Technical Evaluation Report

For the 2020 Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site, South Carolina

Final Report

U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety
and Safeguards
Washington, DC 20555-0001

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ABBREVIATIONS AND ACRONYMS

ITEM	MEANING
ADAMS	NRC's Agencywide Documents Access and Management System
ALARA	As Low As Reasonably Achievable
Bq	Becquerel
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
ES	Executive Summary
FEPs	Features, Events, and Processes
FMB	Fourmile Branch
ft	Feet
GCL	Geosynthetic Clay Layer
GCU	Gordon Confining Unit
GSA	General Separations Area
HDPE	High Density Polyethylene
I	Iodine
K_d	Distribution Coefficient
km	Kilometer
LAZ	Lower Aquifer Zone
LLDL	Lower Lateral Drainage Layer
MA	Monitoring Area
MF	Monitoring Factor
mi	Mile
mrem	Millirem
mSv	Millisievert
NDAA	Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005
NRC	U.S. Nuclear Regulatory Commission
PA	Performance Assessment
pC	Picocurie
OOV	Onsite Observation Visit
PMR	Periodic Monitoring Report
PO	Performance Objective
QA	Quality Assurance
QC	Quality Control
RAI	Request for Additional Information
Rn	Radon
RPP	Radiation Protection Program
RSI	Request for Supplemental Information
S	Second
SCDHEC	South Carolina Department of Health and Environmental Control
SDF	Saltstone Disposal Facility
SDS	Saltstone Disposal Structure
SDU	Saltstone Disposal Unit
SPF	Saltstone Production Facility
SRS	Savannah River Site
SWPF	Salt Waste Processing Facility
Tc	Technetium
TCCZ	Tan Clay Confining Zone
TER	Technical Evaluation Report

ITEM	MEANING
TRR	Technical Review Report
UAZ	Upper Aquifer Zone
ULDL	Upper Lateral Drainage Layer
UTR	Upper Three Runs
UTRA	Upper Three Runs Aquifer
UTRA-LAZ	Upper Three Runs Aquifer-Lower Aquifer Zone
UTRA-UAZ	Upper Three Runs Aquifer-Upper Aquifer Zone
WIR	Waste Incidental to Reprocessing
Yr	Year

EXECUTIVE SUMMARY

By letter dated July 6, 2020, the U.S. Department of Energy (DOE) submitted the 2020 DOE Savannah River Site (SRS) Saltstone Disposal Facility (SDF) Performance Assessment (PA) to the U.S. Nuclear Regulatory Commission (NRC) (available in the NRC's Agencywide Documents Access and Management System [ADAMS] under Package Accession No. ML20190A055). By letter dated July 10, 2020 (ML20148M201), the NRC acknowledged receipt of that DOE Submittal. By letter dated October 5, 2020 (ML20254A003), the NRC provided a preliminary review of the DOE Submittal along with the NRC Request for Supplemental Information (RSI) Comments. The DOE provided four sets of Responses to the NRC RSI Comments in submittals dated January 18, 2020 (ML21159A059), March 30, 2021 (ML21089A119), June 8, 2021 (ML21160A059), and August 3, 2021 (ML21217A076). The NRC issued four sets of Request for Additional Information (RAI) Questions dated March 1, 2021 (ML21062A214), June 3, 2021 (ML21133A293, December 14, 2021 (ML21341A543) and February 9, 2022 (ML22026A391). The DOE provided Final Responses to the NRC sets of RAI Questions in July 2021 (ML21201A247), November 2021 (ML21321A087), March 2022 (ML22083A049, and April 2022 (ML22118A297).

According to the DOE, the SDF PA was prepared to support the continued operations and eventual final closure of the SDF at the SRS, and it was developed consistent with the requirements of the DOE Order 435.1, Change 1, *Radioactive Waste Management*, and the DOE Standard, DOE-STD-5002-2017, *Disposal Authorization Statement and Tank Closure Documentation*. The SDF is where the disposal structures are located. The SDF, operationally, consists of the Saltstone Production Facility (SPF), where the final mixing of the liquid radioactive waste and dry cement occurs, and the current and future disposal structures (i.e., Saltstone Disposal Structure (SDS) 1, SDS 2A, SDS 2B, SDS 3A, SDS 3B, SDS 4, SDS 5A, SDS 5B, SDS 6 through SDS 12).

According to the DOE, the three purposes of the 2020 SDF PA was for the DOE to demonstrate that a reasonable expectation exists that the design, operation, and eventual closure of the SDF will meet the following requirements:

- DOE Manual 435.1-1, *Radioactive Waste Management Manual*, Chapter IV.P.;
- Title 10 of the *Code of Federal Regulations* (CFR) Part 61, Subpart C Performance Objectives (POs), as required by Section 3116 of *The Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005* (NDAA); and
- Groundwater protection standards pursuant to South Carolina Department of Health and Environmental Control (SCDHEC) Regulation 61-58, *State Primary Drinking Water Regulations*.

The purpose of this NRC Technical Evaluation Report (TER) is to provide the results of the NRC's independent, risk-informed, performance-based technical review of the 2020 SDF PA and its supporting documents under NDAA Section 3116(b) regarding Waste Incidental to Reprocessing (WIR) monitoring (i.e., the 2nd DOE purpose of the 2020 SDF PA), including the NRC conclusions about whether the DOE would meet the 10 CFR Part 61, Subpart C POs.

A PA is a type of systematic risk analysis that addresses the following four questions: (1) what can happen?; (2) how likely is that to happen?; (3) what are the resulting impacts of that happening?; and (4) how do those impacts compare to defined standards? Considering the long time period that long-lived radionuclides could present a risk to human health, a robust PA is needed to establish that the POs will be met for releases from the SDF that may occur many thousands of years in the future.

The 2020 SDF PA is the third DOE SDF PA. The first was in 2005 and second was in 2009 (hereafter, 2009 SDF PA). According to the DOE, the timing of the 2020 SDF PA was associated with four main drivers:

- the design and layout of the SDF disposal structures have undergone major changes since the 2009 SDF PA;
- the breadth of DOE-contractor targeted research and development activities in recent years provided new information and increased the confidence in key transport modeling inputs and assumptions;
- three significant SDF PA Special Analysis documents were issued since the 2009 SDF PA and that information was consolidated into the 2020 SDF PA; and
- DOE-STD-5002-2017, *Disposal Authorization Statement and Tank Closure Documentation*, states that DOE PAs should be revised at a minimum every 10 years and the previous SDF PA was completed in 2009.

The bullets below summarize the DOE five-step process described in Section 2.1.2 (Modeling Process Overview) of the 2020 SDF PA of how the DOE developed the 2020 SDF PA:

- Screen Features, Events, and Processes (FEPs) – "A FEPs Screening Team screened the potential FEPs based on frequency and impact."
- Develop Conceptual Model – "The relevant FEPs were used to inform the development of the conceptual model for the Central Scenario. FEPs not addresses by the Central Scenario were then used to develop the nine alternative conceptual models … ."
- Develop Mathematical Model – "Equations and formulas were developed to quantify the conditions and processes within the conceptual models."
- Implement Submodel – "Submodels were developed by defining the necessary input values and implementing those values into specific modeling programs (or other computation tools), as used for calculating intermediate results from the mathematical models."
- Integrate Submodel – "Interfaces between the various submodels were identified and used to integrate the submodels into a single, integrated PA model."

In the 2020 SDF PA, the DOE evaluated the long-term confinement and isolation of the disposal of salt waste from the reprocessing waste at SRS. The liquid waste resulting from reprocessing spent nuclear fuel is stored in underground carbon steel tanks at SRS. The waste is separated into two streams based on activity. The high activity fraction is high-level waste and is made into a glass waste form. The low activity fraction, called salt waste, is treated in the Salt Waste Processing Facility (SWPF) to reduce the concentrations of certain key radionuclides to the maximum extent practicable. The waste is transferred to Tank 50 for transfer to the SPF. In the

SPF, the waste is mixed with dry materials (i.e., cement, blast furnace slag, fly ash) to form a grout waste form called saltstone. The DOE also evaluated potential use of a cement-free saltstone formula, which the NRC staff addresses in its review as well. The saltstone is pumped into the disposal structures in the SRS SDF for permanent disposal. Note that the SWPF is not part of NRC monitoring of the SDF.

The DOE barriers to the release of radioactivity in the SDF include both chemical and physical barriers. Chemical barriers include: (1) a chemically reducing environment, which limits technetium solubility; and (2) dissolved sulfides, which limit the solubility of technetium and a few other less risk-significant radionuclides. Physical barriers include: (1) an engineered closure cap to limit infiltration; (2) drainage layers and flow barriers above each disposal structure designed to shed water away from the wasteform; (3) disposal structure concrete designed to limit water contact with the saltstone wasteform; and (4) saltstone wasteform designed to limit water flow through the wasteform and radionuclide diffusion out of the wasteform.

In the 2020 SDF PA, the DOE assumed that the final SDF configuration included a total of 15 disposal structures:

- two existing rectangular disposal structures (i.e., SDS 1, SDS 4);
- six existing cylindrical 150-foot diameter disposal structures (i.e., SDS 2A, SDS 2B, SDS 3A, SDS 3B, SDS 5A, SDS 5B);
- one existing cylindrical 375-foot diameter disposal structure (i.e., SDS 6);
- two cylindrical 375-foot diameter disposal structures (i.e., SDS 7, SDS 8) that completed construction between the time of the 2020 DOE Submittal and the NRC issuance of this TER; and
- four future cylindrical 375-foot diameter disposal structures (i.e., SDS 9 through SDS 12).

Note that the DOE assumed that the remediation and decommissioning of the SPF operations would leave minimal residual radioactivity behind on the surface and these activities are not explicitly included in the model.

The projected layout of the 15 SDF disposal structures is in Figure ES-1. An aerial view picture of the SDF from March 2020 is in Figure ES-2. The SPF is the unmarked facility in the center left of Figure ES-2. As shown in Figure ES-1 and Figure ES-2 and in the DOE documents, the DOE uses the term Saltstone Disposal Unit (SDU) to refer to individual disposal structures or pairs of disposal structures.

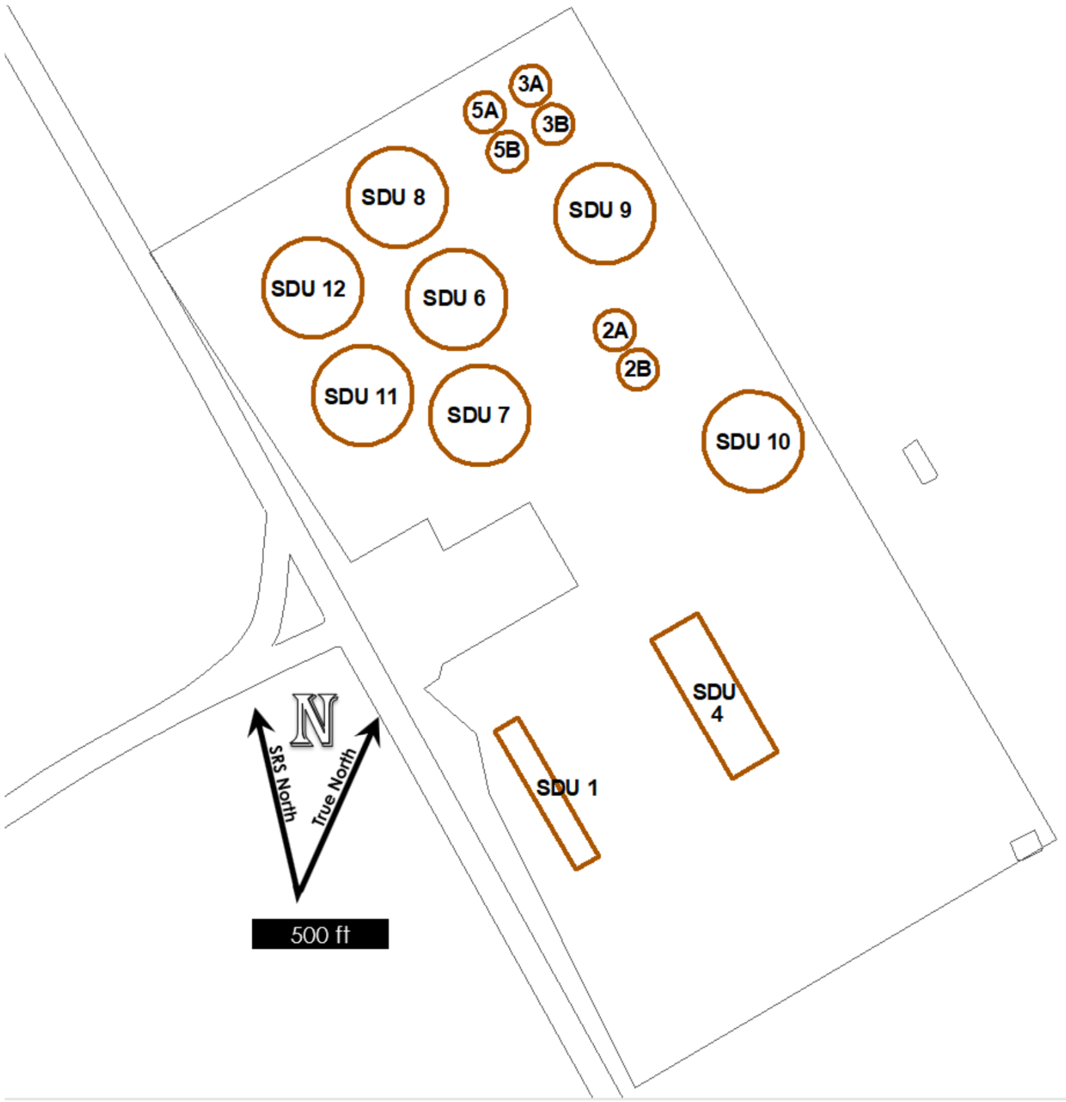

Figure ES-1: Layout of 15 Disposal Structures in the SDF (Figure 1.2-1 in the 2020 DOE SDF PA)

Figure ES-2: SDF Aerial View Picture from March 2020
(Figure 3.2-1 in the 2020 DOE SDF PA)

The DOE will install one overall engineered closure cap over the SDF after the operational period ends, which the DOE expects to occur in 2037. The purpose of it will be to provide SDF physical stabilization, minimize infiltration, and deter intruders. The DOE design is currently preliminary and conceptual in nature. The DOE will complete the final design near the end of the operational period. Currently, the DOE expects to have two individual closure caps in the overall engineered closure cap. One large closure cap would be constructed over the 13 cylindrical disposal structures and one small closure cap would be constructed over the two rectangular disposal structures. The current DOE design layout for the two closure caps is shown in Figure ES-3.

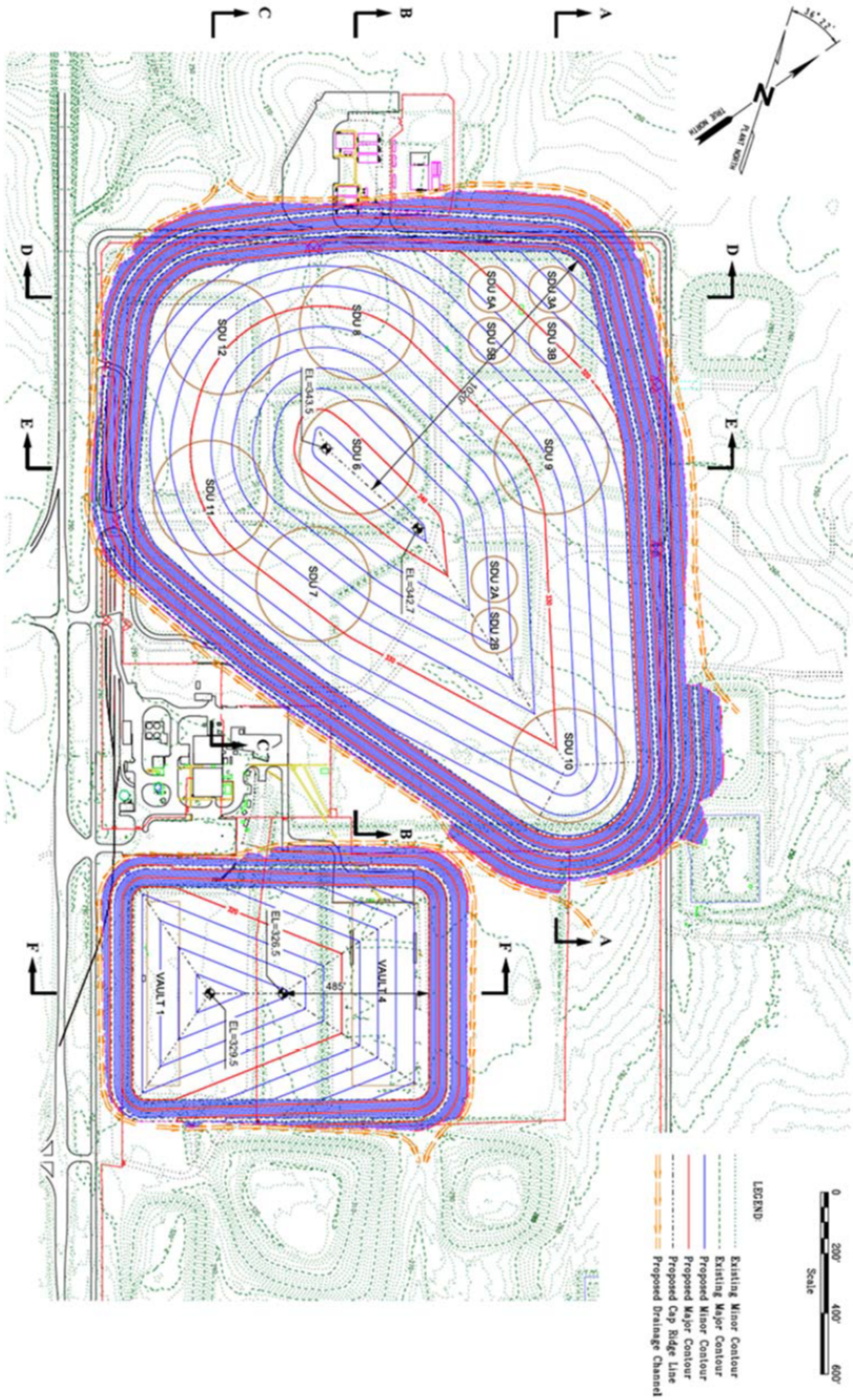

Figure ES-3: Two SDF Closure Caps Design Layout
(Figure 3.2-29 in the 2020 DOE SDF PA)

The DOE developed a system of barriers to isolate the waste from the environment and control potential future releases. The cover system limits infiltration of water to the saltstone disposal structures by diverting water away from the area. The disposal structures are built to contain the waste as it solidifies and in the long term provide additional physical and chemical barriers to the intrusion of water to the waste and release of radionuclides from the saltstone. The saltstone itself was developed to chemically retain the waste. The PA is a set of conceptual and mathematical models to evaluate the performance of these barriers and other features in the environment.

