying grout to sufficiently condition the infiltrating water for the fully and partially submerged tanks. (Duplicate, also applies to MF 3.3)	**Section 3.2.4– To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area pending final resolution of experimental work performed in support MF 2.1. In August 2020, SREL issued the technical report, *Aqueous and Solid Phase Characterization of Potential Tank Fill Material*, SREL-R-21-0001. SREL conducted a series of batch and column studies to address uncertainty in the realistic pH and Eh ranges associated with the grouted waste tank systems, including an evaluation of three candidate Tank Closure Grout (TCG) paste formulations. The observed results generally agreed with previous laboratory tests aimed at defining achievable Eh and pH conditions in tank waste grouted systems. The pH results were predominantly consistent with both the values derived from geochemical modeling and more recent laboratory testing. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will incorporate these testing results and address assumptions regarding flow through the tank grout (i.e., fracture versus matrix) flow and hoe these assumptions may impact the timing of chemical transitions.
		<u>Recommendation [HTF TER – Short- and Immediate-Term]</u> In the HTF TER, NRC staff indicated that DOE should conduct a more comprehensive analysis of contaminant release from the annular regions of Types I and II tanks. Dose projections from the potential release of the radionuclides in the annuli and sand pads are likely to be very sensitive to several key assumptions, which should be well supported. These assumptions include, but are not limited to, (i) the assumed release scenario; (ii) the chemical composition of the infiltrating water; (iii) the volumetric flow rate through grouted tanks, including shrinkage gaps and cracks; and (iv) the solubility of the annulus and sand pad waste. NRC staff also indicated that if the possibility of rise and fall of the water table in the vicinity of the Types I and II tanks cannot be excluded, DOE should evaluate a scenario where water drains from any gaps in the annulus and sand pad regions. (Also applies to MFs 3.1, 3.3, and 3.5)	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. An SA specific to the HTF Type I and Type II Tanks was prepared and issued in August 2016. [SRR-CWDA-2016-00078] This SA updated the radiological and chemical inventories for the HTF Type I and Type II tanks, incorporating lessons learned from the final waste tank characterization results to date.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
3.3 †	**Shrinkage and Cracking of Reducing Grout**	General NRC Monitoring Activities [ML15238A761] NRC staff will review grout formulations, calculations, research, test methods, and results to ensure the disposal facility is designed to minimize fast flow path development. NRC staff may conduct technical reviews in conjunction with onsite observations that could include such activities as video inspections of grout pours, observations of grout tests, and inspection of test specimens. The NRC staff will also continue to monitor the importance of alkali-silica reactivity on cementitious material degradation. The NRC staff will continue to evaluate the potential for shrinkage- and cracking-induced preferential flow through the tank grout. MF 3.3 can be closed when DOE demonstrates (i) preferential fast flow into the waste zone of the tanks or through the waste in the annuli for Types I and II tanks at HTF will not occur or (ii) preferential fast flow into the waste zone of the tanks or through the annuli for Types I and II tanks at HTF will not adversely impact performance (e.g., the performance objective can be met under all chemical conditions as discussed in more detail under MA 2, "Waste Release").	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary. An SA specific to the HTF Type I and Type II Tanks was prepared and issued in August 2016. [SRR-CWDA-2016-00078] This SA updated the radiological and chemical inventories for the HTF Type I and Type II tanks, incorporating lessons learned from the final waste tank characterization results to date. Additional grout testing was performed in FY2020 with emphasis on CLSM formulations. An evaluation memo of the results of the CLSM Test Reports entitled *Characterization and Assessment of CLSM Grouts for Potential Use in Waste Tank Operational Closures*, SRR-CWDA-2020-00045 was issued by WDA in June 2020. In FY2021, additional CLSM characterization was performed which included evaluating Zero-Bleed CLSM; 1) calculating saturated hydraulic conductivity, 2) measure diffusion of Na+ and NO3- from solution into the monolith, and 3) obtain MCCs for Zero-Bleed CLSM. The results are documented in SRRA099188-000015. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will incorporate these testing results and address preferential flow through the tank grout.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		Recommendation [ML15238A761] • DOE should consider design measures to minimize the occurrence of negative features, events, or processes that may promote shrinkage or cracking • DOE should consider removal of in-tank equipment that could lead to development of shrinkage-induced annuli around equipment or corrosion of steel components and associated cracking due to corrosion product expansion. • DOE should promote the ability of the grout to fill all void spaces to minimize imperfectly bonded grout seams and voids that may form between grout pours. • DOE should research and evaluate shrinkage compensating agents for use in its grout formulations to minimize shrinkage, shrinkage gap formation, and creation of annuli and void space within grout. • DOE should ensure temperature gradients are sufficiently low to prevent excessive thermal cracking. Calculations could be conducted to evaluate potential thermal gradients and/or instrumentation could be used to evaluate as-emplaced thermal evolution of grout. • DOE should ensure the grout is designed to consider the potential for cracking due to differential settlement. • It may be useful for DOE to research and deploy methods of detecting early crack development in reducing grout used to fill tanks.	**Section 3.2.4 – To Be Determined Out-Year Testing** Additional grout testing was performed in FY2020 with emphasis on CLSM formulations. An evaluation memo of the results of the CLSM Test Reports entitled Characterization and Assessment of CLSM Grouts for Potential Use in Waste Tank Operational Closures, SRR-CWDA-2020-00045 was issued by WDA in June 2020. In FY2021, additional CLSM characterization was performed which included evaluating Zero-Bleed CLSM; 1) calculating saturated hydraulic conductivity, 2) measure diffusion of Na+ and NO3- from solution into the monolith, and 3) obtain MCCs for Zero-Bleed CLSM. The results are documented in SRRA099188-000015. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will incorporate these testing results and address preferential flow through the tank grout.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
3.3 †	**Shrinkage and Cracking of Reducing Grout**	Recommendation [FTF and HTF TERs – Intermediate- to Long-Term Activity with need contingent on other factors] In the FTF and HTF TERs, NRC staff recommended DOE obtain greater support for its assumption regarding flow through the tank grout (i.e., fracture versus matrix) flow as it impacts the timing of chemical transition or time to release of HRRs at risk-significant solubility. If found to be risk-significant, DOE should consider the appropriateness of using MCCs for matrix materials to simulate fracture flow. In the HTF TER, NRC staff recommended DOE provide more support for the assumption that the engineered system will not interfere with the ability of the overlying grout to sufficiently condition the infiltrating water for the fully and partially submerged tanks. (Duplicate, also applies to MF 3.2)	**Section 3.2.4 – To Be Determined Out-Year Testing** Additional grout testing was performed in FY2020 with emphasis on CLSM formulations. An evaluation memo of the results of the CLSM Test Reports entitled Characterization and Assessment of CLSM Grouts for Potential Use in Waste Tank Operational Closures, SRR-CWDA-2020-00045 was issued by WDA in June 2020. In FY2021, additional CLSM characterization was performed which included evaluating Zero-Bleed CLSM; 1) calculating saturated hydraulic conductivity, 2) measure diffusion of Na+ and NO3- from solution into the monolith, and 3) obtain MCCs for Zero-Bleed CLSM. The results are documented in SRRA099188-000015. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will incorporate these testing results and address preferential flow through the tank grout.
		Recommendation [HTF TER – Short- and Immediate-Term] In the HTF TER, NRC staff indicated that DOE should conduct a more comprehensive analysis of contaminant release from the annular regions of Types I and II tanks. Dose projections from the potential release of the radionuclides in the annuli and sand pads are likely to be very sensitive to several key assumptions, which should be well supported. These assumptions include, but are not limited to, (i) the assumed release scenario; (ii) the chemical composition of the infiltrating water; (iii) the volumetric flow rate through grouted tanks, including shrinkage gaps and cracks; and (iv) the solubility of the annulus and sand pad waste. NRC staff also indicated that if the possibility of rise and fall of the water table in the vicinity of the Types I and II tanks cannot be excluded, DOE should evaluate a scenario where water drains from any gaps in the annulus and sand pad regions. (Also applies to MFs 3.1, 3.2, and 3.5)	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. An SA specific to the HTF Type I and Type II Tanks was prepared and issued in August 2016. [SRR-CWDA-2016-00078] This SA updated the radiological and chemical inventories for the HTF Type I and Type II tanks, incorporating lessons learned from the final waste tank characterization results to date. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will address contaminant release from the annular regions of Types I and II tanks.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		Recommendation [ML13269A365] In the Tanks 18 and 19 Grout Documentation TRR, the NRC staff stated that DOE has not provided sufficient information to rule out preferential pathways from its reference case. NRC staff expects DOE to provide additional information related to the extent and performance impact of shrinkage. During its review of tank grouting video, NRC staff observed potential segregation of tank grout during placement that could enhance the extent of shrinkage along the periphery of the Type IV tanks. NRC staff also expects DOE to provide additional information on the potential for thermal cracking of the grout monolith for Tanks 18F and 19F.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.
3.3 †	**Shrinkage and Cracking of Reducing Grout**	Recommendation [ML12212A192, ML13269A365] DOE indicated that it currently does not have plans to conduct shrinkage testing, but may pursue tests in the future. The NRC staff concur with Stefanko and Langton's (SRNL-STI-2011-00551) recommendations for testing of admixtures and implementation of measures to help mitigate tank grout shrinkage.	Research was performed in FY2017 to improve insights in this area. The intent of the work was to gain an enhanced understanding of tank specific cementitious material properties. Overall results were inconclusive from the shrinkage testing and no further tests are planned in FY2021.
