SRR-CWDA-2021-00005
Revision 0

FY2020 ANNUAL REVIEW
SALTSTONE DISPOSAL FACILITY (Z AREA)
PERFORMANCE ASSESSMENT

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Prepared by: Savannah River Remediation LLC
Waste Disposal Authority
Aiken, SC 29808

Savannah River Remediation
AMENTUM | BECHTEL | JACOBS | BWXT

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EXECUTIVE SUMMARY

The Saltstone Disposal Facility (SDF) presently consists of Saltstone Disposal Units (SDUs) 1, 2, 3, 4, 5, and 6 as described in the *Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site* (SRR-CWDA-2019-00001). Future SDUs are planned to be 375-foot diameter SDUs, similar to SDU 6 completed in 2017. Construction of SDU 7 is nearly complete and the construction of SDUs 8 and 9 are in progress.

The U.S. Department of Energy (DOE), through DOE O 435.1, requires an active maintenance program for the 2019 SDF Performance Assessment (PA), which is satisfied in the *Savannah River Site Liquid Waste Facilities Performance Assessment Maintenance Program FY2020 Implementation Plan*. [SRR-CWDA-2020-00018] A maintenance program is required to continue to reduce uncertainty in the inputs and assumptions in order to provide greater confidence in the results of the analyses and in the long-term plans for public and environmental protection.

DOE O 435.1 also requires an approved Radioactive Waste Management Basis (RWMB). Potential changes identified during the annual review must be evaluated for impact to the SDF RWMB which consists of facility controls and analyses to demonstrate near- and long-term protection of the public, workers, and the environment. Examples of these controls include facility safety documents, waste certification programs, facility waste acceptance criteria (WAC) requirements, low level waste disposal facility closure plans, PAs, Composite Analyses (CAs), and other facility-specific processes, procedures, and analyses made to comply with DOE O 435.1 and its manual. The current DOE approved SDF RWMB is Q-RWM-Z-00001, Rev. 7. [WDPD-20-44]

The 2019 SDF PA was issued in FY2020. The 2019 SDF PA was reviewed by the DOE Low Level Waste Disposal Facility Federal Review Group (LFRG) and SRR received a letter from DOE in June 2020 approving the PA and authorizing continued operation of the SDF. [WDPD-20-32] A revised operating Disposal Authorization Statement (DAS) was issued by DOE-Headquarters to SRR through DOE Savannah River Operations (DOE-SR) as an attachment to the authorization letter.

In 2012, the U.S. Nuclear Regulatory Commission (NRC) reviewed the 2009 SDF PA and issued a *Letter of Concern (Type IV) Regarding U.S. Department of Energy Disposal Activities at the Savannah River Site Saltstone Disposal Facility*, ML120650576, that concluded the NRC did not have reasonable assurance that salt waste disposal at the SDF meets the performance objectives in 10 CFR 61.

SRS received a letter from the NRC dated July 10, 2020 acknowledging receipt of the updated 2019 SDF PA and the subsequent closure of the Type IV letter (ML120650576). NRC stated that since they issued the Type IV letter, the DOE has: (1) significantly changed the design of the saltstone disposal structures; (2) significantly changed the design of the proposed SDF closure cap; (3) substantially revised the SDF groundwater model; and (4) conducted significant new research regarding the physical and chemical properties of the saltstone waste form.

The 2019 SDF PA and those DOE informational and design changes since issuance of the 2009 SDF PA (SRR-CWDA-2009-00017) represent a significant departure from the engineered system and modeling approaches that formed the basis for the NRC 2012 Type IV Letter of Concern.

Therefore, the NRC administratively closed the 2012 Type IV Letter of Concern. [ML20148M201]

The NRC will conduct a technical review of the 2019 SDF PA under Section 3116(b) of the *Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005*. [NDAA_3116] The NRC has initiated an Acceptance Review for the 2019 SDF PA and expects to complete the Acceptance Review in FY2021. Upon completion of the Acceptance Review, the NRC will send a letter to the DOE describing the results of the Acceptance Review. The letter will also contain a schedule for the complete NRC technical review. [ML20148M201]

The 2019 SDF PA establishes controls to govern waste operations and monitoring performance of the SDF. The mechanisms to demonstrate that operations are within the bounds of the Disposal Authorization Statement (DAS) (WDPD-20-32), the RWMB (Q-RWM-Z-00001), and the PA are the WAC, an Unreviewed Waste Management Question (UWMQ) program, periodic inspections of disposal unit integrity, routine engineering evaluation of inventory and operations, and a comprehensive environmental monitoring program. [X-SD-Z-00004, Manual S4 Procedure ENG.46, SRR-CWDA-2020-00006, Manual SW24.6 Section 2.1, WSRC-TR-2005-00257] Data relevant to the critical features, limits, and predictions of the PA are used to evaluate the performance in the previous fiscal year (FY). The performance evaluation conducted for FY2020 made the following determinations:

- The current performance evaluation conducted on SDU 1, SDU 4, SDU Cells 2A/2B, SDU Cells 3A/3B, SDU Cells 5A/5B, and SDU 6 indicates SDF operations through FY2020 were within the performance expectations of the 2019 SDF PA.
- The total inventory of radionuclides accumulated in SDU 1, SDU 4, SDU Cells 2A/2B, SDU Cell 3A, SDU Cells 5A/5B, and SDU 6 through FY2020 was within the range of acceptable inventory values considered in the 2019 SDF PA.
- Research was completed in FY2020 with respect to several ongoing studies on properties considered critical to the performance of saltstone. A more in-depth discussion of on-going and future studies can be found in the *Savannah River Site Liquid Waste Facilities Performance Assessment Maintenance Program FY2020 Implementation Plan*. [SRR-CWDA-2020-00018]
- The routine groundwater monitoring analytical results do not contradict the SDF modeling estimates.

The current performance evaluation conducted on SDU 1, SDU 4, SDU Cells 2A/2B, SDU Cells 3A/3B, SDU Cells 5A/5B, and SDU 6 indicates SDF operations through FY2020 were within the performance expectation of the 2019 SDF PA and complies with the DAS, the RWMB, and DOE O 435.1 requirements.

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ACRONYMS

ARP	Actinide Removal Process
CA	Composite Analysis
CFR	U.S. Code of Federal Regulations
CY	Calendar Year
D_e	Effective Diffusivity
DAS	Disposal Authorization Statement
DLM	Dynamic Leaching Method
DOE	U.S. Department of Energy
DSA	Documented Safety Analysis
EPA	U.S. Environmental Protection Agency
FA	Fly Ash
FTF	F-Area Tank Farm
FY	Fiscal Year
GGBFS	Ground Granulated Blast Furnace Slag
GSA	General Separations Area
GWPS	Groundwater Protection Standard
HTF	H-Area Tank Farm
ICPMS	Inductively Coupled Plasma Mass Spectrometry
K_d	Distribution Coefficient
LAZ	Lower Aquifer Zone
LFRG	Low Level Waste Disposal Facility Federal Review Group
LI	Leachability Index
LLW	Low-Level Waste
MCU	Modular Caustic Side Solvent Extraction Unit
MOP	Member of the Public
MPAD	Most Probable and Defensible
NDAA	*Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005*
NRC	Nuclear Regulatory Commission
NVB	Nonvolatile beta
OPC	Ordinary Portland Cement
PA	Performance Assessment
PQL	Practical Quantitation Limit
RadFLEx	Radionuclide Field Lysimeter Experiment
RWMB	Radioactive Waste Management Basis
R&D	Research and Development