The NRC monitoring of the DOE disposal actions at the SDF has continued during the development of this TER. The NRC has conducted numerous technical reviews and Onsite Observation Visits (OOVs) at the SDF. The links to the associated SDF Technical Review Reports (TRRs) and OOV Reports are at the NRC's SDF Public Website webpage: https://www.nrc.gov/waste/incidental-waste/wir-process/wir-locations/saltstone.html

For more WIR background information about the NDAA, NDAA Monitoring, and the SRS SDF, see Revision 6 of the NRC WIR Periodic Monitoring Report (PMR) (ML19058A272) and the NRC Public Website webpages listed in Table ES-1:

Table ES-1: WIR Background Information

Topic	WIR PMR, Rev. 6	Webpage
NDAA	Section 1	https://www.nrc.gov/waste/incidental-waste/responsib.html
NDAA Monitoring	Appendix A	https://www.nrc.gov/waste/incidental-waste/wir-process/wir-monitoring.html
SRS SDF	Section 3	https://www.nrc.gov/waste/incidental-waste/wir-process/wir-locations/saltstone.html

In support of this review, the NRC staff issued 10 TRRs on specific technical topics. In those NRC staff TRRs, the NRC staff included recommendations for a future revision of the NRC Monitoring Plan for the SDF. A summary of those NRC staff recommended changes are described in the Appendix to this TER. The details of those NRC staff recommended changes are found in the TRRs that were issued in coordination with this TER.

Within one year of issuing this TER, the NRC expects to issue a revised SDF Monitoring Plan, (Rev. 2) that will be based on the already made changes to the existing monitoring plan since SDF Monitoring Plan (Rev. 1) was issued in 2013, this TER, the 10 TRRs issued with this TER, and any changes that the DOE makes based upon this TER.

The following information provides a high-level overview of the NRC staff's findings as described in this TER. For more details of the NRC staff's review, see the appropriate sections of this TER.

- The §61.41 PO (Protection of the General Population from Releases of Radioactivity) is about reducing the consequences of effluents released from a facility resulting in dose to a member of the public. The NRC staff review identified the SDF Closure Cap design, implementation details, and installation quality as important to the projected SDF performance. The NRC staff determined that the projected infiltration rate will be a key parameter in affecting evaluation of releases of radioactivity from the SDF. In the DOE models supporting the 2020 SDF PA, the Closure Cap controls the projected infiltration to the disposal structures. The future performance of the Closure Cap is uncertain because the DOE has not yet finalized the Closure Cap design and implementation plans.

- The §61.42 PO (Protection of Individuals from Inadvertent Intrusion) is about reducing the likelihood that someone in the future will encounter radioactive material and the consequences if they do. The NRC staff review identified that the most important sources of uncertainty in the intrusion analysis was the composition of the drill cuttings (i.e., grout or soil) and the volume of drill cuttings brought to the surface. Although the projected infiltration rate also affected the modeled projected dose to an inadvertent intruder, the infiltration rate was not the largest source of uncertainty in that analysis. The most important case is the unlikely but plausible case that an individual drills a well directly into a 375-foot disposal structure.

- The §61.43 PO (Protection of Individuals during Operations) is about limiting potential exposures of both disposal site workers and members of the public to radioactivity at a disposal site during site operations. The NRC will continue to monitor the DOE activities during operations through environmental monitoring and the radiation protection program as specified in the Monitoring Plan. Note that a description of operations is not a primary purpose of a PA, which is focused on long-term impacts.

- The §61.44 PO (Stability of the Disposal Site after Closure) is about eliminating the need for active maintenance of the site after closure. The NRC staff determined that the design and implementation of the Closure Cap and the future climate at SRS will affect evaluation of the final site stability. However, in the 2020 SDF PA the DOE indicated that the DOE had not finalized the Closure Cap design or made final decisions about key aspects of the implementation of the Closure Cap (e.g., materials specifications).

- Based on the information in this TER and the DOE assumption that the Closure Cap design and implementation will achieve the DOE expected performance, as described in the 2020 SDF PA, the NRC concludes that it has reasonable assurance that the DOE disposal actions at the SDF would meet all the 10 CFR 61 POs, including the §61.40 PO.

1.0 INTRODUCTION

1.1 Monitoring

The Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (NDAA) Section 3116(a) requires that the U.S. Department of Energy (DOE) consult with U.S. Nuclear Regulatory Commission (NRC) on the DOE non-High-Level Waste determinations in an NDAA-Covered State (i.e., Idaho and South Carolina). If the Secretary of Energy determines that the waste in an NDAA-Covered State is Waste Incidental to Reprocessing (WIR), then NDAA Section 3116(b) requires that the NRC, in coordination with the appropriate NDAA-Covered State, monitor the DOE disposal actions to assess compliance with Title10 *Code of Federal Regulations* Part 61, Subpart C Performance Objectives (POs). While this NDAA monitoring occurs in perpetuity, how it is done changes over time based on the risk associated with the DOE disposal actions. The five POs are:

- **§61.40: General Requirement –** Land disposal facilities must be sited, designed, operated, closed, and controlled after closure so that reasonable assurance exists that exposures to humans are within the limits established in the POs in §61.41 through §61.44.

- **§61.41: Protection of the General Population from Releases of Radioactivity –** Concentrations of radioactive material which may be released to the general environment in groundwater, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable.

- **§61.42: Protection of Individuals from Inadvertent Intrusion –** Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.

- **§61.43: Protection of Individuals during Operations –** Operations at the land disposal facility must be conducted in compliance with the standards for radiation protection set out in part 20 of this chapter, except for releases of radioactivity in effluents from the land disposal facility, which shall be governed by §61.41 of this part. Every reasonable effort shall be made to maintain radiation exposures as low as is reasonably achievable.

- **§61.44: Stability of the Disposal Site after Closure –** The disposal facility must be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate to the extent practicable the need for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, or minor custodial care are required.

For more information about NDAA Monitoring, see Appendix A of Revision 6 of the NRC WIR Periodic Monitoring Report (NRC's Agencywide Documents Access and Management System

[ADAMS] under Accession No. (ML19058A272) and the NRC Public Website webpage on WIR monitoring: https://www.nrc.gov/waste/incidental-waste/wir-process/wir-monitoring.html

A performance assessment (PA) for the DOE Savannah River Site (SRS) SDF is a critical element of the DOE demonstration of compliance with the POs at the SDF. The NRC reviews and evaluates any SDF PA under the NDAA. The NRC documents its review of an SDF PA in a TER. The other main NDAA monitoring activities are: Technical Reviews that are documented in NRC TRRs; and Onsite Observation Visits (OOVs), in coordination with the NDAA-Covered State of South Carolina, that are documented in NRC OOV Reports. The NRC monitoring of the DOE disposal actions at the SDF has continued during the development of this TER. The NRC has conducted numerous technical reviews and OOVs at the SDF. The links to the associated SDF TRRs and OOV Reports are at the following NRC Public Website webpage: https://www.nrc.gov/waste/incidental-waste/wir-process/wir-locations/saltstone.html

1.2 Current Review

By letter dated July 6, 2020, the DOE submitted the 2020 DOE SDF PA to the NRC (Package No. ML20190A055) under NDAA Section 3116(b). By letter dated July 10, 2020 (ML20148M201), the NRC acknowledged receipt of that DOE Submittal. By letter dated October 5, 2020 (ML20254A003), the NRC provided a preliminary review of the DOE Submittal along with the NRC Request for Supplemental Information (RSI) Comments. The DOE provided four sets of Responses to the NRC RSI Comments in submittals dated January 18, 2020 (ML21159A059, March 30, 2021 (ML21089A119), June 8, 2021 (ML21160A059), and August 3, 2021 (ML21217A076). The NRC issued four sets of Request for Additional Information (RAI) Questions dated March 1, 2021 (ML21062A214), June 3, 2021 (ML21133A293), December 14, 2021 (ML21341A543) and February 9, 2022 (ML22026A391). By letter dated October 4, 2021 (ML21273A057) the NRC issued the Review Schedule. The DOE provided Final Responses to the NRC sets of RAI Questions in July 2021 (ML21201A247), November 2021 (ML21321A087), March 2022 (ML22083A049), and April 2022 (ML22118A297).

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According to the DOE, the three purposes of the 2020 SDF PA were for the DOE to demonstrate that a reasonable expectation exists that the design, operation, and eventual closure of the SDF will meet the following requirements:

- DOE Manual 435.1-1, *Radioactive Waste Management Manual*, Chapter IV.P.;
- 10 CFR Part 61, Subpart C POs, as required by NDAA Section 3116; and
- Groundwater protection standards pursuant to South Carolina Department of Health and Environmental Control (SCDHEC) Regulation 61-58, *State Primary Drinking Water Regulations*.

The purpose of this NRC TER is to provide the results of the NRC's independent, risk-informed, performance-based technical review of the 2020 SDF PA and its supporting documents under

NDAA Section 3116(b), including the NRC conclusions about whether the DOE would meet the 10 CFR Part 61, Subpart C POs.

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- the design and layout of the SDF disposal structures have undergone major changes since the 2009 SDF PA;

- the breadth of DOE-contractor targeted research and development activities in recent years provided new information and increased the confidence in key transport modeling inputs and assumptions;

- three significant SDF PA Special Analysis documents were issued since the 2009 SDF PA and that information was consolidated into the 2020 SDF PA; and

- DOE-STD-5002-2017, *Disposal Authorization Statement and Tank Closure Documentation*, states that DOE PAs should be revised at a minimum every 10 years and the previous SDF PA was completed in 2009.

Currently, the NRC performs NDAA Monitoring using the SDF Monitoring Plan, Rev. 1, as supplemented by the six NRC letters from June 5, 2017 to October 18, 2021 (ML17097A351, ML18033A071, ML18107A161, ML18219B035, ML19150A295, and ML21279A173). In those six NRC letters supplementing the SDF Monitoring Plan, Rev. 1, the NRC opened monitoring factors, closed monitoring factors, updated text of monitoring factors, changed priorities (i.e., High, Medium, Low, Periodic) of monitoring factors, and clarified how the NRC counted monitoring factors (i.e., previously counted each time it related to a performance objective and now counted once regardless how many times it related to a performance objective).

In support of this review, the NRC staff issued 10 TRRs on specific technical topics. In those NRC staff TRRs, the NRC staff included recommendations for a future revision of the NRC Monitoring Plan for the SDF. A summary of those NRC staff recommended changes are described in the Appendix to this TER. The details of those NRC staff recommended changes are found in the TRRs that were issued in coordination with this TER.

In this TER:

- Chapter 2.0 through Chapter 6.0 provide the results of the overall NRC review of each of the five 10 CFR Part 61 POs;

- Chapter 7.0 provides the overall NRC Conclusions; and
- Chapter 8.0 provides the references.

1.3 Context of the DOE SDF Performance Assessment

The bullets below summarize the DOE five-step process described in Section 2.1.2 (Modeling Process Overview) of the 2020 SDF PA of how the DOE developed the 2020 SDF PA:

- Screen Features, Events, and Processes (FEPs) – “A FEPs Screening Team screened the potential FEPs based on frequency and impact.”
- Develop Conceptual Model – “The relevant FEPs were used to inform the development of the conceptual model for the Central Scenario. FEPs not addresses by the Central Scenario were then used to develop the nine alternative conceptual models … .”
- Develop Mathematical Model – “Equations and formulas were developed to quantify the conditions and processes within the conceptual models.”
- Implement Submodel – “Submodels were developed by defining the necessary input values and implementing those values into specific modeling programs (or other computation tools), as used for calculating intermediate results from the mathematical models.”
- Integrate Submodel – “Interfaces between the various submodels were identified and used to integrate the submodels into a single, integrated PA model.”

The excerpts below provide more detailed information from Section 1.3 (PA Model Development Process) of the 2020 SDF PA:

> “The models used in [the DOE SDF PA] were developed using the relevant FEPs identified during the FEPs screening process … .The FEPs process [identified] those system features, events, and physical processes that may have a significant impact on the performance of the SDF disposal system. [That] process was performed by a team of subject matter experts from … Savannah River National Laboratory …, the DOE Hanford Site, and academia, who determined which FEPs to consider during the development of SDF PA models. The identified FEPs [provided] the basis for understanding the physical systems and features represented within the PA models, including considerations for how the modeled features interact collectively and considerations for how they will evolve over time.”
>
> “After identifying the relevant FEPs, a ‘Central Scenario’ was developed from a range of potential future scenarios using an ‘interaction matrix,’ [as described in NRC Draft NUREG-2175, *Guidance for Conducting Technical Analyses for 10 CFR Part 61* (ML14357A072).] With the interaction matrix approach, primary components of the system (i.e., safety-significant features) [were] identified along with the various interactions between those primary model components (i.e., processes). The system components and interactions between them were used to develop the conceptual model for the Central Scenario … .”

> "Using the conceptual model for the Central Scenario, a … Compliance Case was developed for evaluating the long-term performance of the SDF. [That] conceptual model was also used to develop sensitivity cases for evaluating specific inputs to the Compliance Case, and a probabilistic model to evaluate uncertainties around combinations of values or conditions. In addition to the Central Scenario conceptual model, alternative conceptual models were also developed to evaluate the conditions that [were] different from the Central Scenario. From [those] alternative conceptual models, additional sensitivity cases were developed."
>
> "Note that none [of those] modeling cases [were] developed from a single, comprehensive mathematical model; rather the system [was] subdivided into multiple, manageable submodels. [Those] submodels [were] each run independently, and then integrated to produce the PA results."

Figure 1-1 below provides the overview of submodel integration for the 2020 SDF PA.

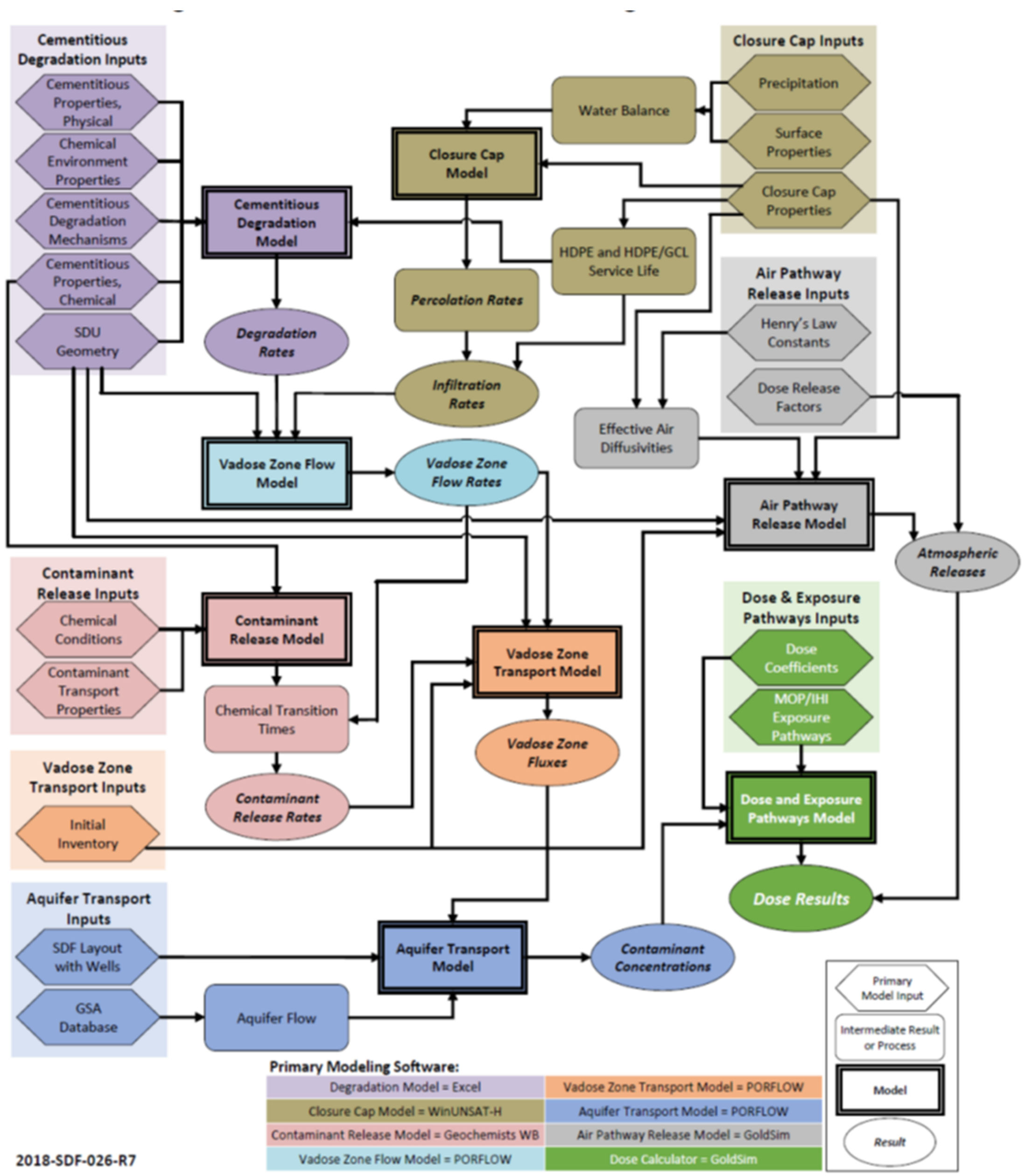

Figure 1-1: Overview of Submodel Integration for the SDF PA (Figure 1.3-1 in the 2020 DOE SDF PA)

"The flow and transport processes simulated within the [2020 SDF PA relied] on complex PORFLOW and GoldSim models. … PORFLOW is a deterministic, three-dimensional flow and transport modeling software. As a deterministic modeling software, the models designed in PORFLOW [used] a single value for each input parameter. … GoldSim is a one-dimensional flow and transport modeling software … used for both deterministic and probabilistic simulations. In probabilistic mode, GoldSim [was] used to evaluate multiple parameter values in a computationally-efficient manner."