		Recommendation [ML12212A192, ML13269A365] The NRC staff believes DOE's conclusion that the temperature rise was sufficiently low for bulk grouting of Tanks 18F and 19F based on a 1 cubic yard [0.8 m^3] bulk scale-up test and will continue to evaluate this technical issue in future onsite observations. A more detailed thermal analysis that considers the specific grout pour sequence and geometry to determine the potential for thermal cracking of the tank grout would improve model support.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.
		Recommendation [ML12212A192, ML13269A365] DOE did not document in the Final Configuration Report (SRR-CWDA-2012-00170) expected causes for the bulk fill grout deviations to mitigate potential concern over the formation of preferential pathways. The Final Configuration Report does provide documentation regarding potential causes of significant deviations in equipment grout fill volumes, however, estimates of remaining void volumes are not provided (e.g., advance design mixer pump [ADMP]). This information could also be used to improve future volume estimates. NRC staff will continue to monitor DOE estimates of void volumes including whether there is additional information that would support a conclusion that the ADMP void spaces were completely filled.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		Recommendation [ML14342A784] In the Tanks 5 and 6 Grout Documentation TRR, the NRC staff stated that DOE has not provided sufficient information and testing to exclude from its reference case preferential flow through the tank grout monolith. During its review of tank grouting video, NRC staff observed potential bleedwater segregation of tank grout during placement that could result in inhomogeneity of the monolith, which can affect flow patterns. The NRC staff will continue to evaluate the potential for shrinkage- and cracking-induced preferential flow through the tank grout.	**Section 3.2.4 – To Be Determined Out-Year Testing** Additional grout testing was performed in FY2020 with emphasis on CLSM formulations. An evaluation memo of the results of the CLSM Test Reports entitled Characterization and Assessment of CLSM Grouts for Potential Use in Waste Tank Operational Closures, SRR-CWDA-2020-00045 was issued by WDA in June 2020. In FY2021, additional CLSM characterization was performed which included evaluating Zero-Bleed CLSM; 1) calculating saturated hydraulic conductivity, 2) measure diffusion of Na+ and NO3- from solution into the monolith, and 3) obtain MCCs for Zero-Bleed CLSM. The results are documented in SRRA099188-000015. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will incorporate these testing results and address preferential flow through the tank grout.
3.3 †	**Shrinkage and Cracking of Reducing Grout**	Recommendation [ML12212A192, ML13269A365] The NRC staff communicated its concern with the potential formation of cracks in the tank grout due to alkali-silica reactivity (ASR). The NRC staff is concerned that DOE's criterion for acceptance of vendor supplied granite aggregate relies on short-term alkali reactivity tests (ASTM Standard C1260-14), which is unlikely to predict the occurrence of ASR over the very long period of performance for compliance with the performance objective specified at 10 CFR 61.41. Evaluating potential ASR in tank grouts and its potential effect on long-term performance of the engineered barrier system would improve model support for the performance of the grout and understanding of the potential for cracking of the grout.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
3.4 †	**Grout Performance**	General NRC Monitoring Activities [ML15238A761] NRC will perform technical review activities related to DOE's testing and development of grout formulations to meet design specifications. Additionally, NRC will monitor DOE's efforts to deliver a grout mix of sufficient quality to meet performance assumptions in DOE's PAs from design to as-emplaced conditions in the field. NRC staff will review relevant procedures and documentation related to such items as grout material procurement, production, testing, acceptance and placement in tank farm components. NRC staff will perform technical review activities in conjunction with onsite observations. Onsite observations will include such activities as observations of grout material storage, tests, and acceptance of grout materials; live video streams of grouting operations; review of archived video footage; review of batch tickets for accepted and rejected loads; tour of the command center; and observation of mock-up tests or visual examination of test specimens. NRC will perform routine monitoring of DOE's use of grout materials to stabilize high-level waste tanks to ensure tank farm PA assumptions regarding the ability of the grouted tank and vaults to serve as a recognizable and durable barrier to intrusion remain valid. The NRC staff will also continue to monitor void volumes in the emplaced grout to the extent information is available and the impact of limestone additions to the grout mix on pH buffering of water contacting the emplaced grout. NRC continues to monitor the potential for segregation of emplaced grout and its impacts on flow through the grout monolith and waste release. In the Tank 16H and Tank 12H Grouting TRR (ML16231A444), the NRC identified information that would enhance DOE's demonstration of grout performance: • DOE should take reasonable measures to ensure a sufficient number of cement trucks are in rotation to optimize grout distribution throughout the tank and minimize mounding. • DOE should address the potential for either a capillary or permeability barrier to form due to the varying hydraulic conductivity of the clean cap and bulk fill grout used in Tank 16H. • DOE should provide additional information regarding the quantity and performance impact of the presence of standing water in Tank 12H during grouting. • DOE should evaluate differences in hydraulic conductivity between the Grade 100 and Grade 120 slag used to fill Tank 12H and any resulting performance impact NRC staff can close this MF after it completes (i) review of DOE-generated grouting documentation and (ii) monitoring of grouting operations. This MF will be reviewed in conjunction with MF 3.1 and can be closed following closure of tanks at FTF and HTF.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
3.4 †	**Grout Performance**	Recommendation [ML12212A192, ML13269A365] The Tanks 18 and 19 Grout Documentation TRR stated that the NRC staff is concerned that the use of commercially-available Portland cements in Tanks 18 and 19 that differ from the grout mix considered in the FTF PA (SRS-REG-2007-00002) because of substitution of up to 5% by weight limestone would lower the pH buffering capacity of the grout and could affect the timing of release of key radionuclides. Evaluating the effect of limestone substitution in Portland cement on the pH buffering capacity of the grout and the release of key radionuclides improves model support for the modeling of chemical states and transitions of water contacting the residual waste.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.
3.5 ‡	**Vault and Annulus Sorption**	General NRC Monitoring Activities [ML15238A761] NRC staff will monitor DOE efforts to study basemat sorption for plutonium and neptunium. NRC staff will review documentation and any analog studies that may provide additional information regarding the ability of the concrete basemats to attenuate release from the tanks or annuli of Types I and II tanks at HTF, including information regarding groundwater inleakage and release from construction joints or other discrete features such as those implicated in the release from HTF Tank 16H. This MF can be closed when (i) sufficient information is available to support assumptions regarding attenuation of key radionuclides (e.g., plutonium, neptunium, cesium, strontium) in the basemats, vaults, or annular grout or (ii) DOE provides sufficient information to show that doses from key radionuclides will be below the dose limits prescribed in the performance objectives with little to no performance from the concrete basemats and vaults and annular grout (e.g., solubility limits for unconditioned groundwater are sufficiently low or natural attenuation of key radionuclides is sufficiently high to compensate for underperformance of the concrete basemat and vaults and annular grout).	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		<u>Recommendation [HTF TER – Short- and Immediate-Term]</u> In the HTF TER, NRC staff indicated that DOE should conduct a more comprehensive analysis of contaminant release from the annular regions of Types I and II tanks. Dose projections from the potential release of the radionuclides in the annuli and sand pads are likely to be very sensitive to several key assumptions, which should be well supported. These assumptions include, but are not limited to, (i) the assumed release scenario; (ii) the chemical composition of the infiltrating water; (iii) the volumetric flow rate through grouted tanks, including shrinkage gaps and cracks; and (iv) the solubility of the annulus and sand pad waste. NRC staff also indicated that if the possibility of rise and fall of the water table in the vicinity of the Types I and II tanks cannot be excluded, DOE should evaluate a scenario where water drains from any gaps in the annulus and sand pad regions. (Also applies to MFs 3.1, 3.2, and 3.3)	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. An SA specific to the HTF Type I and Type II Tanks was prepared and issued in August 2016. [SRR-CWDA-2016-00078] This SA updated the radiological and chemical inventories for the HTF Type I and Type II tanks, incorporating lessons learned from the final waste tank characterization results to date. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will address contaminant release from the annular regions of Types I and II tanks.