SA	Special Analysis
SCDHEC	South Carolina Department of Health and Environmental Control
SDF	Saltstone Disposal Facility
SDI	Salt Disposition Integration
SDU	Saltstone Disposal Unit
SHC	Saturated Hydraulic Conductivity
SPF	Saltstone Production Facility
SRNL	Savannah River National Laboratory
SRR	Savannah River Remediation LLC
SRS	Savannah River Site
SWPF	Salt Waste Production Facility
TCCZ	Tan Clay Confining Zone
UAZ	Upper Aquifer Zone
UTRA	Upper Three Runs Aquifer
UWMQ	Unreviewed Waste Management Question
UWMQE	Unreviewed Waste Management Question Evaluation
WAC	Waste Acceptance Criteria
ZBG	Z Area Background [monitoring well identifiers]

1. PURPOSE OF REVIEW

The Saltstone Disposal Facility (SDF) at the Savannah River Site (SRS) is managed by Savannah River Remediation LLC (SRR) for the U. S. Department of Energy (DOE). The SDF presently consists of Saltstone Disposal Units (SDUs) 1, 2, 3, 4, 5, and 6 as described in the *Performance Assessment* (PA) *for the Saltstone Disposal Facility at the Savannah River Site* (SRR-CWDA-2019-00001), heretofore known as the 2019 SDF PA. Future SDUs are planned to be 375-foot diameter SDUs, similar to SDU 6 completed in 2017. Construction is nearing completion on SDU 7 and has already begun on SDU 8 and SDU 9.

The 2019 SDF PA was issued in FY2020. The 2019 SDF PA was reviewed by the DOE Low Level Waste Disposal Facility Federal Review Group (LFRG) and SRR received a letter from DOE in June 2020 approving the PA and authorizing continued operation of the SDF. [WDPD-20-32] A revised operating Disposal Authorization Statement (DAS) was issued by DOE-Headquarters to SRR through DOE Savannah River Operations (DOE-SR) as an attachment to the authorization letter.

SRS received a letter from the U.S. Nuclear Regulatory Commission (NRC) dated July 10, 2020 acknowledging receipt of the updated PA and closure of the Type IV Letter of Concern (ML120650576). NRC stated that since they issued the Type IV Letter of Concern, the DOE has: (1) significantly changed the design of the saltstone disposal structures; (2) significantly changed the design of the proposed SDF closure cap; (3) substantially revised the SDF groundwater model; and (4) conducted significant new research regarding the physical and chemical properties of the saltstone waste form.

The 2019 SDF PA and those DOE informational and design changes since issuance of the 2009 SDF PA (SRR-CWDA-2009-00017) represent a significant departure from the natural and engineered system that formed the basis for the NRC 2012 Type IV Letter of Concern. Therefore, the NRC administratively closed the 2012 Type IV Letter of Concern. [ML20148M201]

The NRC will conduct a technical review of the 2019 SDF PA under Section 3116(b) of the *Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005*. [NDAA_3116] The NRC has initiated an Acceptance Review for the 2019 SDF PA and expects to complete the Acceptance Review in FY2021. Upon completion of the Acceptance Review, the NRC will send a letter to the DOE describing the results of the Acceptance Review. The letter will also contain a schedule for the complete NRC technical review. [ML20148M201]

The 2019 SDF PA evaluates potential dose impact on a future hypothetical member of the public (MOP), an inadvertent intruder, as well as impacts to the environment from the Low-Level Waste (LLW) disposal facility. [SRR-CWDA-2019-00001] In addition, the 2019 SDF PA demonstrates a reasonable expectation of compliance with pertinent performance objectives as identified in Chapter IV of DOE Manual 435.1-1 and Title 10, of the U.S. Code of Federal Regulations (CFR) Part 61, *Licensing Requirements for Land Disposal of Radioactive Waste,* Subpart C (10 CFR 61) as required by the *Ronald W. Reagan National Defense Authorization Act (NDAA) for Fiscal Year 2005,* Section 3116 (NDAA_3116).

DOE O 435.1 requires an active maintenance program for the 2019 SDF PA, which is satisfied in the *Savannah River Site Liquid Waste Facilities Performance Assessment Maintenance Program FY2020 Implementation Plan*. [SRR-CWDA-2020-00018] A maintenance program is required to continue to reduce uncertainty in the inputs and assumptions in order to provide greater confidence in the results of the analyses and in the long-term plans for public and environmental protection. Additionally, a disciplined process to address potential changes in disposal operations and/or discoveries (e.g., new waste forms, change in disposal unit design) is required to ensure that proposed changes do not adversely affect SDF performance.

Another purpose of the PA maintenance program is to confirm the continued adequacy of the PA through annual reviews of the disposal facility activities. In accordance with the DOE Standard, *Disposal Authorization Statement and Tank Closure Documentation* (DOE-STD-5002-2017), the reviews evaluate and document that SDF operations comply with the DAS (WDPD-20-32) and DOE O 435.1 requirements and determine if the 2019 SDF PA remains valid or if additional actions are required. A review of the 2019 SDF PA was conducted in a systematic manner that incorporates all the following considerations.

1. Radionuclide inventories, waste volumes, and waste types - The review of waste radionuclide inventories and waste volumes includes a comparison of the actual waste receipts to the evaluated inventory.
2. Research and development (R&D) - The R&D activities are primarily documented in technical reports. The R&D activities are designed and funded to provide additional information for further reduction in the uncertainties associated with PAs results. In addition, Special Analyses (SAs) or Unreviewed Waste Management Question Evaluations (UWMQEs) may be conducted to provide new information or to understand impacts of potential or actual changes to the physical facility, operations, or disposal inventory.
3. PA monitoring - The current monitoring program (SRR-CWDA-2020-00006) includes sampling of the salt waste feed stream in Tank 50 to characterize inventory, evaluation of final waste form composition, periodic sampling of grout raw materials, and monitoring of groundwater to detect changing trends in performance. Physical inspections of structures ensure SDU conditions are consistent with model inputs. Monitoring of system parameters help ensure that the system produces a grout with physical and chemical properties that are consistent with that described in the PA.

DOE O 435.1 also requires an approved Radioactive Waste Management Basis (RWMB). Potential changes identified during the annual review must be evaluated for impact to the SDF RWMB which consists of facility controls and analyses to demonstrate near- and long-term protection of public, workers, and the environment. Examples of these controls include facility safety documents, waste certification programs, facility waste acceptance requirements, low level waste disposal facility closure plans, PAs, Composite Analyses (CAs), and other facility-specific processes, procedures, and analyses made to comply with DOE O 435.1 and its manual. The current DOE approved SDF RWMB is Q-RWM-Z-00001, Rev. 7. [WDPD-20-44]

All these factors are reviewed annually to evaluate the need to conduct special studies or to prepare a revision of the 2019 SDF PA.

2. CHANGES POTENTIALLY AFFECTING THE PA, CA, DAS, OR RWMB

2.1 Special Analyses and Unreviewed Waste Management Question Evaluations

2.1.1 Special Analyses

No SAs were issued during FY2020 for the SDF.