"The probabilistic model developed within GoldSim [used] data that was abstracted from the PORFLOW models … . The probabilistic model randomly [sampled] values for

> selected parameters within the Central Scenario to provide insights relative to the influence that parameter uncertainty [exhibited] on the overall performance of the system. …"

The excerpts below provide more detailed information from Section 1.5 (PA Analysis Summary) of the 2020 SDF PA:

> "[The DOE performed analyses] … to evaluate [the] SDF performance considering uncertainties in the future evolution of the [SDF. Those analyses included:]

- A Central Scenario, which [was] evaluated for three sets of input parameters as an indicator of parameter uncertainty … .
- A probabilistic parameter uncertainty analysis of the Central Scenario, which [supplemented and augmented] the understanding of parameter uncertainties … .
- A set of deterministic sensitivity cases to further explore parametric uncertainties, including evaluations of: infiltration rates …, material properties …, contaminant release and transport rates …, future disposal inventories …, dose parameters …, and vadose zone flow and transport conditions … .
- Additional deterministic sensitivity cases developed based on Alternative Conceptual Models …, which [explored] conceptual and mathematical model uncertainties, including: soil-only closure cap scenario …, climate condition scenarios …, cementitious degradation analyses …, early release scenarios …, fast flow path scenarios …, and colloid transport scenario … .
- A set of special deterministic sensitivity cases designed to support [SDF] operations and management decisions related to SDF disposal, including: a design margin analysis …, an analysis that [assumed] soil disposal in [Saltstone Disposal Structure (SDS) 1 …, an analysis that [addressed] the waste bags in [SDS 4] …, and an analysis that [assumed] [SDS 4] will be filled with controlled low strength material … instead of grout … ."

The DOE provided information in reports and in response to the NRC RAI Questions that updated the information in the DOE 2020 SDF PA and supporting documents.

1.4 Site Overview

The DOE SRS is located along the Savannah River in south-central South Carolina, approximately 160.9 kilometers (km) (100 miles (mi)) inland from the Atlantic Coast. The SRS occupies approximately 802.9 square km (310 square mi) and includes portions of Aiken, Barnwell, and Allendale counties in South Carolina (see Figure 1-2). The developed areas of the SRS occupy less than 10 percent of the footprint while the remainder is undeveloped forest or wetlands.

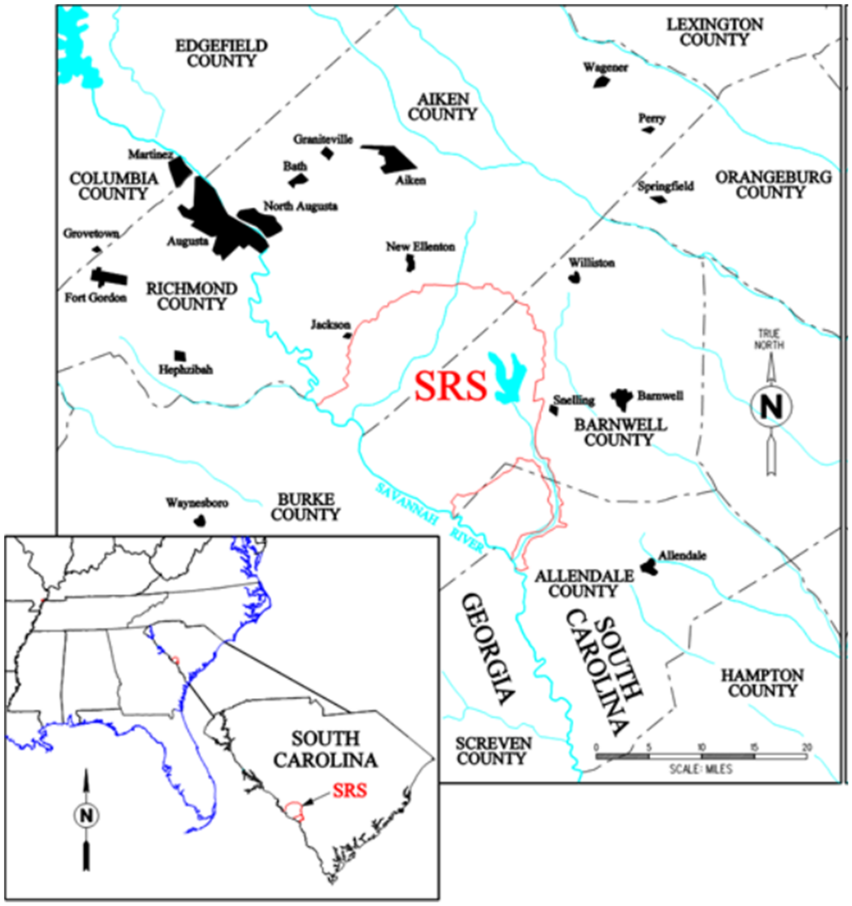

Figure 1-2: SRS General Location Map
(Figure 2.2-1 in the 2020 DOE SDF PA)

The SRS began operation in 1951 producing nuclear material for national defense, research, medical, and space programs. Waste produced onsite from spent nuclear fuel reprocessing for defense purposes has been commingled with non-reprocessing waste resulting from the production of targets for nuclear weapons and production of material for space missions. Significant quantities of radioactive waste are currently stored onsite in large underground waste storage tanks, which were placed into operation between 1954 and 1986. The waste stored in the tanks onsite is a mixture of insoluble metal hydroxide solids, referred to as sludge, and soluble salt supernate. The supernate volume has been reduced by evaporation, which also concentrates the soluble salts to their solubility limits. The resultant solution crystallizes as salts, and the resulting solid is referred to as saltcake. The saltcake and supernate combined are referred to as salt waste.

In the 2020 SDF PA, the DOE evaluated the long-term confinement and isolation of the disposal of salt waste from the reprocessing waste at SRS. The liquid waste resulting from reprocessing spent nuclear fuel is stored in underground carbon steel tanks at SRS. The waste is separated into two streams based on activity. The high activity fraction is high-level waste and is made into a glass waste form. The low activity fraction, called salt waste, is treated in the Salt Waste Processing Facility (SWPF) to reduce the concentrations of certain key radionuclides to the maximum extent practicable. The waste is transferred to Tank 50 for transfer to the Saltstone Production Facility (SPF). In the SPF, the waste is mixed with dry materials (i.e., cement, blast furnace slag, fly ash) to form a grout waste form called saltstone. The DOE also evaluated potential use of a cement-free saltstone formula, which the NRC staff addresses in its review. The saltstone is pumped into the disposal structures in the SRS SDF for permanent disposal. Note that the SWPF and SPF are not a part of NRC's monitoring activities of the SDF.

The DOE barriers to the release of radioactivity in the SDF include both chemical and physical barriers. Chemical barriers include: (1) a chemically reducing environment, which limits technetium solubility, and (2) dissolved sulfides, which limit the solubility of technetium and a few other less risk-significant radionuclides. Physical barriers include: (1) an engineered closure cap to limit infiltration, (2) drainage layers and flow barriers above each disposal structure designed to shed water away from the wasteform, (3) disposal structure concrete designed to limit water contact with the saltstone wasteform, and (4) saltstone wasteform designed to limit water flow through the wasteform and radionuclide diffusion out of the wasteform.

The SPF is permitted as a wastewater treatment facility per the South Carolina Department of Health and Environmental Control (SCDHEC) R.61-67, *Standards for Wastewater Facility Construction* (ML20206L109). The SDF is permitted as a Class 3 Landfill per the SCDHEC R.61-107.19, *SWM: Solid Waste Landfills and Structural Fill* (ML101600010). SPF and SDF operations are also covered by the SCDHEC TV-0080-0041, *Part 70 Air Quality Permit* for the SRS (ML20206L278).

The SRS Z-Area is approximately 0.65 square km (161 acres) and is located in the SRS General Separations Area (GSA), which is in the SRS central region (see Figure 1-3). The SWPF is not located in the Z-Area. The SPF and SDF are located in the Z-Area. The GSA is located atop a ridge running southwest to northeast that forms the drainage divide between two watersheds, the Upper Three Runs (UTR) to the north and the Fourmile Branch (FMB) to the south.

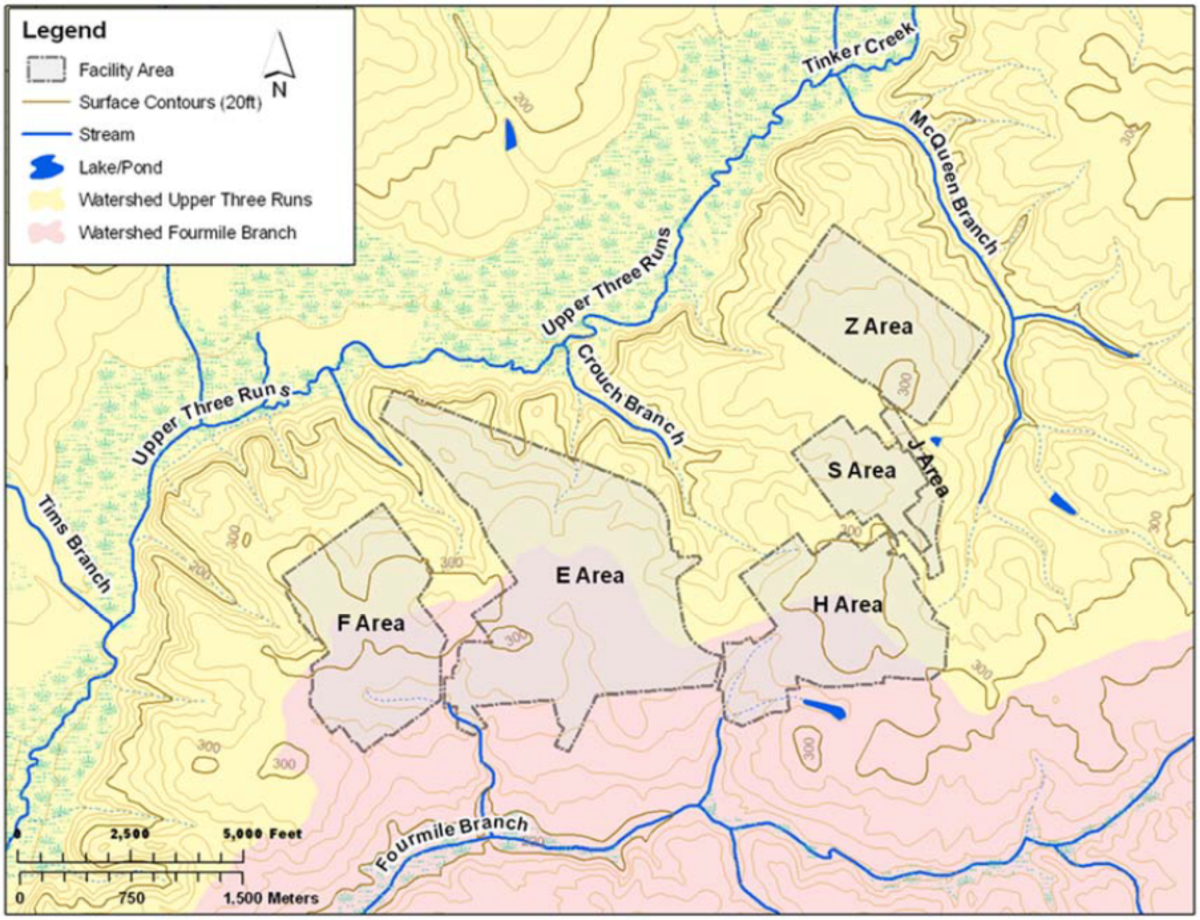

Figure 1-3: SRS General Separations Area (including Z-Area)
(Figure 2.2-2 in the 2020 DOE SDF PA)

The DOE chose the location of the SDF in the Z-Area based on: depth to the water table, distance to surface water and the public, available surface area, surface topography, and proximity to the waste generation sites. In the 2020 SDF PA, the DOE assumed that the final SDF configuration included a total of 15 disposal structures:

- two existing rectangular disposal structures (i.e., SDS 1, SDS 4);
- six existing cylindrical 150-foot diameter disposal structures (i.e., SDS 2A, SDS 2B, SDS 3A, SDS 3B, SDS 5A, SDS 5B);
- one existing cylindrical 375-foot diameter disposal structure (i.e., SDS 6);
- two cylindrical 375-foot diameter disposal structures (i.e., SDS 7, SDS 8) that completed construction between the time of the 2020 DOE Submittal and the NRC issuance of this TER; and
- four future cylindrical 375-foot diameter disposal structures (i.e., SDS 9 through SDS 12).

Note that the DOE assumed that the remediation and decommissioning of the SPF operations will leave minimal residual radioactivity behind on the surface and these activities are not explicitly included in the model.

The projected layout of the 15 SDF disposal structures is in Figure 1-4. An aerial view picture of the SDF from March 2020 is in Figure 1-5. The SPF is the unmarked facility in the center left of Figure 1-5. As shown in Figure 1-4 and Figure 1-5, the DOE uses the term Saltstone Disposal Unit (SDU).

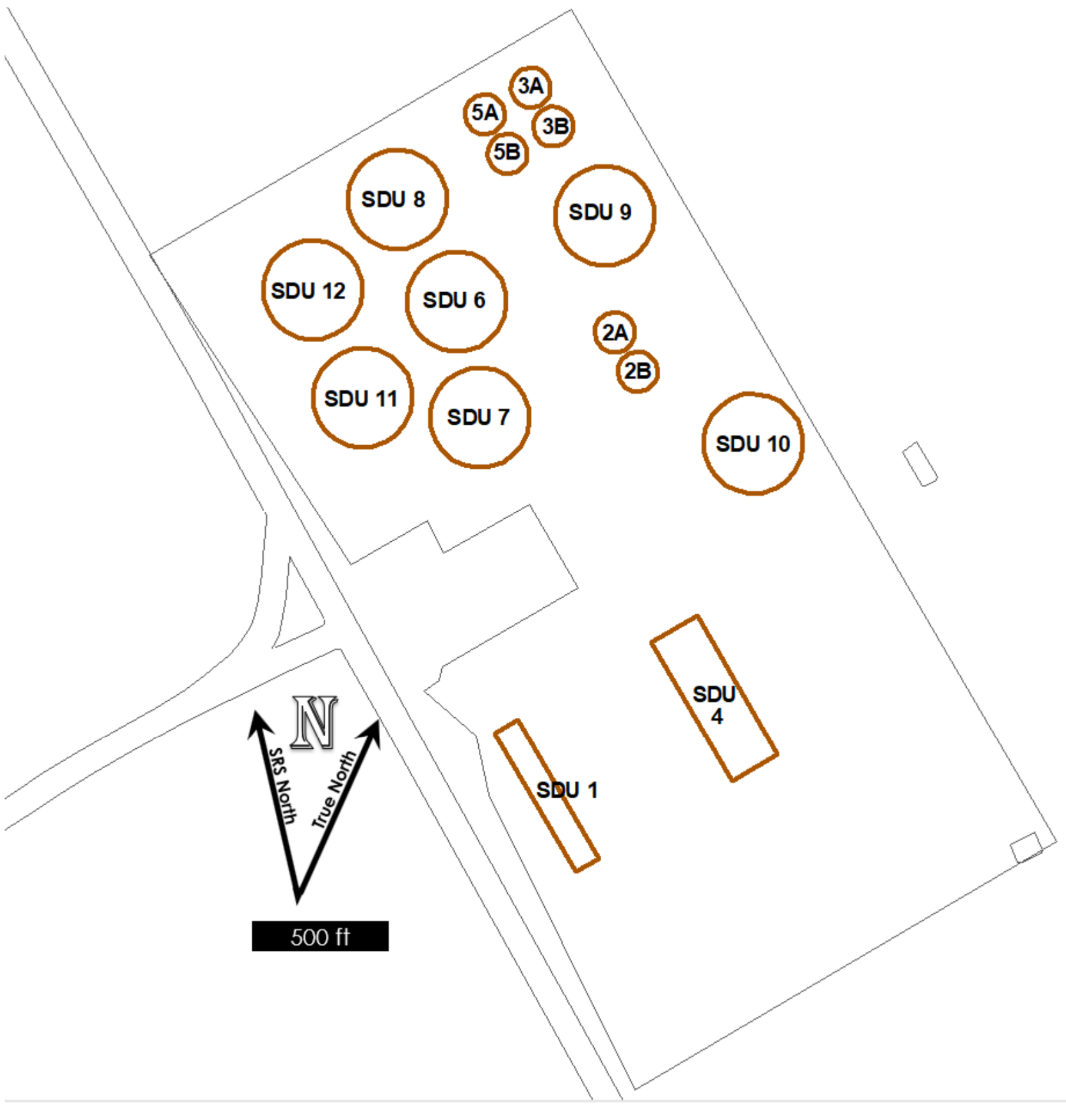

Figure 1.4: Projected Layout of 15 Disposal Structures in the SDF (Figure 1.2-1 in the 2020 DOE SDF PA)

Figure 1-5: SDF Aerial View Picture from March 2020
(Figure 3.2-1 in the 2020 DOE SDF PA)

The subsurface environment beneath the SDF is made up of varying layers of predominantly sandy or predominantly clayey sediments. As a result of the varying texture layers, the subsurface consists of two aquifer units, the Upper Three Runs Aquifer (UTRA) and the Gordon Aquifer, which are separated by the Gordon Confining Unit (GCU). The UTRA is subdivided into the Upper Aquifer Zone (UAZ) and Lower Aquifer Zone (LAZ), which are separated by the Tan Clay Confining Zone (TCCZ). Relative to the GCU, the TCCZ is more permeable. Figure 1-6 is a generalized east-west cross section through the center of the GSA showing the conceptual groundwater flow patterns in the UTRA and the Gordon Aquifer.