3.5 ‡	**Vault and Annulus Sorption**	<u>Recommendation [FTF and HTF TERs – Intermediate-Term]</u> In the FTF and HTF TERs, NRC staff commented that given the wide range of values in the literature, NRC staff recommends DOE obtain additional support for basemat K_ds for plutonium and neptunium, including consideration of solubility affects from previous evaluations and representativeness of experimentally derived values for aged concrete. DOE should continue to evaluate the appropriateness of selected transport parameters (e.g., cementitious material and soil K_ds) and the selection of sorption models during the monitoring period.	**Section 3.2.4 – To Be Determined Out-Year Testing** The geochemical data package (SRNL-STI-2009-00473) used to identify a justified set of geochemical data inputs for the various transport modeling at SRS was updated in July 2016 (it was last revised in March 2010). This update incorporated the numerous experiments and geochemical measurements have been conducted since 2010, resulting in new recommended input values for modeling. The revised geochemical data package integrates recent documented geochemical results, including radionuclide K_d values, solubility values, and cementitious impact factors, and includes a critical evaluation of these values with respect to existing values to assess potential impacts. Two sorption reports were issued in September 2018. The first report (SRRA021685-000011) documented concentrations measured in field lysimeter effluents from the fourth quarter of FY2017 and the second quarter of FY2018. The second report (SRRA021685-000010) documented the detailed solid phase analysis of a field lysimeter (lysimeter 41) with an emplaced Pu(V)NH4(CO3)(s) source.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
3.6 *	**Waste Stabilization (As it Impacts ALARA)**	General NRC Monitoring Activities [ML15238A761] NRC staff will review use of stabilizing materials to determine if DOE has made a reasonable effort to optimize mixing or encapsulating the waste with the stabilizing material. NRC staff will evaluate DOE's use of stabilizing materials to grout features of the tank and vault system that might otherwise lead to preferential flow through the engineered system and into the environment (e.g., grouting of leak detection channels and sumps contained within the concrete basemats). NRC staff will conduct technical reviews and onsite observations under MFs 3.1 to 3.5, bearing in mind the additional function of the stabilizing grout to maintain doses ALARA. NRC staff will close this factor when MFs 3.1 through 3.5 are closed, and if NRC staff finds DOE's use of stabilizing cementitious materials consistent with ALARA criteria.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		No specific NRC staff recommendations identified.	**Section – N/A**
MA 4 – Natural System Performance			
4.1 §	**Natural Attenuation of Key Radionuclides**	General NRC Monitoring Activities [ML15238A761] NRC will monitor DOE's efforts to develop site-specific sorption coefficients that consider the impact of cement-impacted leachate released from the tanks. NRC staff will review any DOE-generated reports or other documentation that provides additional information related to site-specific niobium K_d values. Technical review activities may be conducted in conjunction with onsite observations of any experiments developed to study the attenuation of plutonium, niobium, and other key radionuclides in SRS soils. NRC staff will review information generated by DOE and perform independent modeling to assess whether more mobile forms of plutonium, if evaluated explicitly in DOE's PA modeling, could reach the inadvertent intruder point of compliance (POC) within 10,000 years. This MF can be closed when NRC staff concludes that DOE has adequately assessed the timing and magnitude of Pu-239 release and transport to the 1-m [3.28 ft] POC and DOE provides support for its treatment of plutonium, niobium, and other key radionuclide sorption in the subsurface at FTF or DOE shows that plutonium, niobium, and other key radionuclide sorption in the subsurface is not needed to support its compliance demonstration (e.g., solubility control effectively limits plutonium releases into the natural environment to non-risk-significant levels).	**Section 3.3.3 – Provide General Technical Support on F-Area Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
4.1 §	**Natural Attenuation of Key Radionuclides**	<u>Recommendation [FTF and HTF TERs – Short- and Intermediate-Term]</u> In the FTF TER, NRC staff recommended DOE evaluate appropriateness of averaging K_ds of multiple oxidation states to simulate the transport of plutonium in the natural system. Consistent with the recommendation in the FTF TER, in the HTF TER, NRC staff indicated that a more accurate representation of the transport of multivalent plutonium would be to treat the two species separately, assuming the oxidation state distribution could be reasonably quantified. In the HTF TER, NRC staff also questioned the basis for the sandy sediment K_d for Pu of 650 mL/g derived from SRNL-STI-2011-00672, as well as the cement leachate factors that were derived based on Hanford data (SRNL-STI-2009-00473).	**Section 2.2.2.1 – Long-Term Radiological Lysimeter Program** This task is expected to provide K_d values (including for plutonium) in soil and cementitious materials and additional information about long-term geochemical and transport phenomena that will be used to support the waste release and transport models. The geochemical data package (SRNL-STI-2009-00473) used to identify a justified set of geochemical data inputs for the various transport modeling at SRS was updated in July 2016 (it was last revised in March 2010). This update incorporated the numerous experiments and geochemical measurements have been conducted since 2010 (including Lysimeter testing results), resulting in new recommended input values for modeling. The revised geochemical data package integrates recent documented geochemical results. Two sorption reports were issued in FY2018. The first report (SRRA021685-000011) documented concentrations measured in field lysimeter effluents from the fourth quarter of FY2017 and the second quarter of FY2018. The second report (SRRA021685-000010) documented the detailed solid phase analysis of a field lysimeter (lysimeter 41) with an emplaced Pu(V)NH4(CO3)(s) source. **Section 3.4.1– Prepare Out-Year FTF PA Revisions, Section 3.4.2 – Prepare Out-Year HTF PA Revisions** An SA specific to the HTF Type I and Type II Tanks was prepared and issued in August 2016. [SRR-CWDA-2016-00078] This SA includes sensitivity analyses that provided additional information regarding the sensitivity of HTF dose results to Pu soil K_d values. The next PA revisions will include more analysis of plutonium attenuation. It is expected that sensitivity analyses will show that peak dose results within the performance period are not sensitive to the Natural Attenuation of plutonium given the SA sensitivity analyses.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
4.1 §	**Natural Attenuation of Key Radionuclides**	Recommendation [ML13273A299] The Tanks 5F and 6F Special Analysis TRR stated that additional information related to the niobium K_d is needed to have reasonable assurance that DOE disposal actions at the FTF will meet the performance objectives in 10 CFR Part 61, Subpart C.	Testing being performed in support of the SDF PA will be used for the FTF and HTF PAs as applicable. The geochemical data package (SRNL-STI-2009-00473) used to identify a justified set of geochemical data inputs for the various transport modeling at SRS was updated in July 2016. **Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** The next PA revision will include more analysis of niobium attenuation. It is expected that sensitivity analyses will show that peak dose results within the performance period are not sensitive to the Natural Attenuation of niobium.
		Recommendation [ML12272A124] The Environmental Monitoring TRR stated that the NRC staff will continue to monitor the K_d averaging approach used to simulate plutonium transport in the natural system at FTF. DOE could address the issue by modeling explicitly more mobile and less mobile forms of plutonium in future performance assessment calculations.	**Section 3.2.4 – To Be Determined Out-Year Testing** An SA specific to the HTF Type I and Type II Tanks was prepared and issued in August 2016. [SRR-CWDA-2016-00078] This SA includes sensitivity analyses that provided additional information regarding the sensitivity of HTF dose results to Pu soil K_d values. The next PA revisions will include more analysis of plutonium attenuation. It is expected that sensitivity analyses will show that peak dose results within the performance period are not sensitive to the Natural Attenuation of plutonium given the SA sensitivity analyses.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
4.1 §	Natural Attenuation of Key Radionuclides	Recommendation [ML12272A124] The Environmental Monitoring TRR stated that the NRC staff will continue to monitor support for cement leachate factors developed for plutonium (and other constituents). DOE could provide support for cement leachate factors by performing site-specific analyses.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.
		Recommendation [ML12272A124] The Environmental Monitoring TRR stated that the NRC staff will continue to monitor the basis for selection of the niobium K_d value of 160 L/kg used in the Tanks 5F and 6F Special Analysis. DOE could address the technical issues by verifying the batch experiments did not exceed solubility limits and are representative of conditions at FTF (e.g., plot solid phase versus aqueous phase concentration or K_d versus concentration; evaluate K_d for FTF aquifer soils) or perform additional experiments to verify the niobium K_d.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.
		Recommendation [ML16277A060] As a result of its review of the revised dose methodology for Liquid Waste PAs (SRR-CWDA-2013-00058, Revision 1), NRC identified a number of items that should be addressed in future HTF and FTF PAs revisions. The complete listing of items is documented in the Dose Calculation Methodology TRR.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** These items will be considered in the next PA revision.
4.2 †	Calcareous Zone Character-ization	General NRC Monitoring Activities [ML15238A761] NRC staff should observe field tests and review and evaluate results of tracer tests and field mapping DOE may conduct to ascertain the significance of existing calcareous "soft" zones on flow and transport from the tank farms. NRC Staff will review relevant geotechnical logs acquired in the vicinity of tank farms to stay informed of the potential for and characteristics of soft zones that may be identified in the future. Finally, if DOE opts to employ downhole visualization or other methods to monitor local groundwater velocities associated with soft zones, NRC staff will review and evaluate DOE's analysis of these data. NRC may conduct technical review activities in conjunction with onsite observations of field activities, such as calcareous zone outcrop mapping on Upper Three Runs Creek. This factor will be closed when DOE has provided NRC sufficient information to show its treatment of calcareous zones in the tank farm PAs is reasonable or adequate to assess risk.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
4.2 †	**Calcareous Zone Character-ization**	Recommendation [ML15238A761] DOE could monitor flow velocities at screen levels both consistent and inconsistent with known existing soft zones to assess local fast flow path gradients of soft zones to provide additional confidence that current PA groundwater modeling treatment is acceptable.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.
		Recommendation [FTF and HTF TERs – Next PA Update (Long-Term)] In the FTF and HTF TERs, NRC staff recommended DOE continue to evaluate significance of calcareous zone dissolution on FTF flow and transport, including conduct of tracer studies and field mapping of seepage locations along Upper Three Runs Creek. Site-specific K_ds may also need to be developed for the Upper Three Runs Aquifer-Lower Zone. (Duplicate, also applies to MF 6.2)	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.