2.1.2 Unreviewed Waste Management Question Evaluations

No UWMQEs were performed in FY2020 for the SDF.

2.2 Update the Closure Plan

Management of SRS LLW is regulated under DOE M 435.1-1, *Radioactive Waste Management Manual*. A DAS (WDPD-20-32) revision was issued by DOE in June 2020 authorizing continued operations of the SDF. The DAS specifies the closure plan that complies with DOE M 435.1-1 for SDF must be maintained and modified as needed to reflect facility changes. The SDF closure plan is reviewed annually to determine if a revision is required. The *Closure Plan for the Z-Area Saltstone Disposal Facility*, SRR-CWDA-2020-00005, was updated in FY2020 to capture changes in the recently revised 2019 SDF PA. This Closure Plan provides information for planning, initial design, and basis for PA assumptions related to the final closure configuration of the SDF.

The *Savannah River Site Land Use Plan* (SRNS-RP-2014-00537) provides the framework for integrating the SRS mission and vision with ecological, economic, cultural, and social factors in a regional context and to support decision-making for near-term and long-term use of the site, including the SDF. The Land Use Plan describes the current site conditions, defines a vision for the evolution of the site, outlines actions to achieve the vision, and guides the allocation of resources toward attainment of that vision. This plan provides guidance and direction for the future physical development of the site and provides a framework within which detailed analyses will be conducted to determine the courses of action required to reach optimum site configuration. The plan is based on specific assumptions. If these assumptions were to change, the plan would be updated to reflect the changed conditions. The *Land Use Plan* was issued in November 2014 and no modifications have occurred to the plan, therefore there are no impacts to the current SDF PA/SA.

2.3 Update the SDF Monitoring Plan

The *Performance Assessment Monitoring Plan for the Saltstone Disposal Facility at the Savannah River Site* (SRR-CWDA-2020-00006) (hereinafter referred to as the SDF Monitoring Plan), demonstrates compliance with pertinent requirements of DOE O 435.1 and its associated Manual and Guide. The SDF Monitoring Plan that complies with DOE M 435.1-1 must be maintained and modified as needed to reflect facility changes. The SDF Monitoring Plan is reviewed annually to determine if a revision is required. The SDF Monitoring Plan was updated in FY2020 to capture changes in the recently revised 2019 SDF PA and to incorporate ongoing activities as required by the DAS. [WDPD-20-32]

3. CUMULATIVE EFFECTS OF CHANGES

No UWMQEs were performed in FY2020 against the 2019 SDF PA and therefore there were no changes to evaluate.

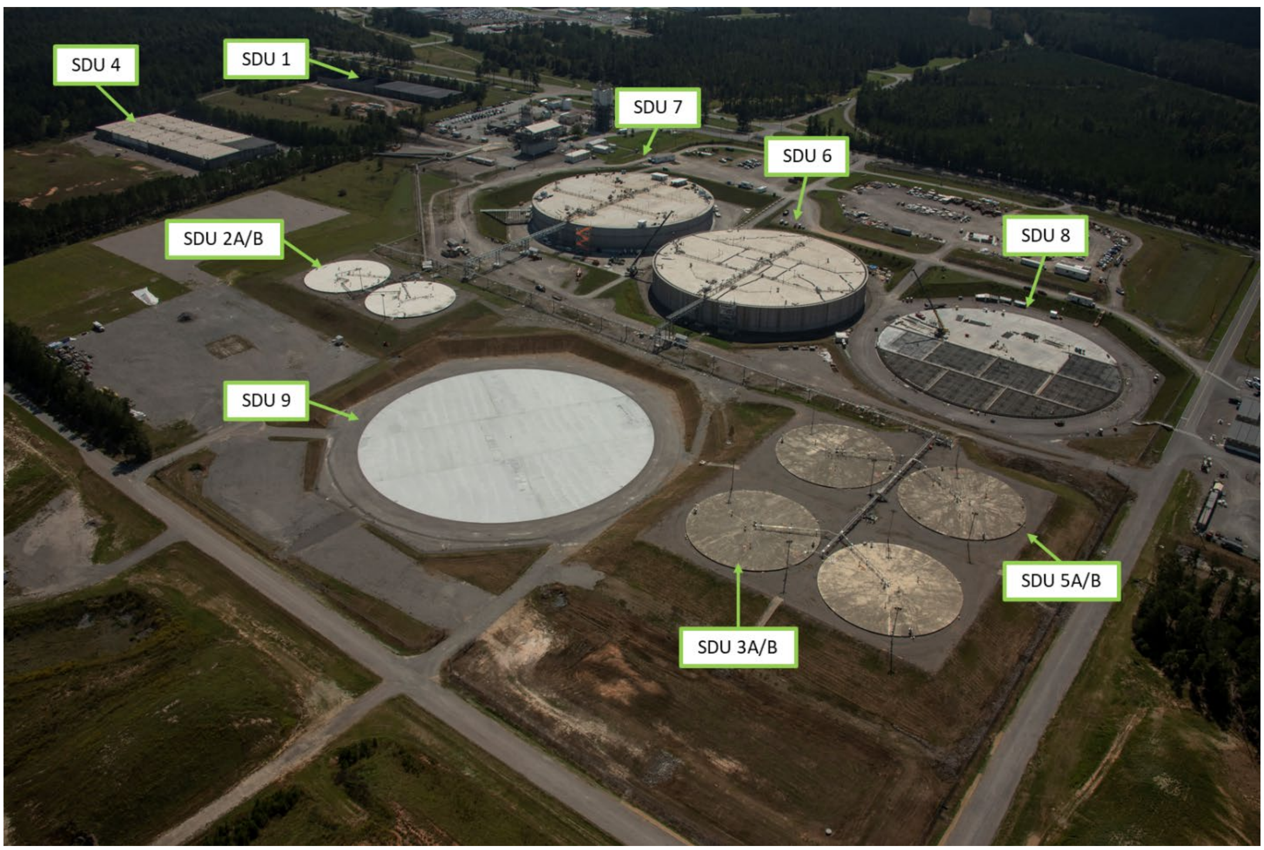
4. WASTE RECEIPTS

4.1 Waste Volumes and Radionuclide Inventories

Construction of rectangular shaped SDUs 1 and 4 was completed between February 1986 and July 1988. The Saltstone Production Facility (SPF) started radioactive operations June 1990. Disposal into SDU 1 occurred intermittently from June 1990 to September 1996. Disposal into SDU 4 began in January 1997 and completed in FY2012.

Initially constructed cylindrical SDUs (2A/2B, 3A/3B and 5A/5B) include cells, 150 feet in diameter by 22 feet high. Future SDUs are anticipated to consist of single cells, 375 feet in diameter and 45 feet high, such as SDU 6 which was placed into operation in 2017. Figure 4.1-1 shows the October 2019 configuration of SDUs at the SDF. Figure 4.1-1 shows the ongoing construction efforts for SDU 7 and SDU 8 as well as the beginning of excavation for SDU 9 (SRR-CWDA-2020-00010).