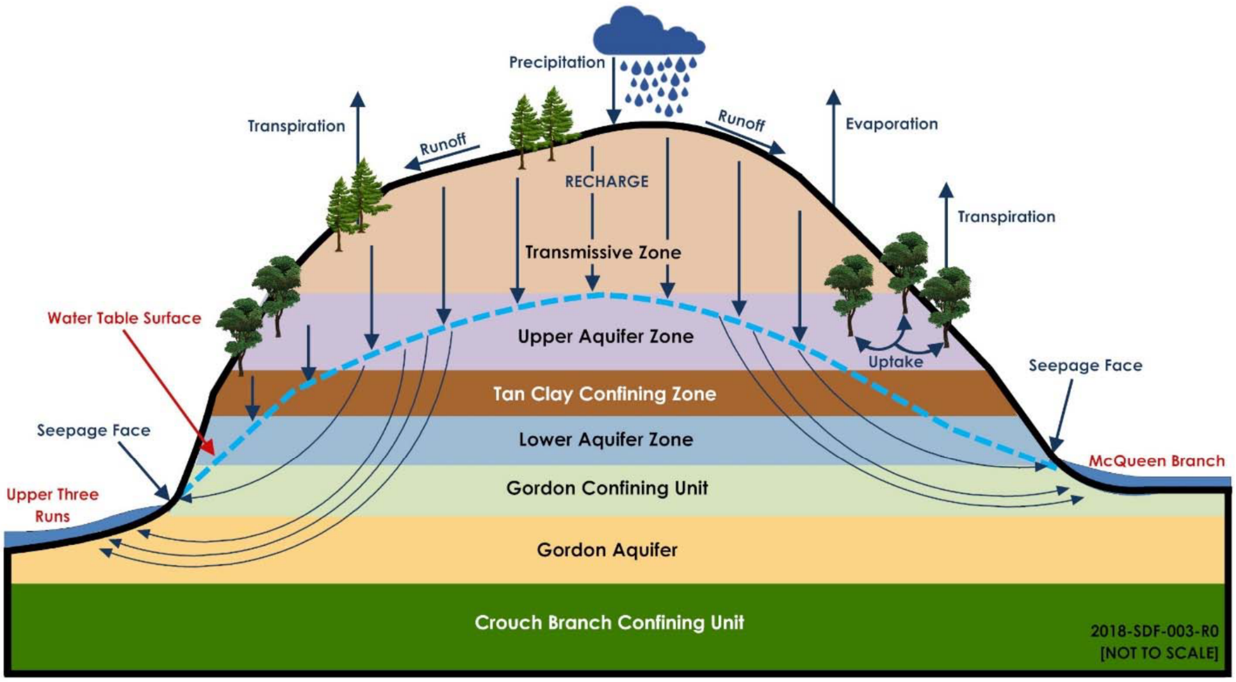

Figure 1-6: Conceptual Diagram of Groundwater Flow Beneath the GSA
(Figure 3.1-29 in the 2020 DOE SDF PA)

The DOE will install one overall engineered closure cap over the SDF after the operational period ends, which the DOE expects to occur in 2037. Its purpose is to provide SDF physical stabilization, minimize infiltration, and deter intruders. The DOE design is currently preliminary and conceptual in nature, so it is not the final design. The DOE will complete the final design near the end of the operational period. Currently, the DOE expects to have two individual closure caps in the overall engineered closure cap. One large closure cap would be constructed over the 13 cylindrical disposal structures and one small closure cap would be constructed over the two rectangular disposal structures. The current DOE design layout for the two closure caps is shown below in Figure 1-7.

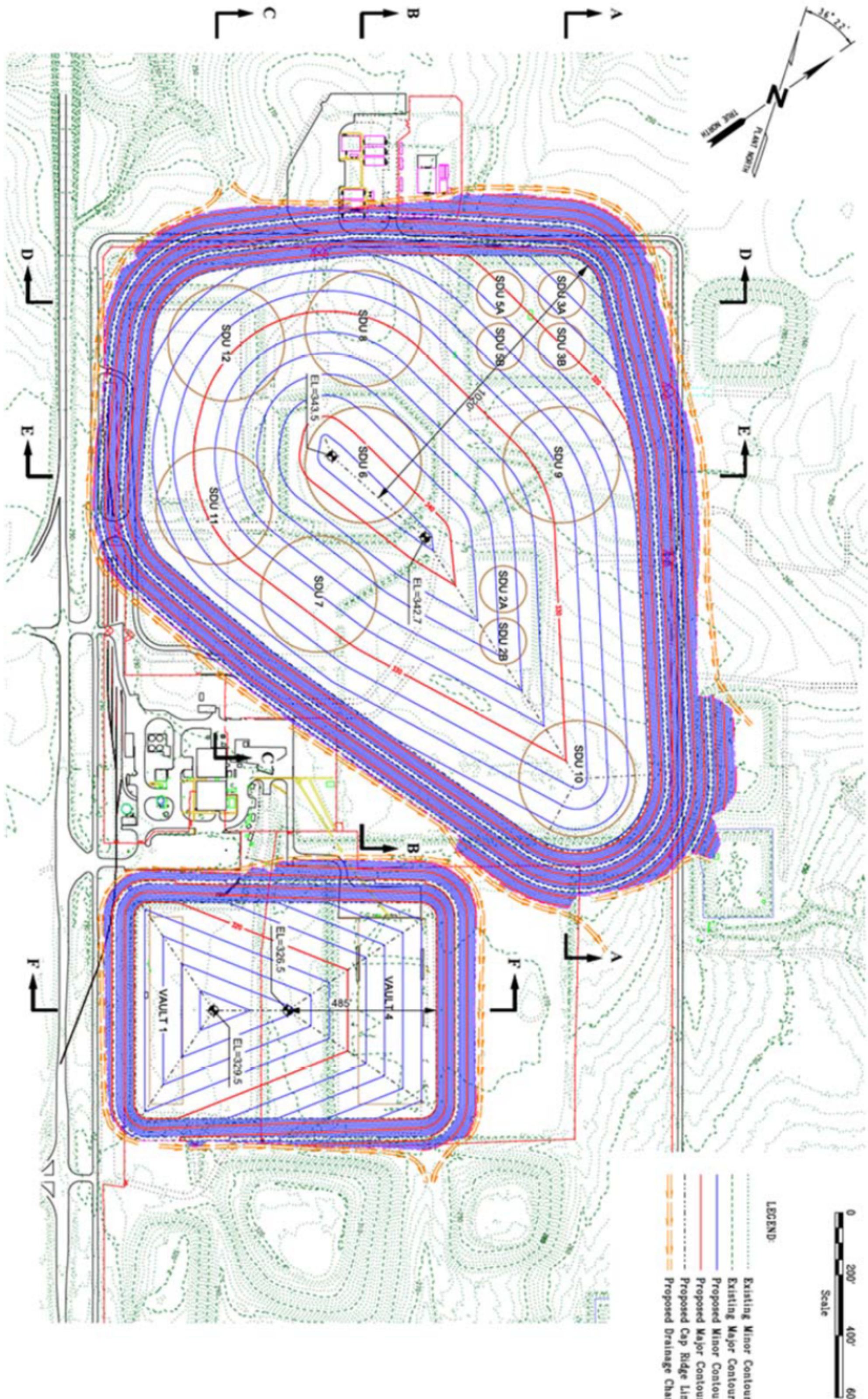

Figure 1-7: Two SDF Closure Caps Design Layout (Figure 3.2-29 in the 2020 DOE SDF PA)

The layers of each of the two SDF closure caps are depicted from top to bottom in Figure 1-8 and in more detail in Figure 1-9.

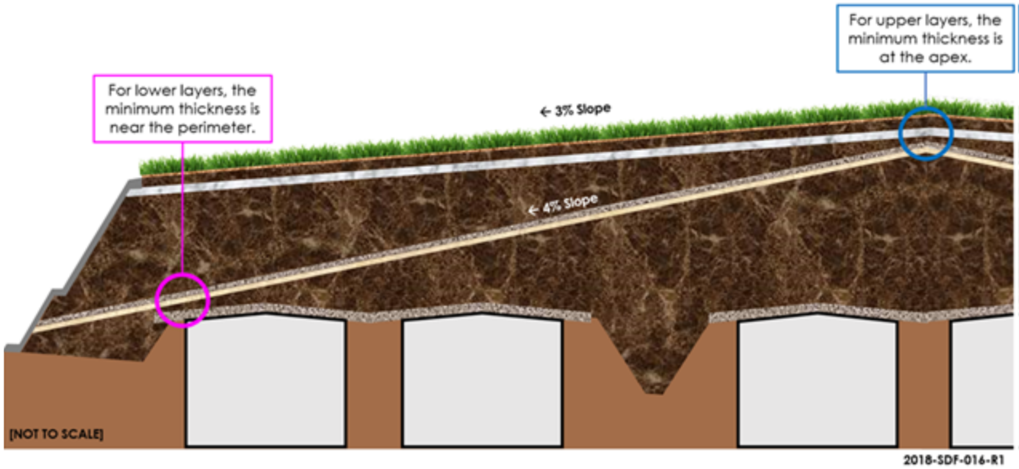

Figure 1-8: SDF Conceptual Closure Cap Configuration (Figure 3.2-23 in the 2020 DOE SDF PA)

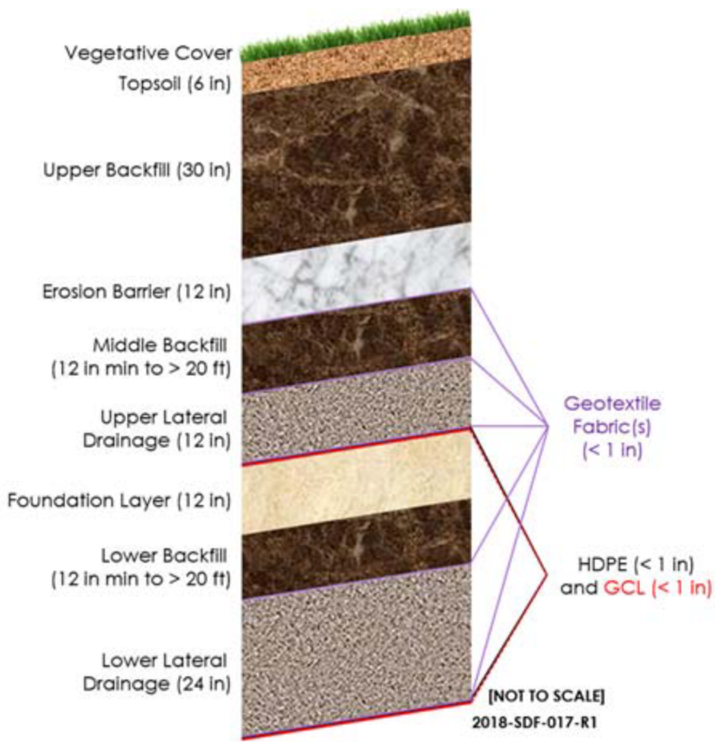

Figure 1-9: SDF Conceptual Closure Cap Layers (Figure 3.2-33 in the 2020 DOE SDF PA)

For more detailed information about the SRS, the SDF, and the disposal structures, see Chapters 2 and 3 in the 2020 DOE SDF PA.

1.5 NRC Review Methods

The NRC staff issued 10 TRRs related to the review of the 2020 SDF PA and its supporting documents. The topics each of the TRRs were: *Dose and Exposure Pathways Model* (DEPM); *Future Scenarios and Conceptual Models* (FSCM); *Hydrogeology, Groundwater Monitoring, and Far-Field Modeling* (HFFM); *Inventory* (INVT); *Intrusion Analysis* (INTA); *Model Integration* (MOIN); *Near Field Flow and Transport* (NFFT); *Percolation Through and Potential Erosion near the Closure Cap* (PECC); *Performance of the Composite Barrier Layers and Lateral Drainage* Layers (CBDL); and *Site Stability* (SIST).

When the NRC staff evaluated the DOE approach, assumption, or conclusion in each TRR, the NRC staff determined one of three categories: (1) acceptable because …; (2) not supported or justified because … but not risk-significant because …; (3) not acceptable because … and NRC will monitor …. The third category corresponds to NRC staff recommended changes for new or revised monitoring areas and/or monitoring factors. The Appendix to this TER contains a summary of those NRC staff recommended changes to the NRC Monitoring Plan for the SDF.

Figure 1-10 through Figure 1-12 below, show how each TRR relates to the NRC staff analysis of projected SDF performance against the POs. Section 1.5.1 of this TER provides additional information about the scope of each TRR. Section 1.5.2 of this TER provides reviews for topics that the NRC staff covered in this TER rather than in a TRR.

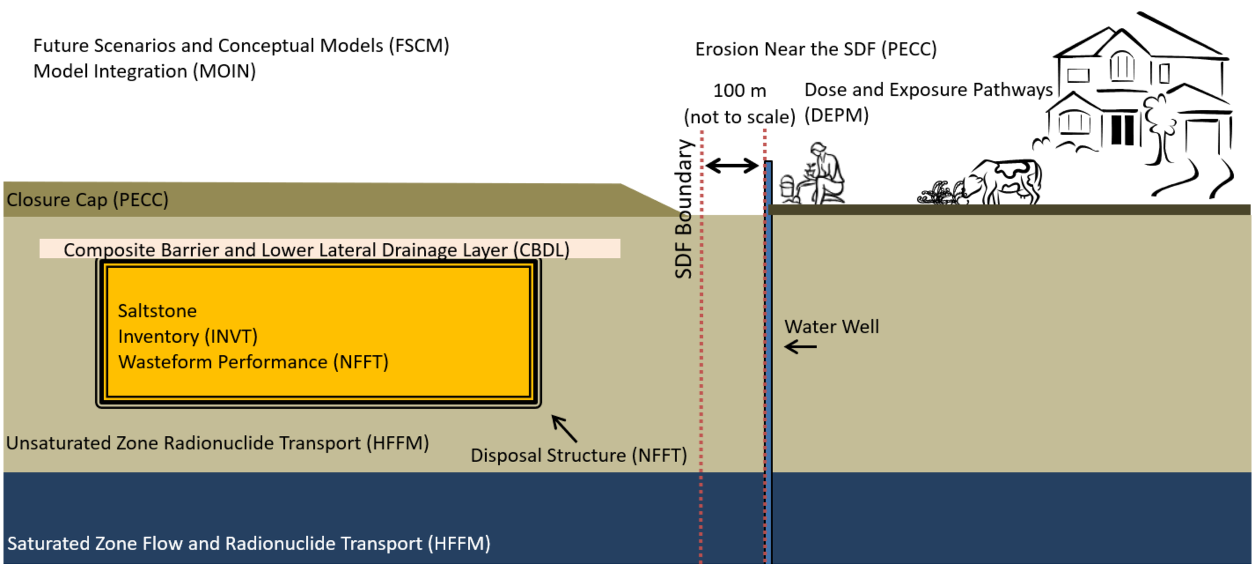

Figure 1-10: NRC Staff TRRs related to the §61.41 PO

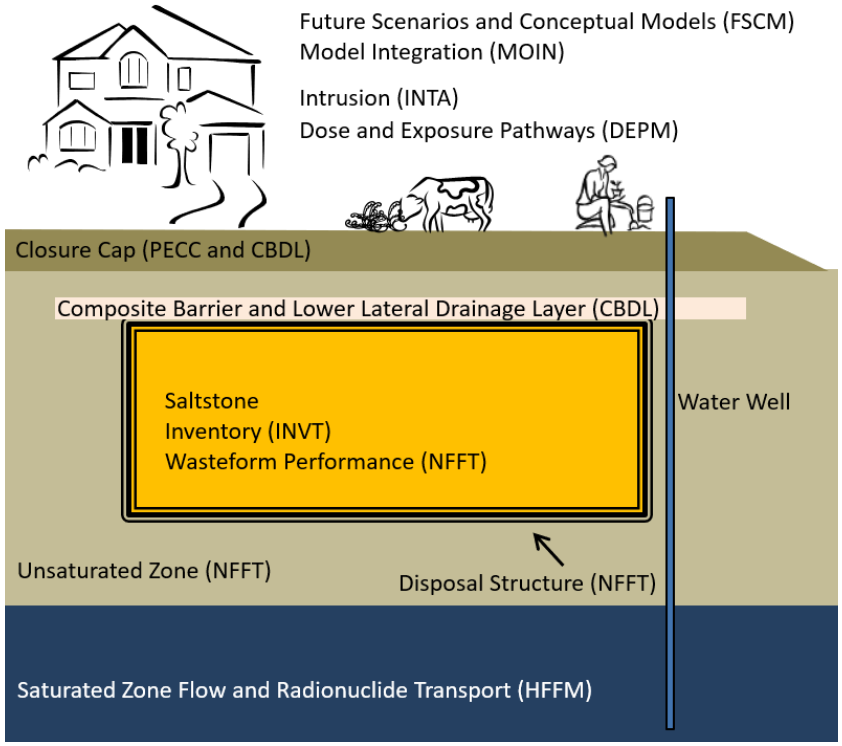

Figure 1-11: NRC Staff TRRs related to the §61.42 PO (DOE primary scenario was a well right next to saltstone and unlikely but plausible DOE scenario was drilling into saltstone)

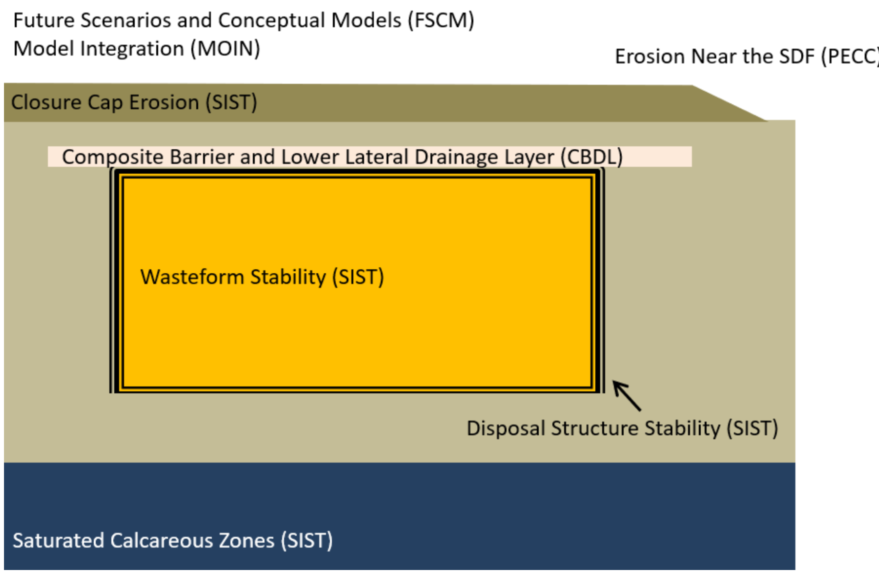

Figure 1-12: NRC Staff TRRs related to the §61.44 PO

1.5.1 NRC Staff Reviews in TRRs

The review scope of each of the NRC 10 TRRs are summarized below:

- Dose and Exposure Pathways Model (DEPM) TRR (ML23017A113):

- The DOE Dose Model for the 2020 SDF PA takes groundwater concentrations of radionuclides as input and represents transfers of those radionuclides from the groundwater, through the food chain, and to a human receptor. The NRC review scope included the modeling parameters and equations that the DOE used to project human exposures to radionuclides once the radionuclides enter the accessible environment and the resulting projected doses. For example, the review addressed DOE calculations related to the radioactivity a person could consume in water or inhale on dust. The review addressed exposures of individuals 100 m (328 ft) from the SDF and at nearby streams. It also addressed some aspects of the potential exposure for an individual who inadvertently intrudes into the SDF 100 years or more after site closure.