4.3 †	**Environmental Monitoring**	General NRC Monitoring Activities [ML15238A761] NRC staff will review any data collected by DOE for the tank farms for the purpose of evaluating disposal facility performance. NRC staff will review and evaluate groundwater monitoring data as a technical_review activity under this factor. NRC staff will continue to review the adequacy of the tank farm monitoring well network with respect to its ability to detect releases from the tank farms. NRC may conduct technical review activities for this monitoring activity in conjunction with onsite observations related to groundwater sampling, well construction, and other field activities. SCDHEC oversight may be leveraged in this area to ensure the quality of data collected. MA 4 will be renamed "Environmental Monitoring" once MF 4.1 and 4.2 have been closed. MA 4 will remain open indefinitely.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [ML12272A124] The Environmental Monitoring TRR stated that the NRC staff will continue to evaluate the source of elevated Tc-99 levels in well FTF 28. It is not clear that releases from the F-Area Inactive Process Sewer Line could migrate vertically to the lower zone of the Upper Three Runs Aquifer in such a short distance from the source. This evaluation is important to ensure that the hydrogeological system at FTF is well understood and that releases from the tanks could be detected by the monitoring well network. DOE could provide additional support for the source of contamination detected at well FTF 28 by performing particle tracking to better understand contaminant plume trajectories. DOE could also perform a more formal statistical analysis of FTF and Western Groundwater Operable Unit well data to correlate contaminant concentrations associated with various sources.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
4.3 †	**Environmental Monitoring**	Recommendation [ML12272A124] The Environmental Monitoring TRR stated that the NRC staff will continue to monitor the ability of the tank farm monitoring well network to detect releases from the tank farm facilities following closure. DOE could (i) evaluate the monitoring well network by performing an analysis of the centerline of plumes emanating from tank sources should releases occur in the future and (ii) provide input on optimal well locations to ensure that future releases from the tank farm facility would be detected.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.
4.3 †	**Environmental Monitoring**	Recommendation [ML18051B009, ML19280A059] The Environmental Monitoring TRR concluded the following: 1) DOE has performed environmental monitoring that provides useful information on the hydrogeological systems at FTF and HTF. This information can also be used to better understand contaminant flow and transport at the tank farm facilities (TFFs) and provide support for DOE Performance Assessment (PA) models, particularly the updated 2018 GSA PORFLOW model. Modeling and monitoring should be conducted iteratively as information is collected to help reduce hydrogeological uncertainties. 2) Significant uncertainty in the source of contaminant plumes detected via the FTF and HTF monitoring well networks exists. A better understanding of contaminant flow and transport processes at the TFFs through more extensive data analysis, modeling, and conceptual model development would provide additional confidence in modeling results. For example, geochemical data could be evaluated to better understand spatial and temporal correlations, evaluate trends, and identify sources. Additional particle tracking simulations could be conducted to help identify the source of contaminant plumes and validate observed versus modeled travel times. 3) PA modeling and groundwater monitoring at the TFFs could be better integrated. PA modeling could be used to determine key constituents and the types of field monitoring data, which would provide the most useful information to evaluate performance of, and detect early releases from, the TFFs. Data from the monitoring program could be used to evaluate model performance and help develop conceptual models for contaminant flow and transport. 4) The latest GSA groundwater model should be used to establish the monitoring well network, particularly to inform vertical placement of wells when such opportunities for additions or other changes to the monitoring well network exist in the future. 5) Additional work is needed to better understand the significance of the observed mobile fraction of Plutonium (Pu) in the natural system. 6) DOE should justify its Pu Kd averaging approach, or explicitly model the various oxidation states of key radionuclides such as Pu in future PA documentation, because explicitly modeling the more mobile fraction of Pu could lead to risk-significant dose significantly earlier in time compared to the current modeling approach.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to these recommendations is currently being performed. DOE will evaluate potential activities in this area when funding is available.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
MA 5 – Closure Cap Performance			
5.1 *	**Long-Term Hydraulic Performance**	General NRC Monitoring Activities [ML15238A761] NRC will monitor additional information to support the assumed long-term hydraulic conductivity of the foundation layer. In addition, NRC staff will monitor construction quality and settlement at the tank farms to help ensure assumed performance of the high density polyethylene/geosynthetic clay liner (HDPE/GCL) composite layer is not adversely impacted. NRC will monitor the quality assurance/quality control for closure cap construction and settlement data collected during tank farm operations as well as nearby facilities. NRC also will review relevant studies and tests related to HDPE/GCL performance. This factor can be closed after DOE's construction of the closure cap and demonstration of its hydraulic performance.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [FTF and HTF TERs – Long-Term Activity] In the FTF and HTF TERs, NRC staff recommended DOE provide additional model support for (i) the long-term hydraulic conductivity of the upper foundation layer and lateral drainage layer and (ii) the long-term erosion of the topsoil layer. (Duplicate, also applies to MF 5.2)	**Section 3.2.4 – To Be Determined Out-Year Testing** Work was begun by the University of Virginia in FY2017 related to degradation of the closure cap layers and resulting infiltration rates based on new field information and calculation methodologies. A Closure Cap degradation document (*Predicting Long-Term Percolation from the SDF Closure Cap*, SRRA107772-000009) was issued in FY2018. This document is being used as the basis for a planned update to the Tank Farm closure cap documents in FY2021.
		Recommendation [FTF and HTF TERs – Long-Term Activity] In the FTF and HTF TERs, NRC staff recommended DOE conduct a preliminary evaluation of erosion protection designs (e.g., assessment of an acceptable rock source, and the ability of an integrated drainage system to accommodate design features) prior to completing the final closure cap design. (Duplicate, also applies to MF 5.2)	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area closer to the time when final closure cap design is being developed. An update to the Tank Farm closure cap documents is planned for FY2021.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
5.2 *	**Long-Term Erosion Protection Design**	General NRC Monitoring Activities [ML15238A761] NRC staff will review and evaluate information pertaining to erosion processes of the vegetative and topsoil layers, including cover maintenance activities. If DOE performs simulations of the influence of clogging and ponding in the perimeter drainage structures on flow in the vadose zone, NRC will review results of these simulations to evaluate risk significance of the uncertainties in the long-term performance of the perimeter drainage structure. NRC will specifically monitor use of the engineered closure cap as a barrier to intrusion. This factor can be closed after DOE's construction of the closure cap and demonstration of its physical stability.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [ML15238A761] NRC staff recommends that DOE provide additional support for the long-term erosion of the topsoil layer and conduct a preliminary evaluation of erosion protection designs.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area closer to the time when final closure cap design is being developed. Work was begun by the University of Virginia in FY2017 related to degradation of the closure cap layers and resulting infiltration rates based on new field information and calculation methodologies. A Closure Cap degradation document (*Predicting Long-Term Percolation from the SDF Closure Cap*, SRRA107772-000009) was issued in FY2018. This document is being used as the basis for a planned update to the Tank Farm closure cap documents in FY2021.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		<u>Recommendation [FTF and HTF TERs – Long-Term Activity]</u> In the FTF and HTF TERs, NRC staff recommended DOE provide additional model support for (i) the long-term hydraulic conductivity of the upper foundation layer and lateral drainage layer and (ii) the long-term erosion of the topsoil layer. (Duplicate, also applies to MF 5.1)	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area closer to the time when final closure cap design is being developed. Work was begun by the University of Virginia in FY2017 related to degradation of the closure cap layers and resulting infiltration rates based on new field information and calculation methodologies. A Closure Cap degradation document (*Predicting Long-Term Percolation from the SDF Closure Cap*, SRRA107772-000009) was issued in FY2018. SRR-CWDA-2021-00043, *Erosion Analysis for the H-Tank Farm and F-Tank Farm Facilities*, has been issued building upon the FTF and HTF closure caps designs and the previously issued SDF analysis, SRR-CWDA-2021-00035, *Erosion Analysis for the Saltstone Disposal Facility*. The analysis utilizes the Revised Universal Soil Loss Equation (RUSLE) to determine the average annual rate of soil loss due to erosion. SRR-CWDA-2021-00076, *Evaluation of the Uncertainties Associated with the F-Area and H-Area Tank Farm Closure Caps and Long-Term Infiltration Rates* was issued in September 2021 and provides a range of infiltration rates for use in the PA models.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
5.2 *	**Long-Term Erosion Protection Design**	<u>Recommendation [FTF and HTF TERs – Long-Term Activity]</u> In the FTF and HTF TERs, NRC staff recommended DOE conduct a preliminary evaluation of erosion protection designs (e.g., assessment of an acceptable rock source, and the ability of an integrated drainage system to accommodate design features) prior to completing the final closure cap design. (Duplicate, also applies to MF 5.1)	**Section 3.2.4 – To Be Determined Out-Year Testing** In FY2021, a report will be prepared to capture a design for a Probable Maximum Precipitation (PMP) event — defined as the greatest amount of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of year — will ensure that the closure cap is capable to withstand these rare rain events. Data for the PMP event was developed for SRS in 1998 using rainfall measurements from 1949 up to 1995. WDA will update the PMP values for SRS cover systems based on an extended record of rainfall measurements and the new PMP event will be incorporated into PA erosion analyses. This new range of PMP values will be used to develop various erosion and infiltration variables to determine the influence of head-cut erosion and/or gullying, and the potential for channel formation or clog formation within the drainage layers, and appropriate riprap sizing. The earthen material that comprises the vegetative cover, topsoil, and upper backfill layer, which provide water storage and help to promote evapotranspiration, are subject to degradation via erosion. Previous investigations on these layers note the lack of a formal study on side-slope failure and down-slope creep of riprap. The riprap material for the erosion barrier, side slope, and toe of the side slope will be sized to optimize drainage capabilities in the upper layers. The erosion analysis will focus on soil erosion by overland flow mechanisms in addition to fluvial processes and gravitational erosion mechanisms from landslides, debris flow, and potential stability issues. Seismic analysis provided by SRNS will be incorporated into the final report.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