Figure 4.1-1: Saltstone Facility Aerial View (October 2020)



Disposal into SDU Cell 2B commenced in September 2012 and disposal into SDU Cell 2A commenced in December 2012. SDU Cells 2A and 2B have a slightly less nominal useable volume for grout disposal due to an additional one foot of clean pour (sulfate resistant concrete) having been placed on the floor. The pour was performed to address suspected compromised areas detected during water tightness testing. Disposal into SDU Cell 2A concluded in June 2014 and disposal into SDU Cell 2B concluded in July 2014. Disposal into SDU Cell 5B commenced in August 2014 and concluded in February 2017 and disposal into SDU Cell 5A commenced in

August 2015 and concluded in August 2016. Disposal into SDU Cell 3A commenced in February 2017; however, the cell is not full and there was no disposal into SDU Cell 3A during FY2019. The first disposal into SDU 6 was in August 2018 and continued through FY2019. No disposal into SDU Cell 3B has occurred. Table 4.1-1 summarizes the SDU waste receipts (i.e., saltstone grout emplaced in each SDU) through FY2019. As noted earlier, there were no disposal operations during FY2020. Table 4.1-1 also provides both the PA-estimated disposal capacity and the operational capacity for each SDU. The PA-estimated disposal capacity is the assumed grout disposal capacity for the SDU used in the PA; while the operational capacity is the actual grout disposal capacity based on operational limits imposed by the *Saltstone Facility Documented Safety Analysis* (DSA) (WSRC-SA-2003-00001).

Future SDUs will be constructed, as needed, in coordination with salt processing production rates. The anticipated quantity and need dates for future SDUs are outlined in the *Liquid Waste System Plan*. [SRR-LWP-2009-00001] The *Liquid Waste System Plan* is updated as necessary to align with the most recent operational, budgetary, and regulatory requirements of the overall Liquid Waste System at SRS. The current revision to the plan is Revision 21.

Table 4.1-1: Saltstone Disposal Unit Waste Receipts Through FY2020

Saltstone Disposal Unit	Disposal Volume (gal) to date	PA-Estimated Disposal Capacity (gal)[a]	Operational Capacity (gal)[b,c,d, e]	Percent Filled (%) Volume[f]	Total Curies Disposed to date (kCi)	PA/CA Impacts
1	5,610,000	10,900,000	10,900,000	51	166	None
2	5,540,000	5,660,000	5,600,000	100	30.2	None
3	693,000	5,660,000	5,600,000	12	2.09	None
4	19,070,000	21,800,000	20,000,000	95	508[g]	None
5	5,540,000	5,660,000	5,600,000	100	26.0	None
6	1,295,000[h,i]	33,700,000	32,800,000	3.9	4.66	None

Note: The "Sum of Fractions or Total curie vs PA Curie Limit" column outlined in the DOE Standard (DOE-STD-5002-2017) is not presented in this table as the individual SDUs do not have a PA curie limit placed on them.

a. PA-estimated disposal capacities are from SRR-CWDA-2017-00032, Table 2.3-1, SDU Fillable Volume.
b. Operational capacity for SDU 1 is the same as the PA-Estimated Disposal Capacity for SDU 1.
c. Operational capacity for SDU 4 is based on an SDU cell fill height of 22.5 feet.
d. Operational capacity for SDU's 2, 3, and 5 are based on an SDU cell fill height of 21.25 feet (X-CLC-Z-00070, X-CLC-Z-00078, X-CLC-Z-00080).
e. Operational capacity for SDU 6 is based on SDU 6 fill height limit of 41 feet (SRR-SDU-2017-00003).
f. Percent filled volume is based on comparison of disposal volume to date to operational capacity.
g. SDU 4 inventory includes the inventory of 10,032 United States Naval Fuel Material Facility 55-gallon drums emplaced in Cell A (SRR-CWDA-2018-00072).
h. The volume of saltstone grout emplaced in SDU 6 is based on the ratio of salt solution to grout (0.633) per the methodology in X-CLC-Z-00086.
i. The volume of saltstone grout emplaced in SDU 6 does not include the minimal volume of non-radioactive grout (i.e., clean cap) that was placed into SDU 6 during start-up testing. [X-CLC-Z-00085]

During FY2020, no additional saltstone was disposed in SDU 1, SDU 4, SDU Cells 2A/2B, SDU Cells 3A/3B, or SDU Cells 5A/5B, therefore the inventories for these SDUs are presented in this annual review to reflect only current decayed inventories (i.e., end of FY2020 (September 30, 2020)), and decayed inventories at closure (i.e., January 1, 2032). The inventories for SDU 3A and SDU 6 were also updated to reflect a comparison of decayed inventories at closure to those modeled in the 2019 SDF PA. These updates are documented in SRR-CWDA-2020-00081, *Determination of SDF Inventories through 9/30/2020*.

4.1.1 Waste Volumes

The salt solution production history through FY2020 is presented in Table 4.1-2, and new waste receipts into the SDF in FY2020 are detailed in Table 4.1-3. An estimate of the remaining grout capacity of SDUs 1 and 4 can be made by comparing the total grout capacity to the level in each cell times the cell surface area (see Table 4.1-1).

SDU 1 is currently at 51% of its operational capacity with Cells A, B, and C being full. SDU 1 Cells D, E, and F are empty. Currently, there are no plans to use SDU 1 Cells D, E, and F for saltstone disposal in the future. [SRR-LWP-2009-00001]

SDU Cell 2A has reached 100% of its operational capacity (21.25 ft of height used relative to 21.25 ft of height available). [X-CLC-Z-00070] SDU Cell 2B has reached 100% of its operational capacity (21.25 ft of height used relative to 21.25 ft of height available). [X-CLC-Z-00070]

SDU Cell 3A has reached 25% of its operational capacity (5.25 ft of height used relative to 21.25 ft of height available). [X-CLC-Z-00085] No saltstone grout has been emplaced in SDU Cell 3B as of the end of FY2020. Table 4.1-1 reflects a 12% filled volume based on comparing the SDU Cell 3A used volume to the combined SDU Cells 3A and 3B operational capacities.

SDU 4 has reached 95% of its operational capacity (930,000 gallons of remaining disposal volume of the 20-million-gallon capacity), not including final clean cap installation. [X-CLC-Z-00052] No additional saltstone was disposed in SDU 4 during FY2020 and there are no plans to dispose of additional saltstone in SDU 4 in the future. SDU 4 Cell A contains 10,032 drums (added to SDU 4 in the 1990s) of cementitious waste generated from the U. S. Naval Fuel Material Facility. [ESH-FSS-9000373] The void space surrounding the drums in SDU 4 Cell A is filled with clean grout.

SDU Cell 5A has reached 100% of its operational capacity (21.25 ft of height used relative to 21.25 ft of height available). [X-CLC-Z-00078] SDU Cell 5B has reached 100% of its operational capacity (21.25 ft of height used relative to 21.25 ft of height available). [X-CLC-Z-00080]

SDU 6 has reached 3.9% of its operational capacity. The percent filled volume is based on a disposal volume of 1,295,000 gallons of saltstone grout emplaced into SDU 6 as of the end of FY2020 [SRR-CWDA-2020-00081]. The methodology used to determine the volume of saltstone grout disposed is provided in Notes h and i of Table 4.1-1, as well as in SRR-CWDA-2020-00081.