- Future Scenarios and Conceptual Models (FSCM) TRR (ML23017A088):
    - The DOE indicated that it considered the Central Scenario to be the scenario that represents the most probable and defensible future evolution of a disposal site. The DOE referred to any future scenario other than the Central Scenario as an alternative scenario. The NRC review scope included evaluating how well the PA represented future scenario and model uncertainty. To assess scenario uncertainty, the NRC staff reviewed potential future performance of the SDF for different future scenarios, including different climate states at the site. To determine how well the PA represented model uncertainty, the NRC staff evaluated the DOE site conceptual models and examined alternative conceptual models.

- Hydrogeology, Groundwater Monitoring, and Far-Field Modeling (HFFM) TRR (ML23017A084):
    - The purpose of this TRR is to document the NRC staff review of the hydrogeology, far-field monitoring, and groundwater monitoring used in the DOE 2020 PA. The NRC review scope included aspects of the hydrogeology that affected the projected dose to hypothetical members of the public at locations 100 m (328 ft) from the SDF boundary. Also, the review scope encompassed reviewing data and information obtained from groundwater monitoring at the SRS, and in particular, at the Z-Area. In addition, the review scope included evaluation of the parameters and equations used in various models by the DOE to simulate flow and transport in the unsaturated zone and saturated zone.

- Intrusion Analysis (INTA) TRR (ML23017A085):
    - The DOE modeled hypothetical drilling into soil near a disposal structure and drilling directly into a disposal structure as two different ways an inadvertent intruder could bring contaminated material to the surface. DOE based the intrusion analyses on many of the same models DOE used to project dose to an offsite member of the public. The review scope included the DOE analyses of the projected dose to an individual who inadvertently intrudes on the SDF.

- Inventory (INVT) TRR (ML23017A087):
    - The DOE modeled the final total radionuclide concentrations in the disposal structures, based on waste created to date and projections of future wastes processed by the SWPF. The NRC review scope included both the radionuclide inventory projections that the DOE used in models and the processes that the DOE used to develop the inventory. Those processes included: radionuclide

screening, calculation of best estimates of radionuclide activities, development of probabilistic distributions for inventory values, and performance of uncertainty and sensitivity analyses. Also, the review scope included the concentrations and volumes of waste emplaced in the SDF.

- Model Integration (MOIN) TRR (ML23017A090):
  - For the development of the 2020 SDF PA, the DOE identified relevant Features, Events, and Processes (FEPs), developed an interaction matrix of the system components and interactions between those components, and formulated a conceptual model and Central Scenario. The Compliance Case was developed from the Central Scenario to evaluate the long-term performance of the SDF. The DOE used a series of integrated submodels to estimate doses to various receptor groups. The NRC review scope included the DOE modeling approach, Quality Assurance (QA) related to the submodel integration, the DOE hybrid approach, and benchmarking of models.

- Near Field Flow and Transport (NFFT) TRR (ML23017A086):
  - Near Field Flow and Transport evaluates the movement of water right around and inside the disposal structures (see Figure 1-10) after it infiltrates through the cover. The NRC review scope included the DOE assessment of near field flow and transport. The near field is generally defined as the area encompassing the lower lateral drainage layer (LLDL), disposal structure, saltstone, and surrounding soils.

Performance of the cover system as a barrier to water flow through either shedding the water away from the disposal structures or evaporation was evaluated through two TRRs.

- Percolation Through and Potential Erosion near the Closure Cap (PECC) TRR (ML23017A083):
  - The TRR evaluates the performance of the cover in its upper levels as the initial part of the barrier system. The NRC review scope included analyses of percolation rates through, and potential erosion near, the closure cap. The NRC staff evaluated model outputs representing the surface cover water balance components such as precipitation, surface runoff, evapotranspiration, shallow infiltration, subsurface drainage, and the resulting deep infiltration. The NRC staff also evaluated potential future erosion processes, including gullying in the immediate area surrounding the SDF.

- Performance of the Composite Barrier Layers and Lateral Drainage Layers (CBDL) TRR (ML23017A089):
  - Water that penetrates the initial layers of the cover system then encounters additional engineered system to divert the water away from the disposal structures. The NRC review scope included the technical bases for modeled material properties of three types of barriers within the closure caps and disposal structures: (1) composite barriers consisting of HDPE geomembrane in combination with GCL; (2) HDPE geomembranes without GCLs, used as liners; and (3) lateral sand drainage layers used in conjunction with HDPE/GCL composite barriers modeled. Also, the review scope included evaluation of parameters and equations used in the DOE models to calculate or simulate flow in the covers.

- Site Stability (SIST) TRR (ML23017A114):
  - This TRR supports the evaluation of the overall Saltstone disposal system for long-term stability. Evaluating the overall stability of the system is important to evaluation of both long-term dose criteria (the 61.41 PO and the 61.42 PO) as well as the stability criteria (the 61.44 PO). The NRC review scope included the site stability with respect to the performance of the disposal structures, waste form, and the closure cap. Also, the review scope included assessment of static and dynamic settlement, including the presence of waste bags in SDS 4, floods, gully erosion, sheet and rill erosion, and slope stability.

1.5.2 NRC Staff Review Not in TRRs

In addition to the topics covered in the TRRs listed above, the NRC staff also performed a high-level review of other technical topics that did not need a TRR. Those topics were:

- DOE Air and Radon Pathway Model (under the §61.41 PO)

- DOE As Low As Reasonably Achievable (ALARA) Process and Analysis (under the §61.41 PO)

- Projected Dose to Inadvertent Intruder from Gaseous Radionuclide that could Volatilize from the SDF (under the §61.42 PO)

- DOE Radiation Protection Program and DOE Environmental Monitoring Program (under the §61.43 PO)

1.5.2.1 DOE Air and Radon Pathway Model (under the §61.41 PO)

The NRC staff performed a high-level review of the DOE Air and Radon Pathway Model. The NRC staff did not write a TRR because the NRC staff previously performed a detailed review of the DOE analysis of the projected dose from radionuclides that could volatilize from the saltstone grout in its analysis of the DOE 2009 SDF PA. As documented in the 2012 NRC TER (ML121170309), the NRC staff determined that radionuclides that could volatilize from saltstone were not expected to be risk-significant for the §61.41 PO.

In the 2020 SDF PA, the DOE re-evaluated the dose contributions from gaseous forms of the same eight radionuclides evaluated in the 2009 SDF PA: carbon-14, chlorine-36, hydrogen-3, I-129, antimony-125, selenium-79, tin-126, and Tc-99. The DOE chose those radionuclides because, based on their volatility and the projected inventory of the radionuclides and their parents, the DOE expected those radionuclides to cause the greatest dose contribution. In the 2012 TER, the NRC staff evaluated the DOE basis for selecting those radionuclides and found it to be acceptable.

In addition, in both the 2009 SDF PA and the 2020 SDF PA, the DOE evaluated the flux of radon-222 (Rn-222) from the ground surface above the SDF. The DOE included seven ancestors of Rn-22 in that calculation: curium-246, plutonium-242, plutonium-238, uranium-238, uranium-234, thorium-230, and radium-226.

Unlike the 2009 SDF PA, in the 2020 SDF PA the DOE simulated volatilization of radionuclides in the saltstone wasteform and transport to the ground surface directly above the disposal structures using the GoldSim modeling platform, rather than with a PORFLOW model. However, the DOE used the same conceptual model and data sources for both models, except for the apparent Henry's Law constant for Rn-222. In the 2012 TER, the NRC staff found the conceptual model and data sources that the DOE used in the 2009 SDF PA to be acceptable. For the 2020 SDF PA, the DOE provided the basis for the apparent Henry's Law constant for Rn-222 in the DOE document SRNL-STI-2017-00331. The NRC staff finds that basis to be acceptable because three different calculation methods gave similar results and the data sources were well documented.

In the 2012 TER, the NRC listed several assumptions that the DOE made in the Air and Radon Pathway model for the 2009 SDF PA that the NRC staff found to be conservative. The DOE made the same assumptions in the 2020 SDF PA. In the 2012 TER, the NRC staff also noted that neglecting the expected increased radionuclide volatility due to high ionic strength in the saltstone pore solutions and neglecting barometric pumping could be non-conservative; however, in the 2012 TER the NRC staff indicated that the staff did not expect those effects to be risk-significant.

As in the 2009 SDF PA, the DOE used the U.S. Environmental Protection Agency code CAP88-PC to evaluate the transport of gaseous radionuclides from the air directly above the disposal structures to the 100-m SDF boundary. The NRC staff did not re-evaluate the DOE CAP88-PC modeling in the review of the 2020 SDF PA because the NRC staff found the modeling to be acceptable in the review of the 2009 SDF PA. For a member of the public at the 100-m boundary, the DOE assumed both indoor and outdoor air concentrations of radionuclides were equal to the values that the DOE calculated using CAP88-PC. For an offsite member of the public, the NRC staff found that assumption to be acceptable because the NRC staff does not expect the radionuclides transported from the SDF to the 100-m boundary to concentrate in indoor air.

In the 2020 SDF PA, the projected that the peak dose within 10,000 years of SDF closure from gaseous radionuclides other than Rn-222 at the 100-m boundary would be 5.2×10^{-11} mSv/yr (5.2×10^{-9} mrem/yr), which is significantly less than the §61.41 PO limit of 0.25 mSv/yr (25 mrem/yr). The DOE projected the peak flux of Rn-222 at the land surface above a disposal structure within 10,000 years of SDF closure would be 2.7×10^{-5} Bq/(m^2·s) [7.4×10^{-4} pCi/(m^2·s)], which is orders of magnitude less than the DOE radon flux standard of 0.74 Bq/(m^2·s) [20 pCi/(m^2·s)]. Previous NRC analyses suggested the DOE radon flux standard of 2.7×10^{-5} Bq/(m^2·s) [7.4×10^{-4} pCi/(m^2·s)] would generally result in an inhalation dose on the order of 0.25 mSv/yr (20 mrem/yr), depending on site-specific conditions. Therefore, the NRC staff determined that the projected radon flux would not significantly contribute to the projected dose to a member of the public at the 100-m SDF boundary.

1.5.2.2 DOE ALARA Process and Analysis (under the §61.41 PO)

The NRC staff performed a high level review of the DOE ALARA process and analysis located in Section 5.9 of the 2020 SDF PA. The DOE used the ALARA process to optimize the DOE disposal facility performance by applying a graded approach to optimization of the disposal system for maintaining doses to members of the public (both individual and collective) and releases to the environment ALARA, per DOE Order 458.1 (*Radiation Protection of the Public and the Environment*) and as described in the *DOE Handbook Optimizing Radiation Protection* *of the Public and the Environment for Use with DOE Order 458.1, ALARA Requirements* (DOE-HDBK-1215-2014).

The DOE documented the SRS ALARA program and processes in the DOE document, WSRC-SA-2003-00001. The main results of the DOE ALARA analysis for the SDF were:

- the member of the public dose results in Section 5.5 of the 2020 SDF PA were more than three orders of magnitude lower than the DOE requirement;
- the air pathway dose results in Section 5.3 of the 2020 SDF PA were more than nine orders of magnitude lower than the DOE requirement; and
- the peak radon flux results in Section 5.3 of the 2020 SDF PA were more than five orders of magnitude lower than the DOE requirement.

The NRC staff found the DOE ALARA analysis in the 2020 SDF PA to be adequate because it followed the DOE ALARA process and the results met the DOE requirement. The DOE plans to maintain the entire center area of the SRS long-term, thereby reducing the probability of exposure to a member of the public from the SDF.

1.5.2.3 Projected Dose to Inadvertent Intruder from Gaseous Radionuclide that could Volatize from the SDF (under the §61.42 PO)

To evaluate the projected dose to an inadvertent intruder from gaseous radionuclides that could volatilize from the SDF, the NRC staff relied on the DOE analyses in both the 2020 SDF PA and the 2009 SDF PA. The NRC staff relied on both analyses because the DOE did not fully evaluate the potential dose to an inadvertent intruder from gaseous radionuclides that could volatilize from the SDF. Instead, Section 6.2.2 in the 2020 SDF PA states:

> "Based on the relatively low results of the air pathways dose at 100-meters . . . . any impacts from the airborne pathways dose is expected to be negligible relative to the impacts drill cuttings and groundwater concentrations and were not included in this analysis."

However, the NRC staff expects that gaseous radionuclide concentrations at the 100-m boundary would be significantly less than the concentrations of radionuclides in a home built directly above a disposal structure. However, in the 2009 SDF PA, the DOE evaluated the potential dose to an inadvertent intruder from (1) radon in a home built on the ground surface above a disposal structure, and (2) the entire activity of all other radionuclides projected to volatilize from the SDF in a year. In the 2012 TER, the NRC staff found that those analyses were acceptable because the DOE based the calculations on assumptions the NRC staff found to be either realistic or conservative. Those DOE analyses resulted in a peak projected dose of 5.2×10^{-7} mSv/yr (5.2×10^{-5} mrem/yr) for an inadvertent intruder from gaseous radionuclides that volatilized from the SDF, which is significantly less than the 5 mSv/yr (500 mrem/yr) the NRC staff uses to assess compliance with the §61.42 PO. Therefore, based on the results of those previous DOE analyses, the NRC staff expected the dose from radionuclides that volatilize from a disposal structure to an individual who inadvertently intrudes on the SDF and builds a home directly above a disposal structure would be far below the 5 mSv/yr (500 mrem/yr) dose limit the NRC staff uses to assess compliance with the §61.42 PO.

1.5.2.4 DOE Radiation Protection Program and DOE Environmental Monitoring Program (under the §61.43 PO)

In Section 2.5.2 of the 2009 DOE SDF PA, the DOE indicated that the §61.43 PO was not addressed in that document and that the DOE did not intend to address it in any future revision of the SDF PA. Consistent with that, the DOE did not provide any information about meeting the §61.43 PO in the 2020 SDF PA.

In the SDF Monitoring Plan, Rev. 1 (ML13100A113), the NRC indicated that MA 8 (Environmental Monitoring) applied to both the §61.41 PO and the §61.42 PO. Since then, the NRC staff determined that MA 8 also relates to the §61.43 PO because the DOE workers at the SDF could be exposed to radionuclides in the environment at the SDF.

In the SDF Monitoring Plan, Rev. 1 (ML13100A113), the NRC indicated that the DOE activities for the §61.43 PO for MA 11 (Radiation Protection Program) would be monitored at the SDF through the end of the institutional control period to verify that the DOE RPP was in place for operations, including worker dose, groundwater, and air effluent.

Regarding MA 8 (Environmental Monitoring), the NRC will continue to monitor the DOE activities for Environmental Monitoring in the future. Regarding MA 11, the NRC determined that the DOE continues to have an adequate RPP in place for SDF operations, the NRC will continue to receive updates from the DOE on the results of the DOE RPP (e.g., doses to workers), and the NRC will continue to monitor the DOE activities at the SDF through the end of the institutional control period to verify that the DOE RPP is in place for operations

2.0 §61.40: GENERAL REQUIREMENT

There are no specific review aspects related to the §61.40 PO. If the NRC concludes that the DOE disposal actions at the SDF would meet the other four specific POs (i.e., §61.41 PO, §61.42 PO, §61.43 PO, §61.44 PO), then the NRC will conclude that the DOE disposal actions at the SDF would meet the §61.40 PO.

3.0 §61.41: PROTECTION OF THE GENERAL POPULATION FROM RELEASES OF RADIOACTIVITY

The projected dose to an offsite member of the public depends on the concentration of radionuclides in the groundwater at the individual's location. The individual could be exposed to those radionuclides through exposure pathways. The concentration of radionuclides in the groundwater depends on the radionuclide concentration in liquid that could enter the aquifer under the disposal structures and the flow rate of that liquid. It also depends on water flow in the aquifer. The concentration of radionuclides in liquid that could exit from the disposal structure depends on the inventory of radionuclides in the waste and the chemical properties of the saltstone wasteform. The amount of water that could exit from the disposal structures depends on the infiltration through the Closure Cap, diversion of water by the engineered barriers over the disposal structures, and physical properties of the saltstone wasteform. In addition, the projected dose to a member of the general population depends in part on site stability, which is addressed under the §61.44 PO.

The NRC staff reviewed technical information regarding the protection of the general population from releases of radioactivity (§61.41 PO). The NRC staff issued TRRs related to that technical information. The main NRC staff determinations related to the §61.41 PO in each TRR are included below:

- Dose and Exposure Pathways Model (DEPM) TRR:
    - The NRC staff determined that the DEPM for the 2020 SDF PA was acceptable because the modeled exposure pathways and parameter values were generally consistent with the definition of the average member of the critical group and the site-specific conditions. Exceptions to that determination were noted in the TRR; however, the NRC staff does not find those exceptions to significantly affect the projected dose.

- Future Scenarios and Conceptual Models (FSCM) TRR:
    - In general, the NRC staff determined that the DOE processes for developing FSCM for the 2020 SDF PA was comprehensive and well documented. Exceptions to that determination were noted in the TRR.