5.3	**Closure Cap Functions That Maintains Doses ALARA**	General NRC Monitoring Activities [ML15238A761] NRC staff will monitor DOE's disposal actions as they pertain to tank farm closure cap design, construction, and maintenance consistent with ALARA criteria. This monitoring area will remain open throughout DOE's development, construction, and completion of final closure caps, unless final design information indicates the MFs are not risk significant. When DOE develops final closure cap designs, NRC will revise the Monitoring Plan, as appropriate, to describe the monitoring activities relevant to the final designs. NRC staff will monitor DOE's development of specific designs for the closure caps and determine whether these designs are likely to significantly alter DOE and NRC conclusions regarding the conceptual design analyzed in the PA. Prior to any construction activities, NRC staff will review specifications for closure cap construction materials and quality assurance/quality control procedures for assuring these materials meet specifications. During construction, NRC staff should observe the placement of these materials and the quality control testing to assure the as-built closure cap will meet design specifications. NRC staff also will evaluate available data from similar covers built on the larger SRS site and other humid sites.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary. Work was begun by the University of Virginia in FY2017 related to degradation of the closure cap layers and resulting infiltration rates based on new field information and calculation methodologies. A Closure Cap degradation document (*Predicting Long-Term Percolation from the SDF Closure Cap*, SRRA107772-000009) was issued in FY2018. SRR-CWDA-2021-00043, *Erosion Analysis for the H-Tank Farm and F-Tank Farm Facilities*, has been issued building upon the FTF and HTF closure caps designs and the previously issued SDF analysis, SRR-CWDA-2021-00035, *Erosion Analysis for the Saltstone Disposal Facility*. The analysis utilizes RUSLE to determine the average annual rate of soil loss due to erosion. SRR-CWDA-2021-00076, *Evaluation of the Uncertainties Associated with the F-Area and H-Area Tank Farm Closure Caps and Long-Term Infiltration Rates* was issued in September 2021 and provides a range of infiltration rates for use in the PA models.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
MA 6 – Performance Assessment Maintenance			
6.1 #	**Scenario Analysis**	<u>General NRC Monitoring Activities [ML15238A761]</u> NRC staff will review PA revisions to evaluate adequacy of scenarios considered. Specifically, NRC staff will review the DOE methodology for identification, screening, and dispositioning of Features, Events, and Processes (FEPs) and the formation of scenarios considered in the PAs. NRC staff should verify FEPs identified by DOE, including all FEPs having a potential to influence compliance with performance objectives. NRC will also evaluate DOE's consideration of FEPs related to inadvertent intrusion. NRC staff should examine the technical basis for screening FEPs from further consideration in the PA. NRC staff also should examine DOE bases for the formation of scenarios considered in the PAs to determine whether they include all FEPs that have not been screened from further consideration. NRC will close this factor when DOE demonstrates that all risk-significant FEPs have been (or will be under another MF) adequately evaluated in PA documentation.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary. In late FY2020, as part of the HTF and future FTF PAs, a report entitled *Features, Events, and Processes for the F-Area and H-Area Tank Farm Performance Assessments* (SRR-CWDA-2020-00074) was initiated. The information presented within the report will inform an upcoming revision to the PAs. As part of a PA, models are used to simulate the release and transport of radionuclides and chemical contaminants from post-closure facilities and to estimate exposure and consequence to potential receptors. Due to the complex nature of PA models, a structured methodology is necessary to ensure that relevant components are adequately addressed during model development. Therefore, PA models must be developed within defined boundaries and with appropriate consideration of relevant (site-specific) FEPs, as derived from a complete set of FEPs. The FEPs report was issued in March 2021. This FEPs document is being used as a foundation for a revision of the HTF PA, scheduled to be completed in FY2023.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		<u>Recommendation [FTF and HTF TERs – Next PA Update]</u> In the FTF TER, NRC staff recommended DOE perform a systematic scenario analysis in which FEPs are identified, screened, and dispositioned using transparent and traceable documentation of the FEPs considered, the screening arguments, and how FEPs are implemented in the models to support future waste determination efforts. DOE performed a FEPs analysis to support the final waste determination for FTF. NRC staff reviewed the FEPs analysis and documented the results of its review in a TRR. (ML13277A063; see also Table B-1) In the HTF TER, similar to the findings in the TRR for FTF, NRC staff recommended that DOE include subject matter experts on the screening team in the specific engineering and scientific disciplines that are pertinent to the professional judgments being made. NRC staff noted that the screening documentation could be more transparent. The NRC staff also recommended that DOE improve the transparency and traceability of its implementation of FEPs to ensure comprehensive, accurate, and traceable links to clear descriptions of how included FEPs are actually implemented in the HTF PA.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** The next PA revision will incorporate the results of FEP analysis updates and any additional information relative to FEPs available at that time. In late FY2020, as part of the HTF and future FTF PAs, a report entitled *Features, Events, and Processes for the F-Area and H-Area Tank Farm Performance Assessments* (SRR-CWDA-2020-00074), was initiated. The information presented within the report will inform an upcoming revision to the PAs. As part of a PA, models are used to simulate the release and transport of radionuclides and chemical contaminants from post-closure facilities and to estimate exposure and consequence to potential receptors. Due to the complex nature of PA models, a structured methodology is necessary to ensure that relevant components are adequately addressed during model development. Therefore, PA models must be developed within defined boundaries and with appropriate consideration of relevant (site-specific) FEPs, as derived from a complete set of FEPs. The FEPs report was issued in March 2021. This FEPs document is being used as a foundation for a revision of the HTF PA scheduled to be completed in FY2023.

MF[1] #	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
6.1 #	**Scenario Analysis**	Recommendation [ML13277A063] In the Review of FEPs TRR, the NRC staff's review of the DOE screening methodology finds that DOE properly focused on likelihood and impact as criteria for screening, but identifies several concerns with DOE's screening of FEPs, including the membership of the FEPs screening team and the documentation of each subject matter expert's basis for judgment. The NRC staff's review also identifies questions with the screening process for selected FEPs. Finally, the NRC staff's review finds that DOE's crosswalk of included FEPs has the potential to enhance transparency and traceability, while NRC staff identifies multiple examples where transparency and traceability are reduced, which results in a loss of confidence that all relevant FEPs are adequately considered in the FTF Performance Assessment.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** The next PA revision will incorporate the results of FEP analysis updates and any additional information relative to FEPs available at that time. In late FY2020, as part of the HTF and future FTF PAs, a report entitled *Features, Events, and Processes for the F-Area and H-Area Tank Farm Performance Assessments* (SRR-CWDA-2020-00074) was initiated. The information presented within the report will inform an upcoming revision to the PAs. As part of a PA, models are used to simulate the release and transport of radionuclides and chemical contaminants from post-closure facilities and to estimate exposure and consequence to potential receptors. Due to the complex nature of PA models, a structured methodology is necessary to ensure that relevant components are adequately addressed during model development. Therefore, PA models must be developed within defined boundaries and with appropriate consideration of relevant (site-specific) FEPs, as derived from a complete set of FEPs. The FEPs report was issued in March 2021 This FEPs document is being used as a foundation for a revision of the HTF PA scheduled to be completed in FY2023.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
6.2 #	**Model and Parameter Support**	General NRC Monitoring Activities [ML15238A761] NRC staff will review DOE's PA revisions to evaluate the selection of models and justification of parameters. Specifically, NRC staff will examine information DOE generates, including experimental and site characterization data and information from literature, to support model selection and justify parameters. NRC staff also will review DOE methods to characterize data and model uncertainty and propagate the uncertainty through the PAs. NRC staff will use a graded approach to focus on aspects of most importance to demonstrating compliance with the performance objectives. This factor can be closed when DOE provides sufficient information to support risk-significant models and/or model parameters listed in Appendix A of the NRC Monitoring Plan related to MF 6.2.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [FTF and HTF TERs – Next PA Update (Long-Term)] In the FTF and HTF TERs, NRC staff recommended DOE continue to evaluate significance of calcareous zone dissolution on FTF flow and transport, including conduct of tracer studies and field mapping of seepage locations along Upper Three Runs Creek. Site-specific K_ds may also need to be developed for the Upper Three Runs Aquifer-Lower Zone. (Duplicate, also applies to MF 4.2)	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.
		Recommendation [FTF TER – Next PA Update] As documented in the FTF TER, DOE will explain the differences in the inventory lists for tanks versus ancillary equipment in future PA documentation. DOE made this commitment in an NRC/DOE teleconference on the FTF RAIs held on June 28, 2011.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** The next PA revision will explain the differences in the inventory lists for tanks versus ancillary equipment. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will incorporate additional ancillary equipment information.
6.2 #	**Model and Parameter Support**	Recommendation [HTF TER – Next PA Update] In the HTF TER, NRC staff repeated an FTF TRR (ML13273A299) comment indicating that DOE should provide a stronger technical basis for the projected inventory multipliers used in the probabilistic analysis. Given the significant fraction of the Tank 5F and 6F radionuclide inventories that were underestimated, it was not clear to the NRC staff that the inventory multipliers should be biased at 100 times less and only 10 times higher. NRC staff went on to state that DOE should analyze trends in projections versus actual inventories by radionuclide to update the multiplier assumptions for the probabilistic analysis.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** The next PA revision will explain the differences in the inventory lists for tanks versus ancillary equipment. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023. This PA will incorporate additional ancillary equipment information.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		Recommendation [FTF and HTF TERs – Long-Term Activity with need contingent on other factors] In the FTF TER, NRC staff recommended DOE consider uncertainty in steel liner performance, including more aggressive service conditions and corrosion mechanisms than assumed in the PA, as well as a patch model for waste release, if deemed to be risk significant. In the HTF TER, similar to previous FTF consultative comments, NRC staff questioned DOE's assumed time-invarient oxygen diffusivity of 10^{-6} cm^2/s given expected degradation of concrete vaults over time and potential presence of bypassing pathways through the system.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.