The FY2020 performance evaluation, conducted on SDU 1, SDU Cells 2A/2B, SDU Cell 3A, SDU 4, SDU Cells 5A/5B and SDU 6, indicates SDF operations were within the performance expectation of the 2019 SDF PA. [SRR-CWDA-2019-00001] All SDF disposal operations are limited by the waste acceptance criteria (WAC), as specified in *Waste Acceptance Criteria for Transfers to the Z-Area Saltstone Production Facility During Salt Disposition Integration (SDI)* (X-SD-Z-00004).

Table 4.1-2: FY2020 Tank 50 Salt Solution Historical Data

Fiscal Year	Salt Solution Disposed (gal)					
	SDU 1	**SDU 4**	**SDU 2**	**SDU 3**	**SDU 5**	**SDU 6**
1990	246,660	0	0	0	0	0
1991	651,279	0	0	0	0	0
1992	105,391	0	0	0	0	0
1993	28,020	0	0	0	0	0
1994	261,058	0	0	0	0	0
1995	129,900	0	0	0	0	0
1996	607,774	0	0	0	0	0
1997	0	212,370	0	0	0	0
1998	0	339,310	0	0	0	0
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	263,830	0	0	0	0
2003	0	1,292,474	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	244,480	0	0	0	0
2008	0	1,342,930	0	0	0	0
2009	0	1,525,728	0	0	0	0
2010	0	1,013,770	0	0	0	0
2011	0	1,486,842	0	0	0	0
2012	0	811,710	439,740	0	0	0
2013	0	0	2,005,340	0	0	0
2014	0	0	486,474	0	680,146	0
2015	0	0	0	0	828,128	0
2016	0	0	0	0	1,506,010	0
2017	0	0	0	61,600	108,060	0
2018	0	0	0	268,384	0	116,875
2019	0	0	0	0	0	703,300
2020	0	0	0	0	0	0
SDU Totals:	2,030,082	8,533,444[a]	2,931,554	329,984	3,122,344	820,175
Total Salt Solution Disposed Through End of September 2020:			17,767,583			

[X-CLC-Z-00084, X-CLC-Z-00085, X-CLC-Z-00086, SRR-CWDA-2020-00081]

a. This volume is only the gallons of Tank 50 salt solution processed to SDU 4. The volume presented does not include the 10,032 United States Naval Fuel Material Facility 55-gallon drums emplaced in Cell A as the waste was not from Tank 50 salt solution processing.

Table 4.1-3: Tank 50 Salt Solution Disposed

Time Period	Salt Solution Disposed (gal)	SDU
1st Quarter FY2020	0	NA
2nd Quarter FY2020	0	NA
3rd Quarter FY2020	0	NA
4th Quarter FY2020	0	NA
Total FY2020 Receipts	0	NA

4.1.2 Waste Inventory

A disposed radionuclide inventory estimate was developed for use in PA modeling. The 2019 SDF PA, based on these inventory estimates, met performance objectives. *Determination of SDF Inventories through 9/30/2020* (SRR-CWDA-2020-00081) includes both the original inventory disposed of at the SDF and the current inventory through FY2020. The current inventory includes decay and ingrowth for SDF operations beginning in 1990 through FY2020. As of the end of FY2020, 738 kilocuries (kCi) have been disposed in the SDF and the current inventory as of the end of FY2020, accounting for decay and daughter ingrowth, is 374 kCi. [SRR-CWDA-2020-00081]

In FY2020, the SPF did not operate or dispose of any low-level salt waste. No low-level salt waste was transferred from Tank 50 to the SPF or grout emplaced in the SDF. [SRR-CWDA-2020-00081]

The current inventories were decayed to 10/1/2032 to match the basis date for closure used in the 2019 SDF PA. For SDU 1 and SDU 4, as well as SDU Cells 2A/2B and SDU Cells 5A/5B, no additional saltstone was disposed in FY2020 and there are no plans to place additional saltstone in these units in the future; therefore, Tables 4.1-4 through 4.1-9 provide only current inventories as of 9/30/2020 and inventories decayed to 10/1/2032.

For SDU Cell 3A, no saltstone was disposed in FY2020. However, it will be used for future processing. So, for SDU Cell 3A (Table 4.1-10) and for SDU 6 (Table 4.1-11), the current FY2020 inventory (decayed to 10/1/2032) was divided by the 2019 SDF PA inventory to generate a ratio. This ratio helps in evaluating the inventory that will be in each SDU upon completion of filling.

The total inventory of radionuclides in SDU 1, SDU 4, SDU Cells 2A/2B, and SDU Cells 5A/5B through FY2020 was what was used in the 2019 SDF PA modeling and therefore do not contradict the performance objectives of the 2019 SDF PA.

The comparison ratios presented in Table 4.1-10 indicate that the current SDU 3A inventories for three radionuclides (Ac-227, Cf-249, and U-232) are currently trending higher than would be expected for SDU 3A relative to the Most Probable and Defensible (MPAD) inventory values that were evaluated in the 2019 SDF PA (SRR-CWDA-2019-00001). Given that 25% of the SDU 3A volume has been filled (indicated as 12% filled in Table 4.1-1 for both 3A and 3B together). These radionuclides fall within the ranges of uncertainty that were considered within the 2019 SDF PA (SRR-CWDA-2019-00001). In addition, because these radionuclides are not significant dose contributors, SDU 3A is significantly smaller than the 375-foot diameter SDUs and because it is located above a subsurface groundwater divide, it is unlikely to become a significant contributor to the total dose results. Therefore, these higher-than-expected concentrations of Ac-227, Cf-249, and U-232 within SDU 3A are not expected to be risk-significant.

The comparison ratios presented in Table 4.1-11 indicate that the current SDU 6 inventories for some of the radionuclides are trending higher than would be expected for SDU 6 relative to the MPAD inventory values that were evaluated in the 2019 SDF PA (SRR-CWDA-2019-00001). Given that 3.9% of the SDU 6 volume has been filled, the total radionuclide inventory in SDU 6 emplaced at the end of FY2020 and decayed to FY2032 was only 0.41% of the PA total for SDU 6. Some variability is to be expected in the waste concentrations during disposal operations, and with more than 96% of the SDU volume still available, it is too early to draw conclusions based on the current values. Nevertheless, because SDU 6 is further from the 100-meter boundary than other SDUs, slightly higher concentrations in SDU 6 of radionuclides that are already insignificant dose contributors in the PA are unlikely to significantly affect the long-term performance of the SDF, because any potential releases from SDU 6 will undergo plume spreading before reaching the points of assessment along the 100-meter boundary.

SRR will continue to monitor the inventories in each SDU and evaluate if the results are within the uncertainty values modeled in the SDF PA. When each SDU is filled it will be evaluated to determine if the inventories are within PA limits and, if exceeded, a UWMQE, or other appropriate evaluation, may be performed to determine impacts.