    - The NRC staff determined that the DOE addressed the implementation of several risk-significant FEPs (i.e., seismicity, subsidence, erosion, weathering, mass wasting) by indicating that a future design of the closure cap would limit the consequences of the FEPs. The NRC staff determined that the risk significance of those FEPs and the uncertainty of the future design and implementation of that design limited the NRC staff ability to assess the projected performance of the SDF.

    - The NRC staff determined that the DOE process for developing an initial list of FEPs was acceptable because it was thorough and well documented. However, the NRC staff determined the FEPs analysis frequently used general FEPs instead of a set of more specific FEPs related to discrete features of the SDF, which caused significant discrete FEPs to be left out the FEPs analysis.

    - The NRC staff determined that the DOE FEPs auditing process was not completely transparent because the DOE did not indicate why the judgement of the analysts who excluded FEPs in the final step of the FEPs auditing process superseded the judgement of the FEPs screening team members who screened those FEPs in.

    - The NRC staff determined that some of the DOE alternative scenarios lacked plausibility because they did not reflect alternative scenarios with a plausible evolution of the site different from that of the Central Scenario. Also, the NRC staff determined that many of the alternative conceptual models did not account for the interdependencies and interrelationships between FEPs that would occur in a plausible alternative future scenario and frequently not all plausible FEPs for a specific alternative scenario were included in the conceptual model. In addition, the NRC staff determined that the DOE did not evaluate all plausible alternative conceptual models for the Central Scenario (e.g., exposure scenario involving potentially significant contaminant transport to the 100 m (328 ft) boundary within the UTRA-UAZ and use of the UTRA-UAZ as the hypothetical receptor’s main water source.)

As discussed in detail in the TRR and summarized in the enclosed Appendix, the NRC staff recommends changing NRC monitoring of the DOE disposal actions at the SDF by opening a new monitoring area and new monitoring factors to include DOE scenarios, conceptual models, identification and screening of FEPs, and designs and analyses; including scenarios with the UTRA-UAZ as the main source of water.

- Hydrogeology, Groundwater Monitoring, and Far-Field Modeling (HFFM) TRR:
  - The NRC staff determined that the models used for simulating unsaturated and saturated flow and transport in the 2020 SDF PA were adequate for modeling the projected dose from the SDF if there is not significant lateral flow and radionuclide transport in the UTRA-UAZ. Those models and their parameter values were generally consistent with the hydrogeological knowledge of the SDF area; however, the models did not represent the potential for significant lateral flow in the UTRA-UAZ.

  - The NRC staff determined that the current groundwater monitoring system for the SDF was not adequate in order to assess whether leaching from saltstone at each disposal structure has occurred because the number of groundwater monitoring wells in the UTRA-UAZ was not adequate. The NRC staff previously made a similar determination in a 2018 TRR (ML18117A494). The NRC staff determined that the most plausible conceptual model of flow and transport suggested that both aquifer zones (i.e., the UAZ and the LAZ) need to have monitoring wells to adequately monitor potential releases from disposal structures. In addition, the NRC staff determined that the UTRA-LAZ had insufficient background wells; therefore, the NRC staff may be unable to assess if leaching from saltstone into the UTRA-LAZ was occurring.

As discussed in detail in the TRR and summarized in the enclosed Appendix, the NRC staff recommends changing NRC monitoring of the DOE disposal actions at the SDF by modifying an existing monitoring area to include monitoring subsurface flow as well as modifying existing monitoring factors to include additional technical issues related to the groundwater monitoring system in the Z-Area and leachate impact factor issues; and opening new monitoring factors to include GSA modeling results, far-field model calibration, and local SDF modeling results.

- Inventory (INVT) TRR:
  - The DOE significantly changed the number and design of the SDF disposal structures since the NRC issued the 2012 TER based on the DOE 2009 SDF PA. Therefore, the NRC staff reviewed the changes in the projected SDF closure inventory in its entirety. The NRC staff evaluated DOE documentation of radionuclides that have already been emplaced in the SDF, radionuclides in the SRS Tank Farms, and radionuclides in H-Canyon that the DOE expects to add to the SRS Tank Farms. The NRC staff determined that the largest source of uncertainty in the inventory for most radionuclides was in the projected inventory in the SRS Tank Farms.

  - The radionuclide concentrations in saltstone were an input into the model the DOE used to project a dose to an individual who inadvertently intrudes into the SDF 100 years or more after site closure.

  - The NRC staff determined that the radionuclide inventories in the DOE 2020 SDF

PA were acceptable for modeling the projected dose from the SDF. In addition, the NRC staff determined that the resulting radionuclide concentrations in saltstone were acceptable as one input to the inventory for modeling the dose to an individual who intrudes on the SDF.

- Model Integration (MOIN) TRR:
  - The NRC staff determined that the integration of DOE 2020 SDF PA submodels was acceptable because of the DOE documented QA activities, the NRC staff limited-scope QA review, and the use of intermediate model results to verify consistency between the conceptual and mathematical models.

  - The NRC staff determined that the SDF GoldSim Model was acceptable for the purpose of providing risk insights for the DOE 2020 SDF PA because: (1) the integration with the deterministic models was traceable and correct, and (2) the DOE benchmarking process provided assurance that the SDF GoldSim Model represented key behaviors of the detailed deterministic models under a range of radionuclides, locations and flow conditions.

- Near Field Flow and Transport (NFFT) TRR:
  - The NRC staff determined that the NFFT modeling in the DOE 2020 SDF PA included several significant improvements from the DOE 2009 SDF PA in areas such as: (1) degradation of saltstone grout in the Compliance Case, (2) initial properties of saltstone grout based on field-emplaced saltstone core samples, (3) solubility-controlled release of technetium (Tc)-99 based on laboratory analysis of saltstone core samples, (4) updated K_d value for iodine (I)-129, (5) reduction in the assumed performance of the disposal structures, and (6) moisture characteristic curves that were less risk-significant and more consistent with the literature.

  - The NRC staff determined that the information provided in the DOE 2020 SDF PA and supporting documents did not provide a sufficient basis for the NRC staff to assess near field flow and transport because the DOE indicated that the design and implementation plan for risk-significant features of the SDF (i.e., the closure cap) has not been completed.

  As discussed in detail in the TRR and summarized in the enclosed Appendix, the NRC staff recommends changing NRC monitoring of the DOE disposal actions at the SDF by modifying existing monitoring factors to include erosion control, not just erosion protection; and opening new monitoring factors to include long-term erosion barrier performance and shallow infiltration.

- Percolation Through and Potential Erosion near the Closure Cap (PECC) TRR:
  - For the deterministic modeling results documented in the DOE 2020 SDF PA, the NRC staff determined that the shallow infiltration estimates were acceptable. Although the NRC staff found that the currently assigned value for the fill material between the stones of the erosion barrier was acceptable for modeling purposes, the final choice of material for the infill between the riprap stones has not been made and the NRC staff determined that the long-term performance of the erosion barrier was risk-significant for modeling both percolation and erosion.

  - The NRC staff determined that the deep infiltration rate estimates the DOE used in the deterministic model in the 2020 SDF PA were not acceptable because the technical bases for the long-term performance of risk-significant cover barrier layers lacked confirmatory evidence and model support to match their risk significance.

- The purpose of the DOE GoldSim-based probabilistic SDF Closure Cap Model the DOE developed in response to NRC RSI Questions was to estimate uncertainty in long-term deep infiltration rates, rather than to provide a compliance demonstration. Thus, the results of the review and evaluation by the NRC staff were in reference to the acceptability or not of the DOE probabilistic modeling exercises to estimate uncertainties and obtain risk insights, rather than in reference to obtaining reasonable assurance with regard to safety standards.

    - The NRC staff determined that the DOE responses to the NRC RSI Questions with regard to uncertainty distributions for the probabilistic mode involving the sand drainage layer, the initial defect frequencies, High Density Polyethylene (HDPE) service life, initial HDPE defect diameters, and the Geosynthetic Clay Layer (GCL) were acceptable because the technical bases were sound and the distributions were sufficiently large to allow risk insights associated with saltstone degradation and dose to be gained.

    - The NRC staff determined that the implementation of the shallow infiltration abstraction (i.e., called percolation by the DOE) for the probabilistic SDF Closure Cap Model was not acceptable due to the large uncertainty in evaporation rates, the long-term hydraulic performance of the erosion barrier, and multiple other reasons.

    - For the probabilistic SDF Closure Cap Model, the NRC staff determined that the deep infiltration rates provided in response to the NRC RSI Question for future modeling was acceptable for uncertainty analyses because the range included values that were orders of magnitude higher than the deep infiltration rates used in the DOE 2020 SDF PA. The NRC staff determined that those rates were acceptable for estimating uncertainties and obtaining risk insights associated with long-term deep infiltration rates.

- The NRC staff determined that the approach and calculations that the DOE used to evaluate erosion near the SDF were largely acceptable. Although the NRC staff determined that the DOE calculations providing gully erosion and sheet and rill erosion results near the SDF were acceptable, with the exception of the rainfall intensity parameter and soil erodibility factor, respectively, the NRC staff determined that the DOE results were incomplete because the DOE did not present results for wetter and drier climate conditions.

As discussed in detail in the TRR and summarized in the enclosed Appendix, the NRC staff recommends changing NRC monitoring of the DOE disposal actions at the SDF by modifying existing monitoring factors to include erosional degradation of the SDF closure cap and the area adjacent to the SDF closure cap, contaminant release from the disposal structures; delay in degradation of saltstone grout; as well as the sorption of iodine in oxidized mud mats, iodine sorption in chemically oxidized cement-free saltstone, and technetium solubility in cement-free saltstone.

- Performance of the Composite Barrier Layers and Lateral Drainage Layers (CBDL) TRR:
  - The NRC staff determined that the calculations and models used to calculate and simulate flow rates into the lower backfill through the Upper Lateral Drainage Layer (ULDL), the HDPE geomembrane, and the GCL (i.e., the ULDL barrier) were not sufficient for modeling the projected dose from the SDF because a number of plausible degradation processes that affect long-term performance of the ULDL barrier, especially long-term processes with the potential to degrade the GCL, were not included or used to calculate or simulate flow rates through the ULDL barrier and into the lower backfill in the SDF PA.

  - The NRC staff determined that confined conditions in the planned ULDL located in the lower portions at the end of long slope lengths were plausible. Such conditions would cause saturated conditions to occur above the ULDL with potentially detrimental results for the stability of the site and the health of the flora (relevant for transpiration) growing on the closure cap surface.

  - The NRC staff determined that long-term performance of the composite barrier layers does rely heavily on a QA/Quality Control component to ensure future emplacements and installations will be managed and executed at a very high standard. Holes, tears, rips, and wrinkles will need to be identified and repaired in such a way as to minimize reduction in long-term performance. Therefore, the NRC staff will make a final determination on demonstrating compliance when the DOE finalizes the Closure Cap design and construction.

  - The NRC staff determined that the calculations and models used to calculate and simulate flow rates through the LLDL and mud-mat barriers were adequate for modeling the projected dose from the SDF because the technical basis and justification associated with those features was sufficient in relation to their significance to performance. As simulated and presented in the DOE 2020 SDF PA, the ULDL barrier was the dominant barrier that reduced flow between the upper and lower portions of the closure cap (i.e., the input and output of the Closure Cap Model) by many orders of magnitudes. As such, the LLDL and mud-mat barriers were best seen as backup barriers; however, if the compliance cases should change to include significant flow through the LLDL barrier and significant surface area of saltstone being exposed to fast pathways through the disposal structures, then the adequacy of these barriers for modeling the projected dose from the SDF would need to be reassessed.

  As discussed in detail in the TRR and summarized in the enclosed Appendix, the NRC staff recommends changing NRC monitoring of the DOE disposal actions at the SDF by opening new monitoring factors to include QA/QC for HDPE/GCL composite barrier and drainage layer installation, long-term HDPE/GCL composite barrier and drainage layer degradation, and potential confined conditions in the ULDL.

- Site Stability (SIST) TRR:
  - The closure cap consists of a series of layers that work in conjunction with each other and the performance of which affects the other layers. For example, the low permeability of the HDPE/GCL composite layer that limits deeper infiltration results in the buildup of hydraulic head in the upper sand drainage layer up to the

topsoil. That creates saturated conditions that could affect plant speciation on top of the cover and result in overland flow, both of which can impact erosion rates. The buildup of head also affects slope stability and could impact the performance of the sand drainage layer.

- o Based on the risk significance and uncertainty in the performance of the closure cap, the NRC staff needs additional confidence in: (1) gully erosion, (2) sheet and rill erosion, (3) slope stability, and (4) sand entrainment.

- o The NRC staff noted that one way to significantly reduce uncertainty and increase confidence in model projections would be to construct and monitor a test cover. The DOE has built test covers at the Hanford site and uranium mill tailing sites for those reasons.

- o The NRC staff determined that the information provided in the DOE 2020 SDF PA and supporting documents did not provide a sufficient basis for the NRC staff to assess the stability of the SDF because the DOE indicated that the design and implementation plan for risk-significant features of the SDF was not complete.

As discussed in detail in the TRR and summarized in the enclosed Appendix, the NRC staff recommends changing NRC monitoring of the DOE disposal actions at the SDF by opening new monitoring factors to include gullying, sheet erosion, rill erosion, and slope stability of the closure cap; flow through the ULDL; degradation of the erosion barrier; static-loading induced settlement; and settlement due to waste bags in SDS 4; as well as by modifying an existing monitoring factor to include settlement due to seismic loading.

<u>Conclusion about the §61.41 PO:</u>

The NRC staff reviewed the DOE 2020 SDF PA, supporting references, the DOE models supporting the PA, and the DOE uncertainty and sensitivity analyses. Based on the NRC staff review of those DOE analyses and independent NRC staff analyses, the NRC staff determined that the projected infiltration rate will be a key variable in evaluation of releases of radioactivity from the SDF. In the DOE models supporting the 2020 SDF PA, the Closure Cap controls the projected infiltration to the disposal structures. In the DOE 2020 SDF PA, the DOE indicated that the Closure Cap design and implementation plan were not final. The NRC staff finds that there is reasonable assurance that the DOE can meet the 10 CFR Part 61 PO for protection of the general population from releases of radioactivity (§61.41) *if* the future DOE Closure Cap design and implementation achieve the DOE expected performance. Therefore, the NRC conclusion depends on the DOE final design and implementation of the Closure Cap, which will be key as the NRC continues to monitor the DOE disposal actions at the SDF. Also, from Section 1.5.2.1 above, the NRC determines that the DOE Air and Radon Pathway Model is acceptable. In addition, from Section 1.5.2.2 above, the NRC determines that the DOE ALARA Process and Analysis is acceptable.

4.0 §61.42: PROTECTION OF INDIVIDUALS FROM INADVERTENT INTRUSION

The NRC staff reviewed technical information regarding the protection of individuals from inadvertent intrusion (§61.42 PO). The NRC staff issued one TRR that solely focused on that technical information. In addition, the NRC staff determined that several aspects of the review for the §61.41 PO relate to this PO, especially concerning groundwater. Radionuclide concentrations in groundwater also affect the projected dose for the §61.42 PO because both an offsite member of the general public (i.e., for the §61.41 PO) and an individual who inadvertently intrudes on the SDF (i.e., for the §61.42 PO) receive a dose from ingesting groundwater. Specifically, the NRC staff determined that the data and models the DOE used to project infiltration through the closure cap, erosion of the closure cap, flow through the composite barrier and drainage layers above the disposal structures, hydraulic performance of saltstone, radionuclide release from saltstone, and saltstone degradation affect the projected dose to an individual who inadvertently intrudes on the SDF.

- The NRC staff determines that the conclusions in the following TRRs are applicable for the §61.42 PO as well as for the §61.41 PO:
    - Dose and Exposure Pathways Model (DEPM) TRR
    - Future Scenarios and Conceptual Models (FSCM) TRR
    - Hydrogeology, Groundwater Monitoring, and Far-Field Modeling (HFFM) TRR
    - Inventory (INVT) TRR
    - Model Integration (MOIN) TRR
    - Near Field Flow and Transport (NFFT) TRR
    - Percolation Through and Potential Erosion near the Closure Cap (PECC) TRR
    - Performance of the Composite Barrier Layers and Lateral Drainage Layers (CBDL) TRR
    - Site Stability (SIST) TRR

- The main NRC staff determinations related to the §61.42 PO in the Intrusion Analysis (INTA) TRR are:

    - The NRC staff finds that the two intrusion analyses in the 2020 SDF PA, as supplemented by the DOE responses to NRC RAI Questions are acceptable for modeling the projected dose because, collectively, the intrusion analyses represent the main sources of radioactivity, intrusion exposure scenarios, and exposure pathways.

    - Although the NRC staff disagrees with the DOE determination that the grout-drilling scenario was an implausible inadvertent intrusion exposure scenario, the NRC staff determines that the DOE analysis of the grout-drilling scenario as an alternative analysis provides sufficient information for the NRC staff to use in its evaluation.

    - The NRC staff determines that, collectively, the deterministic and probabilistic sensitivity analyses are acceptable for providing risk insights into the key model assumptions because they represent key sources of uncertainty in a chronic intrusion exposure scenario. However, the NRC staff also determines that the insights are limited by excluding sensitivity and uncertainty analyses centered on either the acute scenarios or the chronic grout-drilling scenario.

<u>Conclusion about the §61.42 PO:</u>

The NRC staff reviewed the DOE intrusion analysis in the DOE 2020 SDF PA, supporting references, the DOE intrusion model within the SDF GoldSim model, and the DOE uncertainty and sensitivity analyses for inadvertent intrusion. Based on the NRC staff review of those DOE documents and independent NRC staff analyses, the NRC staff finds that the most important sources of uncertainty in the projected dose to an inadvertent intruder is the composition of the drill cuttings (i.e., grout or soil) and the volume of drill cuttings brought to the surface. Although the projected infiltration rate also affects the projected dose to an inadvertent intruder, the infiltration rate is not the largest source of uncertainty in that analysis. The NRC finds that in the unlikely but plausible case that an individual drills a well directly into a 375-foot disposal structure, the NRC staff expects that the projected dose would be less than 5 milliSieverts/yr (mSv/yr) (500 mrem/yr). Therefore, the NRC staff concludes that it has reasonable assurance that waste disposal at the SDF meets the 10 CFR Part 61 Subpar C Performance Objective for protection of individuals from inadvertent intrusion (§61.42). Also, from Section 1.5.2.3 above, the NRC finds that the Projected Dose to Inadvertent Intruder from Gaseous Radionuclide that could Volatize from the SDF is acceptable.