		Recommendation [FTF and HTF TERs – Intermediate-Term] In the FTF TER, NRC staff recommended DOE obtain additional support for probabilistic parameter distributions, including solubility limiting phases, cement K_ds (based on sediment variability), chemical transition times, basemat bypass, and configuration probability. In the HTF TER, NRC staff recommended DOE incorporate in probability distributions "pessimistic" values that exceed base case solubility limits and that DOE obtain support for the solubility and probability assignments	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.
		Recommendation [FTF TER – Long-Term] In FTF TER, NRC staff recommended DOE acquire FTF specific data to support material property assignments, including hydraulic conductivity, MCCs, and K_{ds}.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.
		Recommendation [HTF TER – Prior to final closure] In the HTF TER, NRC staff recommended DOE provide additional model support to understand the effects of perimeter infiltration and focused infiltration in the drainage valley between the East and West Caps on near-field and far-field groundwater flow patterns and radionuclide transport. The analysis should include appropriate refinement of the grid cells receiving recharge and a well-supported value for the diversion of flow.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
6.2 #	**Model and Parameter Support**	<u>Recommendation [FTF and HTF TERs – Long-Term]</u> In the FTF TER, NRC staff indicated that it would monitor DOE's efforts to study the impact of cement leachate on radionuclide mobility. NRC reviewed cement leachate factors utilized in the HTF PA and listed several technical concerns in the HTF TER, most notably the lack of site-specific information and basis for some of the factors. In the Tank 16H Special Analysis TRR (ML15301A710), the NRC indicated that it needs DOE to provide additional information to support its selection of the iodine distribution coefficient.	The geochemical data package (SRNL-STI-2009-00473) used to identify a justified set of geochemical data inputs for the various transport modeling at SRS was updated in July 2016 (it was last revised in March 2010). This update incorporated the numerous experiments and geochemical measurements have been conducted since 2010, resulting in new recommended input values for modeling. The revised geochemical data package integrates recent documented geochemical results, including radionuclide K_d values, solubility values, and cementitious impact factors, and includes a critical evaluation of these values with respect to existing values to assess potential impacts. Distribution Coefficient studies measured the K_ds for various species under oxidizing and reducing conditions in actual subsurface sediments retrieved at SRS (actual SDF soils used). This will be applicable to FTF and HTF modeling as well. **Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.
		<u>Recommendation [FTF TER – Next PA Update]</u> In the FTF TER, NRC staff recommended DOE address the significant amount of dispersion evident in its near-field and far-field PORFLOW models, including evaluation of the need for mesh refinement to ensure that contaminant plumes are not artificially dispersed over the volume of the cells in the far-field model. Nonphysical dispersion may be attributable to large changes in adjacent element size and large differences in element sizes between the vadose zone and far-field models. DOE should evaluate the adequacy of the time discretization of the model(s) for swiftly moving constituents such as Tc-99.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** This recommendation will be considered in the next PA revision. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
6.2 #	**Model and Parameter Support**	Recommendation [FTF TER – Next PA Update] In the FTF TER, NRC staff recommended DOE evaluate the appropriateness of the assumed level of physical dispersion in the FTF model (i.e., dispersivities).	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** This recommendation will be considered in the next PA revision. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).
		Recommendation [FTF and HTF TERs – Next PA Update] In the FTF TER, NRC staff recommended DOE provide greater transparency and traceability of far-field model calibration, including consideration of more extensive calibration focused strictly on the area of interest. In the HTF TER, NRC staff made recommendations similar to those in the FTF TER, but more strongly indicated that the model may not be sufficiently calibrated local to HTF, and recommended specifically that DOE study uncertainty in calibration targets and provide support for hydraulic conductivity assignments (K_h was artificially lowered in elliptical regions during the calibration process), including consideration of conducting pumping tests to provide support for the model and model parameters.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** This recommendation will be considered in the next PA revision. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).
		Recommendation [FTF and HTF TERs – Next PA Update] NRC staff indicated in the FTF TER that Gordon Aquifer concentrations should not be used to demonstrate compliance with the performance objectives if higher concentrations are observed in another aquifer that can support groundwater-dependent pathways. These statements were repeated in the HTF TER.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** This recommendation will be considered in the next PA revision. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		<u>Recommendation [HTF TER– Next PA Update]</u> In the HTF TER, NRC staff recommended DOE evaluate the compliance boundary and loading of the contaminant source cells (i.e., tank cells in the far-field model) to ensure that the dose estimates are not significantly underestimated.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** This recommendation will be considered in the next PA revision. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).
		<u>Recommendation [FTF and HTF TERs – Next PA Update]</u> In the FTF TER, NRC staff recommended DOE evaluate plant transfer factor uncertainty in future updates to its PA. DOE should consider the appropriateness of excluding common vegetable types in its assignment of plant transfer factors (DOE only considers root vegetable data) based on production data rather than household data that might be more appropriate for a resident gardener. In the HTF TER, NRC staff indicated that DOE addressed the use of root vegetable transfer factors; however, uncertainty in plant transfer factors was not addressed.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** A review of the current HTF Base Case conceptual model inputs was performed in 2016 to identify inputs requiring revision (SRR-CWDA-2015-00158), including a review of the dose calculator inputs (SRR-CWDA-2013-00058). This recommendation will be considered further in the next PA revision.
6.2 #	**Model and Parameter Support**	<u>Recommendation [FTF and HTF TERs – Next PA Update]</u> In the FTF TER, NRC staff recommended DOE evaluate appropriateness of assumptions related to drinking water consumption in future updates to its PA, such as partitioning consumption rates based on use of both bottled and community water. Biosphere parameters should be reasonably conservative and reflect the behavior of the average member of the critical group. NRC staff reiterated the FTF TER recommendation in the HTF TER.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** A review of the current HTF Base Case conceptual model inputs was performed in 2016 to identify inputs requiring revision (SRR-CWDA-2015-00158), including a review of the dose calculator inputs (SRR-CWDA-2013-00058). This recommendation will be considered further in the next PA revision.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		Recommendation [FTF TER – Next PA Update] In the FTF TER, NRC staff indicated that DOE better assess uncertainty in the timing of peak dose, given the inherent level of uncertainty associated with predicting doses over tens of thousands of years. Additionally, NRC staff indicated that key parameters, such as steel liner failure times and chemical transition times, may be overly constrained.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** This recommendation will be considered in the next PA revision. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).
		Recommendation [FTF and HTF TERs – Next PA Update] In the FTF TER, NRC staff recommended DOE provide additional support for the likelihood of its base case or expected Case A. In the HTF TER, NRC staff went on to state the NRC staff thinks that additional information is needed to support the compliance case, Case A. Ideally, supporting information would be in the form of additional experimental or field data, natural analogs, peer review, expert elicitation, and other forms of model support. NRC staff stated that without this additional model support, it would be difficult to argue the relative likelihood of the base case compared to alternative cases. Additionally, NRC staff indicated that the uncertainty analysis results not be used to demonstrate compliance with the performance objectives because (i) there is limited support for the base case and (ii) there is limited support for the assignment of the likelihood of alternative cases and consequently, the averaging of alternative cases in the "All Cases" model. NRC staff recommended DOE present the results of alternative cases individually and provide qualitative information regarding the likelihood of alternative cases. Finally, NRC staff indicated that DOE should use the results of its probabilistic analysis to inform areas where additional model support is needed.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** This recommendation will be considered in the next PA revision. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).
6.2 #	**Model and Parameter Support**	Recommendation [FTF and HTF TERs – Next PA Update] In the FTF TER, NRC staff recommended DOE improve transparency and documentation of its benchmarking process. NRC recommends DOE apply a more methodical and systematic approach to the benchmarking process in future updates to its PA. In the HTF TER, NRC staff also noted that DOE could improve its benchmarking process.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** The HTF benchmarking process was detailed in the most recent HTF Goldsim model update (SRR-CWDA-2014-00060), with improved transparency and documentation. This recommendation will be considered further in the next PA revision.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		Recommendation [HTF TER – Next PA Update] In the HTF TER, NRC staff noted that due to significant differences between the GoldSim and PORFLOW modeling results, the NRC staff plans to continue to evaluate the PORFLOW modeling assumptions and results for the compliance case (Case A) during the monitoring period to provide confidence that the timing of peak dose is not artificially delayed. This applies to the inadvertent intruder analysis.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** This recommendation will be considered in the next PA revision. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).
		Recommendation [FTF TER – Next PA Update] In the FTF TER, NRC staff suggested that DOE consider consistency between the plotting interval and calculation time step size. DOE should also correct errors in its probabilistic assessment (e.g., porosity of 1E-20).	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** This recommendation will be considered in the next PA revision. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).
		Recommendation [FTF TER – Next PA Update] NRC made a general comment that DOE could improve its parameter distribution assignments, hybrid modeling approach, benchmarking process, and evaluation and interpretation of probabilistic modeling results. With respect to parameter distributions, NRC included several items in its open items database (see Appendix B in ML12212A192), most of which are listed in other recommendations, with the exception of probability of basemat bypass flow.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** This recommendation will be considered in the next PA revision. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
		Recommendation [ML16277A060] As a result of its review of the revised dose methodology for Liquid Waste PAs (SRR-CWDA-2013-00058, Revision 1), NRC identified a number of items that should be addressed in future HTF and FTF PAs revisions. The complete listing of items is documented in the Dose Calculation Methodology TRR.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** These items will be considered in the next PA revision. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).