Table 4.1-4: Saltstone Disposal Facility SDU 1 Inventory

Radionuclide	Current Inventory [a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032 [a] (Ci)
Ac-227	1.79E-06	2.35E-06
Al-26	2.62E-01	2.62E-01
Am-241	2.04E-03	2.26E-03
Am-242m	6.72E-05	6.33E-05
Am-243	1.42E-03	1.42E-03
Ba-137m[b]	5.59E+00	4.24E+00
C-14	1.31E+00	1.31E+00
Cf-249	8.74E-13	8.54E-13
Cf-251	3.08E-14	3.05E-14
Cl-36	9.75E-08	9.75E-08
Cm-243	4.32E-04	3.25E-04
Cm-244	2.70E-03	1.70E-03
Cm-245	2.72E-04	2.71E-04
Cm-247	1.59E-13	1.59E-13
Cm-248	1.66E-13	1.66E-13
Co-60	2.96E-04	6.10E-05
Cs-135	4.95E-02	4.95E-02
Cs-137	5.92E+00	4.49E+00
Eu-152	1.33E-03	7.21E-04
Eu-154	4.18E-04	1.59E-04
H-3	1.15E+01	5.85E+00
I-129	2.01E-01	2.01E-01
K-40	9.75E-08	9.75E-08
Nb-93m	7.55E-01	7.53E-01
Nb-94	2.03E-03	2.03E-03
Ni-59	2.30E-03	2.30E-03
Ni-63	1.17E-01	1.08E-01
Np-237	3.94E-03	3.94E-03
Pa-231	3.21E-06	3.85E-06
Pd-107	8.38E-03	8.38E-03
Pt-193	1.58E+00	1.34E+00
Pu-238	7.02E-03	6.39E-03
Pu-239	1.43E-02	1.43E-02
Pu-240	1.35E-02	1.35E-02
Pu-241	1.78E-02	1.01E-02
Pu-242	1.57E-03	1.57E-03
Pu-244	1.01E-05	1.01E-05
Ra-226	5.54E-07	8.39E-07
Ra-228	7.68E-06	7.68E-06
Se-79	3.44E-01	3.44E-01
Sm-151	5.41E-03	4.94E-03

Table 4.1-4: Saltstone Disposal Facility SDU 1 Inventory (Continued)

Radionuclide	Current Inventory [a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032[a] (Ci)
Sn-126	1.22E+00	1.22E+00
Sr-90	1.44E-02	1.08E-02
Tc-99	4.93E+01	4.93E+01
Th-229	4.24E-04	5.05E-04
Th-230	5.00E-05	6.09E-05
Th-232	7.68E-06	7.69E-06
U-232	6.35E-04	5.63E-04
U-233	7.76E-02	7.76E-02
U-234	9.93E-02	9.93E-02
U-235	2.51E-03	2.51E-03
U-236	6.49E-03	6.49E-03
U-238	1.07E-02	1.07E-02
Y-90[b]	1.44E-02	1.08E-02
Zr-93	7.68E-01	7.69E-01

[a] Inventories account for decay and ingrowth from SRR-CWDA-2020-00081.

[b] Data included for inventory only, radionuclide not included in SDF modeling due to short half-life (SRNL-STI-2009-00115 Section 4.2).

Table 4.1-5: Saltstone Disposal Facility SDU 4 Inventory

Radionuclide	Current Inventory[a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032 [a] (Ci)
Ac-227	6.70E-05	8.79E-05
Al-26	9.75E-01	9.75E-01
Am-241	2.08E+01	2.15E+01
Am-242m	1.88E-02	1.77E-02
Am-243	5.18E-01	5.17E-01
Ba-137m[b]	1.50E+05	1.14E+05
C-14	6.51E+00	6.50E+00
Cf-249	2.76E-01	2.69E-01
Cf-251	9.28E-02	9.20E-02
Cl-36	1.49E-02	1.49E-02
Cm-243	7.77E-03	5.84E-03
Cm-244	2.90E+01	1.83E+01
Cm-245	7.78E-01	7.78E-01
Cm-247	1.06E-01	1.06E-01
Cm-248	7.43E-13	7.43E-13
Co-60	4.84E-02	9.96E-03
Cs-135	1.73E+00	1.73E+00
Cs-137	1.59E+05	1.21E+05
Eu-152	6.36E-02	3.44E-02
Eu-154	2.49E+00	9.45E-01
H-3	3.06E+01	1.56E+01
I-129	2.77E-01	2.77E-01
K-40	1.49E-02	1.49E-02
Nb-93m	1.08E+03	1.76E+03
Nb-94	8.93E-02	8.93E-02
Ni-59	7.89E-02	7.89E-02
Ni-63	3.07E+00	2.83E+00
Np-237	5.76E-01	5.76E-01
Pa-231	1.20E-04	1.44E-04
Pd-107	3.75E-02	3.75E-02
Pt-193	8.56E+00	7.25E+00
Pu-238	3.05E+02	2.78E+02
Pu-239	5.86E+01	5.86E+01
Pu-240	7.28E+01	7.27E+01
Pu-241	7.83E+01	4.41E+01
Pu-242	4.12E+00	4.12E+00
Pu-244	1.68E-02	1.68E-02
Ra-226	4.33E-05	7.15E-05
Ra-228	2.10E-04	2.10E-04
Se-79	9.75E+00	9.75E+00
Sm-151	1.93E+01	1.76E+01

Table 4.1-5: Saltstone Disposal Facility SDU 4 Inventory (Continued)

Radionuclide	Current Inventory[a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032[c] (Ci)
Sn-126	2.22E+00	2.22E+00
Sr-90	2.22E+03	1.66E+03
Tc-99	6.34E+02	6.34E+02
Th-229	3.63E+00	3.64E+00
Th-230	4.98E-03	5.97E-03
Th-232	2.10E-04	2.10E-04
U-232	1.15E-01	1.02E-01
U-233	8.86E+00	8.86E+00
U-234	8.97E+00	8.98E+00
U-235	9.37E-02	9.37E-02
U-236	8.34E-02	8.35E-02
U-238	7.93E-02	7.93E-02
Y-90[b]	2.22E+03	1.66E+03
Zr-93	8.15E+00	8.15E+00

[a] Inventories account for decay and ingrowth from SRR-CWDA-2020-00081.

[b] Data included for inventory only, radionuclide not included in SDF modeling due to short half-life (SRNL-STI-2009-00115 Section 4.2).

Table 4.1-6: Saltstone Disposal Facility SDU Cell 2A Inventory

Radionuclide	Current Inventory [a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032 [a] (Ci)
Ac-227	7.11E-07	9.32E-07
Al-26	8.98E-04	8.98E-04
Am-241	6.66E-02	8.64E-02
Am-242m	9.84E-03	9.28E-03
Am-243	4.21E-03	4.22E-03
Ba-137m[b]	5.47E+03	4.15E+03
C-14	2.41E+00	2.41E+00
Cf-249	1.77E-02	1.73E-02
Cf-251	1.34E-02	1.32E-02
Cl-36	1.06E-04	1.06E-04
Cm-243	5.03E-04	3.78E-04
Cm-244	1.76E-01	1.11E-01
Cm-245	1.45E-02	1.46E-02
Cm-247	1.67E-02	1.67E-02
Cm-248	1.20E-13	1.20E-13
Co-60	6.32E-04	1.30E-04
Cs-135	3.36E-02	3.36E-02
Cs-137	5.80E+03	4.40E+03
Eu-152	2.24E-04	1.21E-04
Eu-154	6.56E-03	2.49E-03
H-3	1.98E+00	1.01E+00
I-129	7.31E-02	7.31E-02
K-40	1.06E-04	1.06E-04
Nb-93m	2.76E-01	2.69E-01
Nb-94	1.89E-03	1.89E-03
Ni-59	9.16E-04	9.16E-04
Ni-63	4.36E-02	4.01E-02
Np-237	1.60E-01	1.60E-01
Pa-231	1.27E-06	1.53E-06
Pd-107	6.03E-03	6.03E-03
Pt-193	1.51E+00	1.28E+00
Pu-238	5.59E+00	5.08E+00
Pu-239	5.28E-01	5.28E-01
Pu-240	5.28E-01	5.27E-01
Pu-241	1.45E+00	8.20E-01
Pu-242	3.76E-01	3.76E-01
Pu-244	1.74E-03	1.74E-03
Ra-226	2.58E-06	6.93E-06
Ra-228	1.26E-05	1.26E-05
Se-79	1.34E-01	1.34E-01
Sm-151	1.63E-01	1.48E-01