5.0 §61.43: PROTECTION OF INDIVIDUALS DURING OPERATIONS

While the §61.43 PO is not applicable to post-closure, the NRC staff reviewed technical information regarding the protection of individuals from operations (§61.43 PO) in previous monitoring. The two monitoring areas related to the §61.43 PO (i.e., Monitoring Area (MA) 8 (Environmental Monitoring) and MA 11 (Radiation Protection Program (RPP)) were addressed in a TRR, even though the §61.43 PO was not specifically addressed in that TRR. The technical information related to the §61.43 PO is in the Hydrogeology, Groundwater Monitoring, and Far-Field Modeling (HFFM) TRR.

Conclusion about the §61.43 PO:

The NRC will continue to monitor the DOE activities in MA 8 (Environmental Monitoring) and MA 11 (Radiation Protection Program) during operations. The NRC staff concludes that it has reasonable assurance that waste disposal at the SDF meets the §61.43 PO because the NRC staff evaluated the DOE Radiation Protection Program in one of the early OOVs and found the Program to be acceptable and the DOE provides the NRC with routine updates on the doses recorded under the Program.

6.0 §61.44: STABILITY OF THE DISPOSAL SITE AFTER CLOSURE

The NRC staff reviewed technical information regarding the stability of the disposal site after closure (§61.44 PO). The NRC staff issued two TRRs related to that technical information for the §61.44 PO. The technical information of that TRR related to the §61.44 PO is in the Site Stability (SIST) TRR and in the Percolation Through and Potential Erosion near the Closure Cap (PECC) TRR.

Conclusion about the §61.44 PO:

The NRC staff reviewed the DOE 2020 SDF PA, supporting references, the DOE models supporting the PA, and the DOE uncertainty and sensitivity analyses. Based on the NRC staff review of those DOE documents and independent NRC staff analyses, the NRC staff expects that the design and implementation of the Closure Cap will significantly affect site stability. However, in the 2020 SDF PA the DOE indicated that the DOE had not finalized the Closure Cap design or made final decisions about key aspects of the implementation of the Closure Cap (e.g., materials specifications). The NRC staff finds that there is reasonable assurance that the DOE can meet the §61.44 PO *if* the future DOE Closure Cap design and implementation achieve the DOE expected performance. Therefore, the NRC conclusion about the §61.44 PO depends on the DOE final design and implementation of the Closure Cap.

7.0 NRC CONCLUSIONS

The NRC conducted its independent, risk-informed, performance-based technical review pursuant to the NDAA. The NRC reviewed the 2020 DOE SDF PA and its supporting documents, including documents provided by the DOE after the DOE Submittal. Based on the information in this TER, if the DOE Closure Cap design and implementation achieve the DOE expected performance as described in the 2020 SDF PA, then the NRC concludes that it has reasonable assurance that the DOE disposal actions at the SDF meet or will meet all the 10 CFR Part 61 POs, including the §61.40 PO.

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APPENDIX: CHANGES TO THE NRC MONITORNG PLAN

The U.S. Nuclear Regulatory Commission (NRC), in coordination with the State of South Carolina, monitors U.S. Department of Energy (DOE) disposal actions at the DOE Savannah River Site (SRS) Saltstone Disposal Facility (SDF) in perpetuity to determine whether the DOE would meet the Title 10 of the *Code of Federal Regulations* (CFR) Part 61, Subpart C Performance Objectives (POs), under Section 3116(b) of *The Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005* (NDAA).

The POs are the following:

- **§61.40: General Requirement –** Land disposal facilities must be sited, designed, operated, closed, and controlled after closure so that reasonable assurance exists that exposures to humans are within the limits established in the POs in §61.41 through §61.44.

- **§61.41: Protection of the General Population from Releases of Radioactivity –** Concentrations of radioactive material which may be released to the general environment in groundwater, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable.

- **§61.42: Protection of Individuals from Inadvertent Intrusion –** Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.

- **§61.43: Protection of Individuals during Operations –** Operations at the land disposal facility must be conducted in compliance with the standards for radiation protection set out in part 20 of this chapter, except for releases of radioactivity in effluents from the land disposal facility, which shall be governed by §61.41 of this part. Every reasonable effort shall be made to maintain radiation exposures as low as is reasonably achievable.

- **§61.44: Stability of the Disposal Site after Closure –** The disposal facility must be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate to the extent practicable the need for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, or minor custodial care are required.

The current NRC SDF Monitoring Plan, Rev. 1 (NRC's Agencywide Documents Access and Management System [ADAMS] under Accession No. ML13100A113) is based on major technical areas identified as monitoring areas and within each monitoring area are one or more specific technical topics identified as monitoring factors. The scope and approach for SDF Monitoring Plan, Rev. 1 were developed as a result of: (1) the NRC review of the DOE 2009 SDF PA and its supporting documents, as shown in the NRC 2012 TER for the SDF, and (2) the NRC experience from monitoring the DOE disposal actions at the SDF under SDF Monitoring Plan, Rev. 0, such that the NRC determined that the Key Monitoring Areas in SDF Monitoring Plan, Rev. 0 were too broad and needed more specificity.

Based upon the POs, the NRC created/identified monitoring areas and related each PO, except for §61.40, to one or more monitoring area. Then, the NRC created/identified monitoring factors and related each monitoring area to one or more monitoring factor. Note that the combination of monitoring areas/monitoring factors in SDF Monitoring Plan, Rev. 1 replaced the Key Monitoring Areas in SDF Monitoring Plan, Rev. 0. The NRC included the “Factors” from Appendix A of the NRC 2012 TER and the three then “Open Issues” under SDF Monitoring Plan, Rev. 0 in the monitoring factors. The NRC included in the description of each monitoring factor what the NRC expected to happen in order to “Close” the monitoring factor. After the NRC issued SDF Monitoring Plan, Rev. 0, the NRC created priorities for each monitoring factor of High, Medium, Low, or Periodic.

The SDF Monitoring Plan, Rev. 1 was supplemented by six NRC letters from June 5, 2017, to October 18, 2021 (ML17097A351, ML18033A071, ML18107A161, ML18219B035, ML19150A295, ML21279A173). In those six NRC letters, the NRC OPENED monitoring factors, CLOSED monitoring factors, UPDATED text of monitoring factors, CHANGED priorities of monitoring factors, and CLARIFIED how the NRC counted monitoring factors.

Table A-1 below provides the overall structure of the NRC Monitoring Plan for the SDF after implementing changes, including *italics* (for additions) and ~~strikeout~~ (for deletions), from the six NRC Letters Supplementing SDF Monitoring Plan, Rev. 1.

Table A-1: Overall Structure of NRC Monitoring Plan for the SDF After Implementing Changes from Six NRC Letters Supplementing SDF Monitoring Plan, Rev. 1

Monitoring Area (MA)	Monitoring Factor (MF)	Performance Objective(s)	Priority
MA 1: Inventory			
	MF 1.01: Inventory in Disposal Structures	§61.41 & §61.42	Periodic
	MF 1.02: Methods Used to Assess Inventory	§61.41 & §61.42	Medium
MA 2: Infiltration and Erosion Control			
	MF 2.01: Hydraulic Performance of Closure Cap	§61.41 & §61.42	~~Low~~ *Medium*
	MF 2.02: Erosion Protection	§61.41 & §61.42	Low
MA 3: Waste Form Hydraulic Performance			
	~~MF 3.01: Hydraulic Conductivity of Field-Emplaced Saltstone~~ **CLOSED**	~~§61.41 & §61.42~~	~~High~~
	~~MF 3.02: Variability of Field-Emplaced Saltstone~~ **CLOSED**	~~§61.41 & §61.42~~	~~High~~
	MF 3.03: Applicability of Laboratory Data to Field-Emplaced Saltstone	§61.41 & §61.42	High
	~~MF 3.04: Effect of Curing Temperature on Saltstone Hydraulic Properties~~ **CLOSED**	~~§61.41 & §61.42~~	~~High~~
MA 4: Waste Form Physical Degradation			
	MF 4.01: Waste Form Matrix Degradation	§61.41 & §61.42	High
	MF 4.02: Waste Form Macroscopic Fracturing	§61.41 & §61.42	High

Monitoring Area (MA)	Monitoring Factor (MF)	Performance Objective(s)	Priority
MA 5: Waste Form Chemical Degradation			
	MF 5.01: Radionuclide Release from Field-Emplaced Saltstone	§61.41 & §61.42	High
	MF 5.02: Chemical Reduction of Tc by Saltstone	§61.41 & §61.42	~~High~~ *Medium*
	MF 5.03: Reducing Capacity of Saltstone	§61.41 & §61.42	~~Medium~~ *Low*
	MF 5.04: Certain Risk-Significant K_d Values for Saltstone	§61.41 & §61.42	Medium
	~~MF 5.05: Potential for Short-Term Rinse-Release from Saltstone~~ **CLOSED**	~~§61.41 & §61.42~~	~~Medium~~
MA 6: Disposal Structure Performance			
	MF 6.01: Certain Risk-Significant K_d Values in Disposal Structure Concrete	§61.41 & §61.42	Medium
	~~MF 6.02: Tc Sorption in Disposal Structure Concrete~~ **CLOSED**	~~§61.41 & §61.42~~	~~High~~
	MF 6.03: Performance of Disposal Structure Roofs and HDPE/GCL Layers	§61.41 & §61.42	Medium
	MF 6.04: Disposal Structure Concrete Fracturing	§61.41 & §61.42	Medium
	MF 6.05: Integrity of Non-cementitious Materials	§61.41 & §61.42	Medium
MA 7: Subsurface Transport			
	MF 7.01: Certain Risk-Significant K_d Values in Site Sand and Clay	§61.41 & §61.42	Medium
MA 8: Environmental Monitoring			
	MF 8.01: Leak Detection	§61.41, §61.42, *& §61.43*	Periodic
	MF 8.02: Groundwater Monitoring	§61.41 & §61.42	Periodic
	MF 8.03: Identification and Monitoring of Groundwater Plumes in the Z-Area	*§61.41, §61.42, & §61.43*	*Periodic*
MA 9: Site Stability			
	MF 9.01: Settlement Due to Increased Overburden	§61.41, §61.42, & §61.44	Medium
	MF 9.02: Settlement Due to Dissolution of Calcareous Sediment	§61.41, §61.42, & §61.44	Medium
MA 10: Performance Assessment Model Revisions			
	MF 10.01: Implementation of Conceptual Models	§61.41 & §61.42	High
	MF 10.02: Defensibility of Conceptual Models	§61.41 & §61.42	High
	MF 10.03: Diffusivity in Degraded Saltstone	§61.41 & §61.42	Medium
	MF 10.04: K_d Values for Saltstone	§61.41 & §61.42	Low
	MF 10.05: Moisture Characteristic Curves	§61.41 & §61.42	~~Low~~ *Medium*

Monitoring Area (MA)	Monitoring Factor (MF)	Performance Objective(s)	Priority
	MF 10.06: K_d Values for Disposal Structure Concrete	§61.41 & §61.42	Low
	MF 10.07: Calculation of Build-Up in Biosphere Soil	§61.41 & §61.42	Low
	MF 10.08: Consumption Factors and Uncertainty Distributions for Transfer Factors	§61.41 & §61.42	Medium
	MF 10.09: K_d Values for SRS Soil	§61.41 & §61.42	Low
	MF 10.10: Far-Field Model Calibration	§61.41	Medium
	MF 10.11: Far-Field Model Source Loading Approach	§61.41	Medium
	MF 10.12: Far-Field Model Dispersion	§61.41	Medium
	MF 10.13: Impact of Calcareous Zones on Contaminant Flow and Transport	§61.41	Low
	MF 10.14: Scenario Development and Defensibility	*§61.41*	*Medium*
MA 11: Radiation Protection Program			
	MF 11.01: Dose to Individuals During Operations	§61.43	Periodic
	MF 11.02: Air Monitoring	§61.43	Periodic

In the NRC Technical Review Reports (TRRs) for this NRC TER for the SDF, the NRC staff recommends changes to NRC monitoring of DOE disposal actions at the SDF, including: (1) relating each of the monitoring areas to the appropriate PO, (2) relating each of the monitoring areas to one or more monitoring factors, and (3) specific changes to the NRC Monitoring Plan for the SDF

Those TRRs were described in Section 1.5.1 of the TER and for convenience the TRRs are listed below:

- Dose and Exposure Pathways Model (DEPM) TRR
- Future Scenarios and Conceptual Models (FSCM) TRR
- Hydrogeology, Groundwater Monitoring, and Far-Field Modeling (HFFM) TRR
- Intrusion Analysis (INTA) TRR
- Inventory (INVT) TRR
- Model Integration (MOIN) TRR
- Near Field Flow and Transport (NFFT) TRR
- Percolation Through and Potential Erosion near the Closure Cap (PECC) TRR
- Performance of the Composite Barrier Layers and Lateral Drainage Layers (CBDL) TRR

- Site Stability (SIST) TRR

Within one year of issuing this TER, the NRC expects to issue a revised SDF Monitoring Plan, (Rev. 2) that will be based on the already made changes to the existing monitoring plan since SDF Monitoring Plan (Rev. 1) was issued in 2013, this TER, the 10 TRRs issued with this TER, and any changes that the DOE makes based upon this TER.

Table 1-4 in the 2013 NRC Monitoring Plan for the SDF (Rev. 1) contains how the Monitoring Areas related to the Performance Objectives at that time. Table A-2 below updates that table and contains the NRC staff recommended Monitoring Areas vs. Performance Objectives, including the changes recommended in *italics* (for additions) and ~~strikeout~~ (for deletions) in the TRRs.

Table A-2: NRC Staff Recommended Monitoring Areas vs. Performance Objectives

Monitoring Area (MA)	§61.41 PO	§61.42 PO	§61.43 PO	§61.44 PO
MA 1: Inventory	X	X		
MA 2: Infiltration and Erosion Control *(UPDATE Title of monitoring area from PECC TRR and UPDATE to Add §61.44 from SIST TRR)*	X	X		*X*
MA 3: Waste Form Hydraulic Performance	X	X		
MA 4: Waste Form Physical Degradation	X	X		
MA 5: Waste Form Chemical Degradation	X	X		
MA 6: Disposal Structure Performance	X	X		
MA 7: Subsurface Flow and Transport *(UPDATE Title of monitoring area from HFFM TRR)*	X	X		
MA 8: Environmental Monitoring *(UPDATE to Add §61.43 PO, not specific to a TRR)*	X	X	*X*	
MA 9: Site Stability	X	X		X
~~MA 10: Performance Assessment Model Revisions~~ *(CLOSE MA 10, CLOSE monitoring factors, OPEN similar technical issues under new monitoring factors in other monitoring areas from multiple TRRs)*	~~X~~	~~X~~		
MA 11: Radiation Protection Program			X	
MA 12: Biosphere *(OPEN new monitoring area from DEPM TRR)*	*X*	*X*		
MA 13: Inadvertent Intrusion *(OPEN new monitoring area from INTA TRR)*		*X*		
MA 14: Future Scenarios and Conceptual Models *(OPEN new monitoring area from FSCM TRR)*	*X*	*X*		

Table A-3 below contains the NRC staff recommended changes to the NRC Monitoring Plan for the SDF, including: (1) relating each of the monitoring areas to one or more monitoring factors, (2) the unique identification number (ID#) referencing the TRR Code and number in that TRR for the recommended change, and (3) the specific change.