		Recommendation [ML19277H550] DOE should consider the following in future updates to the GSA PORFLOW model to increase accuracy and reduce uncertainty in contaminant flow and transport modeling: • More extensive calibration in the areas of interest for waste disposal activities, including FTF and HTF, and evaluation of calibration statistics local to these areas. • Hydraulic conductivity measurements near HTF and other areas where additional data collection is important to model calibration to reduce uncertainty in calibrated parameters. • Evaluation of more recent baseflow measurements for model validation consistent with the time over which water level measurements were averaged to develop calibration targets, and consideration of uncertainty in baseflow to Upper Three Runs Creek when evaluating model performance • Evaluation of the sensitivity of the results to changes in recharge, and other parameters. • Sensitivity analysis to identify observations and parameters most important to the results where additional data collection could be conducted to reduce model uncertainty. • More extensive analysis of the impact of flow model and parameter uncertainty on the results of the PAs.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** These items will be considered in the next PA revision. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
6.3 #	**FTF PA Revisions (Additional Considerations)**	General NRC Monitoring Activities [ML15238A761] NRC staff will review the revised PAs and issue a TER documenting the results of its review. NRC staff will pay special attention to supporting documentation generated since the last PA revision, including results of experiments, analog studies, models, and peer reviews conducted to support key Monitoring Areas listed in the NRC Monitoring Plan. NRC will evaluate any revisions to the tank farm PAs to ensure inadvertent intrusion into tank farm components were properly evaluated in the 10 CFR 61.42 analyses. This MF can be closed when NRC staff concludes that DOE has adequately evaluated FEPs and scenarios related to inadvertent intrusion in its PA documentation and that its LW PA Maintenance Program is sufficient to evaluate new and significant information related to 10 CFR 61.41 and 10 CFR 61.42 in the future.	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** Future revisions to the FTF PA will be provided to NRC for review in support of NRC's monitoring role. **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
6.3 #	**FTF PA Revisions (Additional Considerations)**	Recommendation [ML18242A259] In the Tank 18F Waste Release Testing TRR, NRC staff concluded that additional waste release testing and updated geochemical modeling are needed for NRC staff to have confidence in the PA results. The NRC staff offered the following additional conclusions and comments related to waste release testing and PA modeling. • DOE should consider a larger range of uncertainty in key radionuclide solubility due to experimental limitations (e.g., substantial metal losses of uranium during leach testing which compromised the utility of the uranium data collected from the experiments and apparent lack of ability to achieve equilibrium conditions particularly for Pu and Tc). • DOE should perform probabilistic or multi-variate sensitivity analysis considering uncertainty in performance of multiple barriers including scenarios that evaluate basemat bypass, early hydraulic failure due to water table rise or preferential flow through the system, and consider the impact of higher mobility forms of Pu in the natural system. • DOE should explain differences in PORFLOW and GoldSim modeling results (e.g., Pu peak doses of around 5 mSv/yr (500 mrem/yr) in the Tanks 18/19 SA (SRR-CWDA-2010-00124) versus 7 mSv/yr (700 mrem/yr) in SRR-CWDA-2016-00086). • DOE should evaluate the impact of the early, high concentration release of Pu or justify why the rinse sample results are not applicable to alternative conceptual models involving water table rise or preferential flow through the system. • DOE should continue to study and develop models to account for higher mobility forms of Pu in the natural system including models that consider two fractions of Pu (relatively high mobility and low mobility forms) as well as the potential for oxidation and reduction reactions affecting the mobility of Pu in the subsurface along the flow paths away from the tank to the 1 m and 100 m compliance points. • DOE should evaluate the impact of transport of key radionuclides from the waste zone up into the tank grout, and if found to be risk-significant, provide additional support for the transport mechanism(s).	**Section 3.4.1 – Prepare Out-Year FTF PA Revisions** Future revisions to the FTF PA will be provided to NRC for review in support of NRC's monitoring role. **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** Testing of actual waste (i.e., Tank 18 and Tank 12 residuals) was performed in FY2016 and FY2018. The solubilities of I, Pu, Np, U, and Tc were tested under simulated waste tank chemistry conditions using Tank 18 and Tank 12 residual waste samples. The NRC conclusions and comments relating to waste release testing were incorporated into the Tank 12 testing to the extent practical and will be addressed further in any future testing. A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure).

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
MA 7 – Protection of Individuals During Operations			
7.1 ±	Protection of Workers During Operations	General NRC Monitoring Activities [ML15238A761] NRC staff should review, on at least an annual basis, DOE reports and records that are related to dose during waste disposal operations to assess whether doses are within the limits found in 10 CFR Part 20 and are ALARA. NRC staff should periodically confirm programs and policies presented in the waste determination (DOE/SRS-WD-2012-001) continue to be in effect during the operational period. In particular, NRC staff should verify personnel involved in waste disposal operations are provided dosimetry and are familiar with requirements of the radiation protection program. NRC will leverage staff in its Region I office with experience in radiation protection inspections to support onsite observations in this area. This factor will be closed at the end of the assumed 100-year institutional control period or after operational doses are expected to be reduced to non-risk-significant levels following tank closure activities.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [FTF and HTF TERs – Ongoing] No specific recommendations identified, NRC concluded DOE can demonstrate compliance with protection of individuals during operations and DOE provides adequate information that individuals will be protected during operations.	**Section – N/A**
7.2 ±	Air Monitoring	General NRC Monitoring Activities [ML15238A761] NRC will review air monitoring data to determine whether activity released in the air, as a result of tank farm disposal activities, could cause a MOP located at the SRS boundary to receive a dose of greater than 10 mrem/yr through the air pathway. NRC staff should periodically confirm the air monitoring program continues to adequately assess the risk of tank farm operations. As part of this review, NRC staff should evaluate whether sampling locations and sampling methodologies are adequate to assess airborne emissions from the tank farms or rely on independent verification from the SCDHEC. NRC staff expects the dose from airborne emissions to be small. If the airborne emissions dose becomes more risk significant, then NRC staff will need to evaluate the air monitoring program in greater detail. This factor will be closed at the end of the assumed 100-year institutional control period or when operational doses are expected to be reduced to non-risk-significant levels following tank closure activities.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [FTF and HTF TERs – Ongoing] No specific recommendations identified, NRC concluded DOE can demonstrate compliance with protection of individuals during operations and DOE provides adequate information that individuals will be protected during operations.	**Section – N/A**

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
7.3 ±	ALARA	General NRC Monitoring Activities [ML15238A761] NRC staff's monitoring of ALARA under 10 CFR 61.43 will be carried out through monitoring of the Radiation Protection Program and related activities. NRC staff should periodically (or at the appropriate time relevant to each measure) review documents associated with the following measures for ensuring ALARA: (i) a documented Radiation Protection Program; (ii) a Documented Safety Analysis; (iii) radiological design for protection of occupational workers and the public; (iv) regulatory and contractual enforcement mechanisms; (v) access controls, training, and dosimetry; and (vi) occupational radiation exposure history. These measures are described in the waste determination or basis documents (DOE/SRS-WD-2012-001 and DOE/SRS-WD-2014-001). This factor will be closed at the end of an assumed 100-year institutional control period or when operational doses are expected to be reduced to non-risk-significant levels following tank closure activities.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary. **Section 3.4.2 – Prepare Out-Year HTF PA Revisions** A revision of the HTF PA was initiated in FY2020 and is scheduled to be completed in FY2023 (in support of Tank 15 operational closure, the next scheduled HTF tank closure). The new PA will contain additional ALARA analyses.
		No specific NRC recommendations identified.	**Section – N/A**

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
MA 8 – Site Stability			
8.1 #	**Settlement**	General NRC Monitoring Activities [ML15238A761] Technical reviews and onsite observations of settlement will be conducted by the NRC staff to assess compliance with 10 CFR 61.44. Reviews will focus on (i) settlement data collected during closure operations of the tank farms, (ii) settlement data collected from analogous sites, and (iii) updated settlement modeling investigations. NRC Technical reviews related to the risk significance of calcareous zones will be conducted to assess compliance with 10 CFR 61.44. Reviews will focus on (i) processes that have resulted in the formation of sinks at the SRS and specifically at the tank farms at the General Separations Area, (ii) the potential for these processes to affect site stability throughout the performance period, and (iii) the potential dose consequences from subsidence related to dissolution of calcareous sediment. DOE stated that it will consider static-loading-induced settlement, seismically induced liquefaction and subsequent settlement, and seismically induced slope instability in the final design of the closure cap. NRC staff will review DOE's consideration of these processes as information is made available. To assess compliance with 10 CFR 61.44, NRC staff will visually observe the facility for obvious signs of degeneration of the facility. For example, evidence of ponded water on the cap surface may be a sign of differential settlement. Surface fractures may be evidence of underlying displacement. NRC staff also may plan site visits to observe the facility after severe weather events (e.g., storms, tornados) to ascertain how well the facility can withstand these events. NRC staff should also discuss any maintenance activities that are performed at the disposal facility (e.g., repairs to engineered surface barriers) with SCDHEC. This monitoring activity is expected to remain open indefinitely.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [ML15238A761] NRC staff expects DOE to inform it of changes to features in the immediate area that might affect site stability. These changes may include (i) vegetation denudation at the surface due to fires or storms; (ii) erosion features caused by extreme precipitation events or long-term processes; or (iii) visible surface changes due to significant biotic intrusion, earthquakes, or other geological processes.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [FTF and HTF TERs – Intermediate-Term] In the FTF and HTF TERs, NRC staff recommended DOE continue to evaluate closure cap settlement and stability, including consideration of (i) increased overburden from the tank grout and closure cap on settlement and (ii) potential for subsidence associated with ongoing dissolution of calcareous sediment in the Santee Formation.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
8.1 #	**Settlement**	Recommendation [FTF and HTF TERs – Intermediate-Term] In the FTF and HTF TERs, NRC staff concluded that assumed long-term compressive strength of the grout monolith is not adequately supported and may be optimistic based on observations of vault cracks, discussed in TER Section 4.2.9.1 (ML112371715). While cracking of the vault concrete and tank grout is not expected to result in significant structural tank collapse, the integrity of the vault concrete and tank grout is important to steel liner performance and waste release.	**Section 3.2.4 – To Be Determined Out-Year Testing** No work related to this recommendation is currently being performed. DOE will evaluate potential activities in this area when funding is available.