Table 4.1-6: Saltstone Disposal Facility SDU Cell 2A Inventory (Continued)

Radionuclide	Current Inventory [a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032 [a] (Ci)
Sn-126	7.62E-01	7.62E-01
Sr-90	1.56E+01	1.17E+01
Tc-99	1.14E+02	1.14E+02
Th-229	2.94E-03	3.93E-03
Th-230	8.08E-04	8.76E-04
Th-232	1.26E-05	1.26E-05
U-232	1.33E-02	1.18E-02
U-233	9.51E-01	9.51E-01
U-234	6.16E-01	6.16E-01
U-235	9.93E-04	9.93E-04
U-236	6.37E-03	6.37E-03
U-238	2.24E-02	2.24E-02
Y-90[b]	1.57E+01	1.17E+01
Zr-93	2.64E-01	2.64E-01

[a] Inventories account for decay and ingrowth from SRR-CWDA-2020-00081.

[b] Data included for inventory only, radionuclide not included in SDF modeling due to short half-life (SRNL-STI-2009-00115 Section 4.2).

Table 4.1-7: Saltstone Disposal Facility SDU Cell 2B Inventory

Radionuclide	Current Inventory [a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032 [a] (Ci)
Ac-227	9.12E-07	1.20E-06
Al-26	8.55E-04	8.56E-04
Am-241	8.04E-02	9.87E-02
Am-242m	6.26E-03	5.90E-03
Am-243	4.89E-03	4.90E-03
Ba-137m[b]	6.74E+03	5.11E+03
C-14	2.44E+00	2.44E+00
Cf-249	1.46E-02	1.43E-02
Cf-251	1.08E-02	1.07E-02
Cl-36	1.30E-04	1.30E-04
Cm-243	5.00E-04	3.76E-04
Cm-244	2.00E-01	1.26E-01
Cm-245	2.22E-02	2.22E-02
Cm-247	1.41E-02	1.41E-02
Cm-248	1.20E-13	1.20E-13
Co-60	7.09E-04	1.46E-04
Cs-135	3.38E-02	3.38E-02
Cs-137	7.14E+03	5.41E+03
Eu-152	2.26E-04	1.22E-04
Eu-154	1.18E-02	4.47E-03
H-3	1.68E+00	8.57E-01
I-129	6.83E-02	6.83E-02
K-40	1.30E-04	1.30E-04
Nb-93m	4.18E-01	4.00E-01
Nb-94	1.63E-03	1.63E-03
Ni-59	7.32E-04	7.32E-04
Ni-63	3.47E-02	3.20E-02
Np-237	9.61E-02	9.61E-02
Pa-231	1.63E-06	1.96E-06
Pd-107	6.06E-03	6.06E-03
Pt-193	1.51E+00	1.28E+00
Pu-238	5.31E+00	4.83E+00
Pu-239	5.19E-01	5.19E-01
Pu-240	5.19E-01	5.18E-01
Pu-241	1.37E+00	7.79E-01
Pu-242	5.21E-01	5.21E-01
Pu-244	2.42E-03	2.42E-03
Ra-226	1.49E-06	3.94E-06
Ra-228	1.92E-05	1.92E-05
Se-79	1.23E-01	1.23E-01
Sm-151	1.43E-01	1.30E-01

Table 4.1-7: Saltstone Disposal Facility SDU Cell 2B Inventory (Continued)

Radionuclide	Current Inventory [a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032 [a] (Ci)
Sn-126	6.83E-01	6.83E-01
Sr-90	1.92E+01	1.44E+01
Tc-99	1.37E+02	1.37E+02
Th-229	6.37E-03	7.75E-03
Th-230	4.28E-04	5.22E-04
Th-232	1.92E-05	1.92E-05
U-232	1.30E-02	1.15E-02
U-233	1.32E+00	1.32E+00
U-234	8.54E-01	8.54E-01
U-235	1.27E-03	1.27E-03
U-236	8.85E-03	8.85E-03
U-238	2.65E-02	2.65E-02
Y-90[b]	1.92E+01	1.44E+01
Zr-93	3.83E-01	3.83E-01

[a] Inventories account for decay and ingrowth from SRR-CWDA-2020-00081.
[b] Data included for inventory only, radionuclide not included in SDF modeling due to short half-life (SRNL-STI-2009-00115 Section 4.2).

Table 4.1-8: Saltstone Disposal Facility SDU Cell 5A Inventory

Radionuclide	Current Inventory [a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032 [a] (Ci)
Ac-227	4.00E-05	2.80E-05
Al-26	1.02E-03	1.02E-03
Am-241	2.02E-01	5.29E-01
Am-242m	9.94E-04	9.37E-04
Am-243	3.91E-03	3.93E-03
Ba-137m[b]	3.39E+03	2.57E+03
C-14	3.18E+00	3.17E+00
Cf-249	2.22E-02	2.17E-02
Cf-251	1.68E-02	1.66E-02
Cl-36	3.10E-03	3.10E-03
Cm-243	5.76E-04	4.33E-04
Cm-244	8.71E-02	5.50E-02
Cm-245	1.50E-02	1.50E-02
Cm-247	2.13E-02	2.13E-02
Cm-248	1.28E-13	1.28E-13
Co-60	1.67E-02	3.43E-03
Cs-135	3.60E-02	3.60E-02
Cs-137	3.59E+03	2.72E+03
Eu-152	2.40E-04	1.30E-04
Eu-154	3.40E-03	1.29E-03
H-3	4.84E+00	2.46E+00
I-129	1.39E-01	1.39E-01
K-40	3.10E-03	3.10E-03
Nb-93m	5.13E-01	4.26E-01
Nb-94	2.66E-03	2.65E-03
Ni-59	1.26E-03	1.26E-03
Ni-63	6.09E-02	5.61E-02
Np-237	8.51E-02	8.51E-02
Pa-231	1.96E-06	2.35E-06
Pd-107	6.46E-03	6.46E-03
Pt-193	1.68E+00	1.42E+00
Pu-238	7.42E+01	6.75E+01
Pu-239	1.86E+00	1.86E+00
Pu-240	1.85E+00	1.85E+00
Pu-241	2.30E+01	1.29E+01
Pu-242	4.61E-01	4.61E-01
Pu-244	2.14E-03	2.14E-03
Ra-226	5.03E-07	1.75E-06
Ra-228	1.35E-05	1.35E-05
Se-79	2.72E-01	2.72E-01
Sm-151	2.52E-01	2.30E-01

Table 4.1-8: Saltstone Disposal Facility SDU Cell 5A Inventory (Continued)

Radionuclide	Current Inventory [a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032 [a] (Ci)
Sn-126	1.65E+00	1.65E+00
Sr-90	4.58E+02	3.44E+02
Tc-99	1.75E+02	1.75E+02
Th-229	6.35E-04	1.86E-03
Th-230	2.00E-04	2.83E-04
Th-232	1.35E-05	1.35E-05
U-232	1.40E-02	1.24E-02
U-233	1.17E+00	1.17E+00
U-234	7.56E-01	7.59E-01
U-235	1.53E-03	1.53E-03
U-236	7.82E-03	7.82E-03
U-238	3.28E-02	3.28E-02
Y-90[b]	4.58E+02	3.44E+02
Zr-93	3.05E-01	3.05E-01

[a] Inventories account for decay and ingrowth from SRR-CWDA-2020-00081.