Table A-3: NRC Staff Recommended Changes to the NRC Monitoring Plan for the SDF

ID#	Item(s)	Change(s)
INVT-01	Table A-1: *Projected Inventory at Time of Closure*	UPDATE Text of Table A-1
INVT-02, -04, & -05	Monitoring Factor (MF) 1.01: *Inventory in Disposal Structures*	UPDATE Text of MF 1.01
INVT-03	MF 1.02: *Methods Used to Assess Inventory*	UPDATE Text of MF 1.02
CBDL-01	New MF 2.03: *Confidence in QA/QC for HDPE/GCL Composite Barrier and Drainage Layer Installation*	OPEN MF 2.03 with High Priority
CBDL-02	New MF 2.04: *Long-Term HDPE/GCL Composite Barrier and Drainage Layer Degradation*	OPEN MF 2.04 with High Priority
CBDL-03, -04, & -05	MF 2.03: *Confidence in QA/QC for HDPE/GCL Composite Barrier and Drainage Layer Installation*	UPDATE Text of MF 2.03
CBDL-06, -07, & -08	MF 2.04: *Long-Term HDPE/GCL Composite Barrier and Drainage Layer Degradation*	UPDATE Text of MF 2.04
CBDL-09	New MF 2.05: *Potential Confined Conditions in the ULDL*	OPEN MF 2.05 with High Priority
PECC-01	New MF 2.06: *Long-Term Erosion Barrier Performance*	OPEN MF 2.06 with Medium Priority
PECC-02	New MF 2.07: *Shallow Infiltration*	OPEN MF 2.07 with Medium Priority
PECC-03	MF 2.02: *Erosion Protection*	UPDATE Title of MF 2.02 to *Erosion Control of the SDF Engineered Surface Cover and Adjacent Area*, UPDATE Priority of MF 2.02 to High, and UPDATE Text of MF 2.02
NFFT-01	New MF 6.06: *Localized Contaminant Release*	OPEN MF 6.06 with Medium Priority
NFFT-02	New MF 4.03: *Moisture Characteristic Curves for Saltstone* New MF 6.07: *Moisture Characteristic Curves for Disposal Structure Concrete* MF 10.05: *Moisture Characteristic Curves*	OPEN MF 4.03 with Low Priority, OPEN MF 6.07 with Low Priority, and CLOSE MF 10.05
NFFT-03	MF 4.01: *Waste Form Matrix Degradation* MF 10.03: *Diffusivity in Degraded Saltstone*	UPDATE Text of MF 4.01 and CLOSE MF 10.03
NFFT-04	MF 3.03: *Applicability of Laboratory Data to Field-Emplaced Saltstone*	UPDATE Priority of MF 3.03 to Medium
NFFT-05	MF 4.01: *Waste Form Matrix Degradation*	UPDATE Text of MF 4.01 and UPDATE Text of MF 4.02

ID#	Item(s)	Change(s)
	MF 4.02: *Waste Form Macroscopic Fracturing*	
NFFT-06	MF 6.01: *Certain Risk-Significant K_d Values in Disposal Structure Concrete*	UPDATE Text of MF 6.01
NFFT-07	MF 5.04: *Certain Risk-Significant K_d Values for Saltstone*	UPDATE Text of MF 5.04
NFFT-08	MF 5.04: *Certain Risk-Significant Kd Values for Saltstone*	UDPATE Title of MF 5.04 to *Certain Risk-Significant K_d Values and Solubility Limits for Saltstone* UPDATE Text of MF 5.04
NFFT-09	MF 5.04: *Certain Risk-Significant Kd Values and Solubility Limits for Saltstone* MF 6.01: *Certain Risk-Significant K_d Values in Disposal Structure* Concrete MF 10.04: *K_d Values for Saltstone* MF 10.06: *K_d Values for Disposal Structure Concrete*	UPDATE Title of MF 5.04 to *K_d Values and Solubility Limits for Saltstone* UPDATE Text of MF 5.04 CLOSE MF 10.04 UPDATE Title of MF 6.01 to *K_d Values in Disposal Structure Concrete* UDPATE Text of MF 6.01 CLOSE MF 10.06
NFFT-10	MF 5.01: *Radionuclide Release from Field-Emplaced Saltstone*	UPDATE Priority of MF 5.01 to Low
NFFT-11	MF 5.02: *Chemical Reduction of Tc by Saltstone*	UPDATE Priority of MF 5.02 to Low
HFFM-01	Monitoring Area (MA) 7: *Subsurface Transport*	UPDATE Title of MA 7 to *Subsurface Flow and Transport*
HFFM-02	MF 8.03: *Identification and Monitoring of Groundwater Plumes in the Z-Area*	UPDATE Text of MF 8.03
HFFM-03	New MF 7.02: *K_d Values for SRS Soil* MF 10.09: *K_d Values for SRS Soil*	OPEN MF 7.02 with Low Priority and CLOSE MF 10.09
HFFM-04	MF 7.01: *Certain Risk-Significant K_d Values in Site Sand and Clay*	CLOSE MF 7.01
HFFM-05	New MF 7.03: *Confidence in GSA Modeling Results*	OPEN MF 7.03 with Medium Priority
HFFM-06	MF 7.03: *Confidence in GSA Modeling Results* MF 10.10: *Far-Field Model Calibration*	UPDATE Text of MF 7.03 CLOSE MF 10.10
HFFM-07	MF 10.11: *Far-Field Model Source Loading Approach*	CLOSE MF 10.11
HFFM-08	MF 10.12: *Far-Field Model Dispersion*	CLOSE MF 10.12
HFFM-09	New MF 7.04: *Confidence in Local SDF Modeling Results*	OPEN MF 7.04 with Medium Priority
HFFM-10	New MF 7.05: *Impact of Calcareous Zones on Contaminant Flow and Transport*	OPEN MF 7.05 with Low Priority CLOSE MF 10.13

ID#	Item(s)	Change(s)
	MF 10.13: *Impact of Calcareous Zones on Contaminant Flow and Transport*	
SIST-01	New MF 9.03: *Gullying of the Closure Cap*	OPEN MF 9.03 with Medium Priority
SIST-02	New MF 9.04: *Sheet and Rill Erosion of the Closure Cap*	OPEN MF 9.04 with Medium Priority
SIST-03	New MF 9.05: *Slope Stability of the SDF Closure Cap*	OPEN MF 9.05 with High Priority
SIST-04	New MF 9.06 *Flow through the ULDL*	OPEN MF 9.06 with High Priority
SIST-05	New MF 9.07: *Degradation of the Erosion Barrier*	OPEN MF 9.07 with Medium Priority
SIST-06	New MF 9.08: *Static-Loading Induced Settlement*	OPEN MF 9.08 with Medium Priority
SIST-07	MF 9.01: *Settlement Due to Increased Overburden and Seismic Loading*	UPDATE Text of MF 9.01
SIST-08	New MF 9.09: *Settlement Due to Waste Bags in SDS 4*	OPEN MF 9.09 with Medium Priority
FCSM-01	New MA 14: *Future Scenarios and Conceptual Models*	OPEN MA 14 under both §61.41 and §61.42
FCSM-02	New MF 14.01: *Scenario Development and Defensibility* MF 10.14: *Scenario Development and Defensibility*	OPEN MF 14.01 with Medium Priority CLOSE MF 10.14
FCSM-03	New MF 14.02: *Defensibility of Conceptual Models* MF 10.02: *Defensibility of Conceptual Models*	OPEN MF 14.02 with High Priority CLOSE MF 10.02
FCSM-04	New MF 14.04: *Identification and Screening of Features, Events, and Processes*	OPEN MF 14.04 with Medium Priority
FCSM-05	New MF 14.05: *Future Designs and Analyses as They Pertain to Potential Degradation Processes and Performance*	OPEN MF 14.05 with High Priority
FCSM-06	MF 14.01: *Scenario Development and Defensibility*	UPDATE Text of MF 14.01
FCSM-07	New MF 14.06: *Groundwater Yield of the UTRA-UAZ in the Z-Area*	OPEN MF 14.06 with High Priority
MOIN-01	New MF 14.03: *Implementation of Conceptual Models* MF 10.01: *Implementation of Conceptual Models*	OPEN MF 14.03 with Medium Priority CLOSE MF 10.01
DEPM-01	New MA 12: *Biosphere*	OPEN MA 12 under both §61.41 and §61.42
DEPM-02	MF 7.02: *K_d Values for SRS Soil*	UPDATE Text of MF 7.02 CLOSE MF 10.07

ID#	Item(s)	Change(s)
	MF 10.07: *Calculation of Build-Up in Biosphere Soil*	
DEPM-03	New MF 12.01: *Ingestion Pathway Parameters* MF 10.08: *Consumption Factors and Uncertainty Distributions for Transfer Factors*	OPEN MF 12.01 with Medium Priority CLOSE MF 10.08
DEPM-04, -05, & -06	MF 12.01: *Ingestion Pathway Parameters*	UPDATE Text of MF 12.01
DEPM-07	New MF 12.02: *Inhalation Pathway Parameters*	OPEN MF 12.02 with Low Priority
INTA-01	New MA 13: *Inadvertent Intrusion*	OPEN MA 13 under §61.42
INTA-02	New MF 13.01: *Intrusion Source Terms*	OPEN MF 13.01 with Low Priority
INTA-03	MF 13.01: *Intrusion Source Terms*	UPDATE Text MF 13.01
INTA-04	New MF 13.02: *Intrusion Exposure Pathways*	OPEN MF 13.02 with Medium Priority

Table A-4 below provides the overall structure of the future NRC Monitoring Plan for the SDF (i.e., monitoring area, monitoring factor(s), performance objectives, priority) with the changes from the current monitoring plan in *italics* (for additions) and ~~strikeout~~ (for deletions), including the already implemented changes from the six supplemental letters (with Accession No.) and if the NRC staff recommended changes from the TRRs are implemented:

Table A-4: Overall Structure of Future NRC Monitoring Plan for the SDF

Monitoring Area (MA)	Monitoring Factor (MF)	Performance Objective(s)	Priority
MA 1: *Inventory*			
	MF 1.01: *Inventory in Disposal Structures*	§61.41 & §61.42	Periodic
	MF 1.02: Methods Used to Assess Inventory	§61.41 & §61.42	Medium
MA 2: *Infiltration and Erosion Control*			
	MF 2.01: *Hydraulic Performance of Closure Cap* – see ML18107A161	§61.41, §61.42 *& §61.44*	~~Low~~ Medium
	MF 2.02: ~~Erosion Protection~~ *Erosion Control of the SDF Engineered Surface Cover and Adjacent Area*	§61.41, §61.42 *& §61.44*	~~Low~~ High
	MF 2.03: *Confidence in QA/QC for HDPE/GCL Composite Barrier and Drainage Layer Installation*	§61.41, §61.42 *& §61.44*	High
	MF 2.04: *Long-Term HDPE/GCL Composite Barrier and Drainage Layer Degradation*	§61.41, §61.42 *& §61.44*	High
	MF 2.05: *Potential Confined Conditions in the ULDL*	§61.41, §61.42 *& §61.44*	High
	MF 2.06: *Long-Term Erosion Barrier Performance*	§61.41, §61.42 *& §61.44*	Medium
	MF 2.07: *Shallow Infiltration*	§61.41, §61.42 *& §61.44*	Medium

Monitoring Area (MA)	Monitoring Factor (MF)	Performance Objective(s)	Priority
MA 3: Waste Form Hydraulic Performance			
	~~MF 3.01: Hydraulic Conductivity of Field-Emplaced Saltstone~~ **CLOSED** – see ML17097A351	~~§61.41 & §61.42~~	~~High~~
	~~MF 3.02: Variability of Field-Emplaced Saltstone~~ **CLOSED** – see ML17097A351	~~§61.41 & §61.42~~	~~High~~
	MF 3.03: Applicability of Laboratory Data to Field-Emplaced Saltstone – see ML17097A351	§61.41 & §61.42	~~High~~ Medium
	~~MF 3.04: Effect of Curing Temperature on Saltstone Hydraulic Properties~~ **CLOSED** – see ML17097A351	~~§61.41 & §61.42~~	~~High~~
MA 4: Waste Form Physical Degradation			
	MF 4.01: Waste Form Matrix Degradation	§61.41 & §61.42	High
	MF 4.02: Waste Form Macroscopic Fracturing	§61.41 & §61.42	High
	MF 4.03: Moisture Characteristic Curves for Saltstone	§61.41 & §61.42	Low
MA 5: Waste Form Chemical Degradation			
	MF 5.01: Radionuclide Release from Field-Emplaced Saltstone	§61.41 & §61.42	~~High~~ Low
	MF 5.02: Chemical Reduction of Tc by Saltstone – see ML18219B035 and TRR	§61.41 & §61.42	~~High~~ ~~Medium~~ Low
	MF 5.03: Reducing Capacity of Saltstone – see ML18219B035	§61.41 & §61.42	~~Medium~~ Low
	MF 5.04: ~~Certain Risk-Significant K_d Values for Saltstone~~ ~~Certain Risk-Significant K_d Values and Solubility Limits for Saltstone~~ K_d Values and Solubility Limits for Saltstone	§61.41 & §61.42	Medium
	~~MF 5.05: Potential for Short-Term Rinse-Release from Saltstone~~ **CLOSED** – see ML18219B035	~~§61.41 & §61.42~~	~~Medium~~
MA 6: Disposal Structure Performance			
	MF 6.01: ~~Certain Risk-Significant K_d Values in Disposal Structure Concrete~~ K_d Values in Disposal Structure Concrete	§61.41 & §61.42	Medium
	~~MF 6.02: Tc Sorption in Disposal Structure Concrete~~ **CLOSED** – see ML18219B035	~~§61.41 & §61.42~~	~~High~~
	MF 6.03: Performance of Disposal Structure Roofs and HDPE/GCL Layers	§61.41 & §61.42	Medium
	MF 6.04: Disposal Structure Concrete Fracturing	§61.41 & §61.42	Medium

Monitoring Area (MA)	Monitoring Factor (MF)	Performance Objective(s)	Priority
	MF 6.05: Integrity of Non-cementitious Materials	§61.41 & §61.42	Medium
	MF 6.06: Localized Contaminant Release	§61.41 & §61.42	Medium
	MF 6.07: Moisture Characteristic Curves for Disposal Structure Concrete	§61.41 & §61.42	Low
MA 7: ~~Subsurface Transport~~ Subsurface Flow and Transport			
	~~MF 7.01: Certain Risk-Significant K_d Values in Site Sand and Clay~~ **CLOSED**	~~§61.41 & §61.42~~	~~Medium~~
	MF 7.02: K_d Values for SRS Soil	§61.41 & §61.42	Low
	MF 7.03: Confidence in GSA Modeling Results	§61.41 & §61.42	Medium
	MF 7.04: Confidence in Local SDF Modeling Results	§61.41 & §61.42	Medium
	MF 7.05: Impact of Calcareous Zones on Contaminant Flow and Transport	§61.41 & §61.42	Low
MA 8: Environmental Monitoring			
	MF 8.01: Leak Detection – see ML18219B035	§61.41, §61.42, & §61.43	Periodic
	MF 8.02: Groundwater Monitoring – see ML18219B035	§61.41, §61.42, & §61.43	Periodic
	MF 8.03: Identification and Monitoring of Groundwater Plumes in the Z-Area – see ML18219B035	§61.41, §61.42, & §61.43	Periodic
MA 9: Site Stability			
	MF 9.01: Settlement Due to Increased Overburden	§61.41, §61.42, & §61.44	Medium
	MF 9.02: Settlement Due to Dissolution of Calcareous Sediment	§61.41, §61.42, & §61.44	Medium
	MF 9.03: Gullying of the Closure Cap	§61.41, §61.42, & §61.44	Medium
	MF 9.04: Sheet and Rill Erosion of the Closure Cap	§61.41, §61.42, & §61.44	Medium
	MF 9.05: Slope Stability of the SDF Closure Cap	§61.41, §61.42, & §61.44	High
	MF 9.06 Flow through the ULDL	§61.41, §61.42, & §61.44	High
	MF 9.07: Degradation of the Erosion Barrier	§61.41, §61.42, & §61.44	Medium
	MF 9.08: Static-Loading Induced Settlement	§61.41, §61.42, & §61.44	Medium
	MF 9.09: Settlement Due to Waste Bags in SDS 4	§61.41, §61.42, & §61.44	Medium
~~MA 10: Performance Assessment Model Revisions~~ **CLOSED**			

Monitoring Area (MA)	Monitoring Factor (MF)	Performance Objective(s)	Priority
	MF 10.01: Implementation of Conceptual Models **CLOSED by incorporating it into new MF 14.03**	§61.41 & §61.42	High
	MF 10.02: Defensibility of Conceptual Models **CLOSED by incorporating it into new MF 14.02**	§61.41 & §61.42	High
	MF 10.03: Diffusivity in Degraded Saltstone **CLOSED by incorporating it into MF 4.01**	§61.41 & §61.42	Medium
	MF 10.04: K_d Values for Saltstone **CLOSED by incorporating it into MF 5.04**	§61.41 & §61.42	Low
	MF 10.05: Moisture Characteristic Curves **CLOSED by incorporating it into both new MF 4.03 and new MF 6.07**	§61.41 & §61.42	Low Medium
	MF 10.06: K_d Values for Disposal Structure Concrete **CLOSED by incorporating it into MF 6.01**	§61.41 & §61.42	Low
	MF 10.07: Calculation of Build-Up in Biosphere Soil **CLOSED by incorporating it into new MF 7.02**	§61.41 & §61.42	Low
	MF 10.08: Consumption Factors and Uncertainty Distributions for Transfer Factors **CLOSED by incorporating it into new MF 12.01**	§61.41 & §61.42	Medium
	MF 10.09: K_d Values for SRS Soil **CLOSED by incorporating it into new MF 7.02**	§61.41 & §61.42	Low
	MF 10.10: Far-Field Model Calibration **CLOSED by incorporating it into new MF 7.03**	§61.41	Medium
	MF 10.11: Far-Field Model Source Loading Approach **CLOSED**	§61.41	Medium
	MF 10.12: Far-Field Model Dispersion **CLOSED**	§61.41	Medium
	MF 10.13: Impact of Calcareous Zones on Contaminant Flow and Transport **CLOSED by incorporating it into new MF 7.05**	§61.41	Low
	MF 10.14: Scenario Development and Defensibility **CLOSED by incorporating it into new MF 14.01**	§61.41	Medium
MA 11: Radiation Protection Program			
	MF 11.01: Dose to Individuals During Operations	§61.43	Periodic
	MF 11.02: Air Monitoring	§61.43	Periodic
MA 12: Biosphere			
	MF 12.01: Ingestion Pathway Parameters	§61.41 & §61.42	Medium
	MF 12.02: Inhalation Pathway Parameters	§61.41 & §61.42	Low
MA 13: Inadvertent Intrusion			
	MF 13.01: Intrusion Source Terms	§61.42	Low

Monitoring Area (MA)	Monitoring Factor (MF)	Performance Objective(s)	Priority
	MF 13.02: Intrusion Exposure Pathways	§61.42	Medium
MA 14: Future Scenarios and Conceptual Models			
	MF 14.01: Scenario Development and Defensibility	§61.41 & §61.42	Medium
	MF 14.02: Defensibility of Conceptual Models	§61.41 & §61.42	High
	MF 14.03: Implementation of Conceptual Models	§61.41 & §61.42	Medium
	MF 14.04: Identification and Screening of Features, Events, and Processes	§61.41 & §61.42	Medium
	MF 14.05: Future Designs and Analyses as They Pertain to Potential Degradation Processes and Performance	§61.41 & §61.42	High
	MF 14.06: Groundwater Yield of the UTRA-UAZ in the Z-Area	§61.41 & §61.42	High

Table A-5 and Table A-6 below summarize the status of the monitoring areas and the monitoring factors of the future NRC Monitoring Plan for the SDF (i.e., total #, # open, # closed) after already implementing the changes from the six supplemental letters and if the NRC Staff recommended changes from the TRRs are implemented:

Table A-5: Status of Monitoring Areas in Future NRC Monitoring Plan for the SDF

TOTAL # of Monitoring Areas	14
# of OPEN Monitoring Areas	13
# of CLOSED Monitoring Areas	1
MA 8 (Environmental Monitoring) and MA 11 (Radiation Protection Program) only have Priority=Periodic monitoring factors, so those two monitoring areas will always be OPEN because the NRC, in coordination with South Carolina, performs Monitoring at the SDF in perpetuity.	

Table A-6: Status of Monitoring Factors in Future NRC Monitoring Plan for the SDF

TOTAL # of Monitoring Factors	71
# of OPEN Monitoring Factors	51
# of CLOSED Monitoring Factors	20