TER Recommendations Only			
N/A #	**N/A**	Recommendation [FTF and HTF TERs] In the FTF TER, NRC staff recommended DOE specifically consider and evaluate HRR removal in its technology selection and effectiveness evaluations consistent with the NDAA. In the HTF TER, NRC staff recommended DOE provide more emphasis on removal of HRR in its technology selection process and provide a clear linkage between the HTF PA results, including information regarding the long-term risks associated with the HTF facility, and the demonstration that HRRs have been removed to the MEP per Criterion 2.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [FTF and HTF TERs] In the FTF TER, NRC staff recommended DOE continuously evaluate new technologies, participate in technology exchanges, and not default to previous evaluations for technology selection. In the HTF TER, NRC staff recommended DOE continue evaluating new technologies for future use as tank closure progresses, especially if previously used technologies are no longer practical to use. Furthermore, for those tanks in which conditions are dissimilar (e.g., Tank 48), the NRC staff would expect DOE to reevaluate technologies as opposed to relying on previously performed technology evaluations. The NRC staff also recommended DOE continue its efforts to participate in technology exchanges so that it can stay informed of potential new cleaning technologies. New technologies or improvements to current technologies should be fully considered in the selection process for future tank cleaning. DOE should try to optimize operational parameters for existing technologies and technologies to be developed in the future to ensure that removal of HRRs is not hampered or made more difficult because of poor planning or lack of investment in waste characterization.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [HTF TER] In the HTF TER, NRC staff indicated that DOE's approach to optimization of technology through sampling and monitoring during cleaning should be documented. The NRC staff also recommended DOE consider how it might better assess and optimize the effectiveness of selected technologies (e.g., obtain better baseline information).	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
N/A \#	N/A	Recommendation [HTF TER] In the HTF TER, NRC staff noted that, although the results from mapping contain uncertainties, performing the tank mapping methodology during multiple cleaning phases will provide additional information on the effectiveness of specific technologies. As such, the NRC staff recommended DOE perform the tank mapping consistently and as frequently as practical throughout the cleaning process.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [HTF TER] In the HTF TER, NRC staff recommended DOE should obtain better baseline information from which it could better assess oxalic acid effectiveness.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [HTF TER] In the HTF TER, NRC staff supported DOE's efforts to re-evaluate oxalic acid cleaning against downstream impacts to determine the future role of oxalic acid cleaning, as opposed to relying on previous evaluations of oxalic acid technology.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [HTF TER] In the HTF TER, NRC staff noted that each final characterization should be accompanied by a Technical Task Request and a Quality Assurance and Quality Control Plan.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [HTF TER] In the HTF TER, NRC staff indicated that to help overcome the limitations encountered with cleaning Tanks 5 and 6 for the cleaning of future tanks, the NRC staff recommends that DOE evaluate the effectiveness of the submersible mixer pumps with respect to bulk sludge removal versus residual heel removal. The NRC staff also recommends that DOE compare the efficiency and effectiveness of the submersible mixer pump to previously used technologies or readily available technologies.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [HTF TER] In the HTF TER, NRC staff noted that if oxalic acid is not available to be used for cleaning future tanks and a technology with similar proven effectiveness is not used as an alternative, DOE may need to reconsider the validity of assuming that the cooling coil and tank wall surface inventory is negligible.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [HTF TER] In the HTF TER, NRC staff recommended DOE should develop separate site-specific factors for risk-significant annular waste versus tank waste sources in the future. Annular and tank sources would then be separately compared to adjusted waste classification concentration limits to determine the classification of HTF components.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
N/A #	N/A	Recommendation [HTF TER] In the FTF TER, NRC recommended DOE more fully evaluate or document its consideration of alternatives to additional HRR removal, including (i) modifications to existing technologies (e.g., upgraded Mantis or enhanced chemical cleaning); (ii) modification to tank system components (e.g., installation of new risers or removal of equipment from existing risers); (iii) sequential cleaning (e.g., sequencing of mechanical and chemical technologies in Tank 18F); and (iv) alternative cleaning technologies (e.g., alternative reagents to leach HRRs out of residual heels).	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [HTF TER] In the FTF TER, NRC recommended DOE better quantify technology effectiveness. For example, DOE should better characterize waste and residual tank inventory prior to deployment of cleaning technologies to better assess effectiveness. In the HTF TER, NRC staff recommended, to the extent practical, DOE consider obtaining data on HRR inventories prior to and following major cleaning campaigns (e.g., before and after treatment of Type I tanks with oxalic acid) to provide effectiveness measurements for chemical cleaning and mechanical feed-and-bleed.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.
		Recommendation [HTF TER] In the HTF TER, NRC staff noted that given the potential risk significance of the waste remaining in the Tank 16 annulus, the NRC staff recommends that DOE more fully evaluate the practicality of additional radionuclide removal from the Tank 16H annulus versus the long-term benefit of reduced risk considering uncertainty in the releases of radionuclides from the Tank 16 annulus. While DOE's HTF PA demonstrates that the risk from waste remaining in the annulus is reasonable, alternative waste release models may lead to higher risk estimates. NRC staff went on to note that at this stage, DOE has provided a rough order of magnitude cost-benefit analysis of additional HRR removal from the Tank 16H annulus to the NRC staff (U-ESR-H-00107). The NRC staff acknowledges that DOE is still preparing the final removal report and recommends that DOE provide a more detailed cost benefit analysis to support the Criterion 2 demonstration for Tank 16H in the final removal report. NRC staff indicated that it would like to obtain a copy of the final removal report when it is complete.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary. An SA specific to the HTF Type I and Type II Tanks was prepared and issued in August 2016. [SRR-CWDA-2016-00078] This SA updated the radiological and chemical inventories for the HTF Type I and Type II tanks, incorporating lessons learned from the final waste tank characterization results to date.
		Recommendation [HTF TER] In the HTF TER, NRC staff noted that DOE improved the operating plan for Tank 12H by requiring the availability of the transfer receipt tank to be confirmed prior to acid addition. The NRC staff encourages DOE to continue to analyze the lessons learned from these prior cleaning campaigns to prevent limitations of the liquid waste system from unexpectedly influencing the effectiveness of future cleaning campaigns.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.

MF[1]	Factor	NRC Monitoring Activities[2] / Recommendation(s)	Related PA Maintenance Activities as Described in this Document
N/A \#	N/A	Recommendation [FTF and HTF TERs] In the FTF TER, the NRC staff recommended DOE include more specificity in its process for determining HRRs are removed to the MEP, including (i) defining the term end states versus removal goals and (ii) clarifying when conditions are sufficiently similar to warrant use of a previous technology evaluation. NRC staff also recommended DOE continue to better define the documented process to be used to demonstrate removal to the MEP to ensure consistent (nonarbitrary) application of the criterion. In the HTF TER, NRC staff noted that Appendix B of the draft basis for the waste determination for HTF (DOE/SRS-WD-2013-001) outlines a general approach to demonstrate that the HRRs will be removed to the MEP. However, DOE could still improve the standardization of metrics for determining that the anticipated end states have been reached.	**Section 3.3.3 – Provide General Technical Support on Tank Farm PA Issues** Ongoing support of NRC's monitoring role will be provided as necessary.

1 Monitoring Factors are color-coded based on NRC-determined prioritizations in NRC Monitoring Plan. [ML15328A761] Symbols are included for clarity.

§	**High Priority Recommended**	*	**Lower Priority**
‡	**High Priority Dependent or More Difficult**	±	**Not Prioritized – Periodic**
†	**Medium Priority**	#	**Not Prioritized – Not Periodic**

2 Recommendations noted by "[FTF and HTF TER – timing]" are from the NRC TERs for FTF [ML112371715] and HTF [ML14094A496]. Other recommendations are from the FTF and HTF Monitoring Plan Table A-1 [ML15238A761], which replaced the FTF Monitoring Plan [ML12212A192], or from other various NRC TRRs. [ML12272A082, ML12272A124, ML13273A299, ML13085A291, ML13269A365, ML13277A063, ML13100A230, ML13080A401, ML14342A784, ML15301A710, ML15301A830, ML16196A179, ML16231A444, ML16277A060, ML17277B235, ML18051B153, ML18242A259, ML19277H550, ML19280A059, ML19298A092]