[b] Data included for inventory only, radionuclide not included in SDF modeling due to short half-life (SRNL-STI-2009-00115 Section 4.2).

Table 4.1-9: Saltstone Disposal Facility SDU Cell 5B Inventory

Radionuclide	Current Inventory [a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032 [a] (Ci)
Ac-227	6.62E-05	4.58E-05
Al-26	8.59E-04	8.59E-04
Am-241	7.79E-02	1.86E-01
Am-242m	8.20E-04	7.73E-04
Am-243	9.21E-03	9.22E-03
Ba-137m[c]	7.00E+03	5.31E+03
C-14	3.78E+00	3.77E+00
Cf-249	1.82E-02	1.78E-02
Cf-251	1.51E-02	1.50E-02
Cl-36	7.71E-04	7.71E-04
Cm-243	5.59E-04	4.20E-04
Cm-244	9.88E-02	6.24E-02
Cm-245	1.31E-02	1.31E-02
Cm-247	1.77E-02	1.77E-02
Cm-248	1.27E-13	1.27E-13
Co-60	7.69E-04	1.58E-04
Cs-135	3.58E-02	3.58E-02
Cs-137	7.42E+03	5.62E+03
Eu-152	2.39E-04	1.29E-04
Eu-154	3.54E-03	1.34E-03
H-3	2.97E+00	1.51E+00
I-129	8.68E-02	8.68E-02
K-40	1.72E-03	1.72E-03
Nb-93m	3.11E-01	2.98E-01
Nb-94	2.06E-03	2.06E-03
Ni-59	5.15E-04	5.15E-04
Ni-63	2.48E-02	2.29E-02
Np-237	7.76E-02	7.76E-02
Pa-231	1.62E-06	1.95E-06
Pd-107	6.42E-03	6.42E-03
Pt-193	1.65E+00	1.39E+00
Pu-238	2.56E+01	2.33E+01
Pu-239	7.39E-01	7.39E-01
Pu-240	7.39E-01	7.38E-01
Pu-241	7.62E+00	4.27E+00
Pu-242	4.21E-01	4.21E-01
Pu-244	1.95E-03	1.95E-03
Ra-226	5.23E-07	1.67E-06
Ra-228	2.26E-05	2.26E-05
Se-79	1.68E-01	1.68E-01
Sm-151	2.08E-01	1.90E-01

Table 4.1-9: Saltstone Disposal Facility SDU Cell 5B Inventory (Continued)

Radionuclide	Current Inventory [a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032 [a] (Ci)
Sn-126	9.47E-01	9.47E-01
Sr-90	1.14E+02	8.56E+01
Tc-99	1.20E+02	1.20E+02
Th-229	5.92E-04	1.71E-03
Th-230	1.85E-04	2.60E-04
Th-232	2.26E-05	2.26E-05
U-232	1.92E-02	1.70E-02
U-233	1.07E+00	1.07E+00
U-234	6.87E-01	6.88E-01
U-235	1.27E-03	1.27E-03
U-236	7.18E-03	7.18E-03
U-238	2.85E-02	2.85E-02
Y-90[b]	1.14E+02	8.57E+01
Zr-93	2.86E-01	2.86E-01

[a] Inventories account for decay and ingrowth from SRR-CWDA-2020-00081.

[b] Data included for inventory only, radionuclide not included in SDF modeling due to short half-life (SRNL-STI-2009-00115 Section 4.2).

Table 4.1-10: Saltstone Disposal Facility SDU Cell 3A Inventory Comparison

Radionuclide	Current Inventory [a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032 [a] (Ci)	Evaluated Total Inventory per SDU[b] 10/1/2032 (Ci)	Comparison Ratio
Ac-227	2.98E-05	2.05E-05	1.45E-05	1.41E+00
Al-26	1.32E-04	1.32E-04	3.54E-01	3.73E-04
Am-241	5.97E-02	1.97E-01	2.06E+02	9.56E-04
Am-242m	5.34E-05	5.03E-05	1.00E-01	5.03E-04
Am-243	3.77E-04	3.78E-04	8.34E-02	4.53E-03
Ba-137m[c]	8.69E+02	6.59E+02	N/A	N/A
C-14	7.02E-01	7.01E-01	8.21E+00	8.54E-02
Cf-249	8.77E-04	8.57E-04	8.50E-04	1.01E+00
Cf-251	6.09E-04	6.03E-04	6.01E-04	1.00E+00
Cl-36	2.50E-04	2.50E-04	1.33E-02	1.88E-02
Cm-243	1.26E-04	9.49E-05	4.48E-04	2.12E-01
Cm-244	8.47E-03	5.35E-03	1.48E+00	3.61E-03
Cm-245	2.05E-03	2.05E-03	2.74E-03	7.48E-01
Cm-247	8.38E-04	8.39E-04	8.39E-04	1.00E+00
Cm-248	2.70E-14	2.70E-14	N/A	N/A
Co-60	3.44E-04	7.07E-05	1.11E-01	6.37E-04
Cs-135	7.58E-03	7.58E-03	2.35E-02	3.23E-01
Cs-137	9.21E+02	6.98E+02	3.70E+03	1.89E-01
Eu-152	5.06E-05	2.74E-05	1.16E-01	2.36E-04
Eu-154	1.35E-03	5.13E-04	1.07E+00	4.79E-04
H-3	1.42E+00	7.24E-01	4.54E+01	1.59E-02
I-129	4.36E-02	4.36E-02	1.92E-01	2.27E-01
K-40	2.50E-04	2.50E-04	1.33E-02	1.88E-02
Nb-93m	1.18E-01	9.43E-02	1.36E+00	6.93E-02
Nb-94	4.45E-04	4.45E-04	2.33E-03	1.91E-01
Ni-59	3.04E-04	3.04E-04	N/A	N/A
Ni-63	1.49E-02	1.37E-02	2.90E+00	4.72E-03
Np-237	1.42E-02	1.42E-02	1.79E-01	7.93E-02
Pa-231	3.33E-07	3.99E-07	4.55E-06	8.77E-02
Pd-107	1.36E-03	1.36E-03	1.41E-02	9.65E-02
Pt-193	3.62E-01	3.07E-01	1.23E+00	2.50E-01
Pu-238	3.13E+01	2.85E+01	2.12E+03	1.34E-02
Pu-239	7.86E-01	7.86E-01	1.31E+02	6.00E-03
Pu-240	7.86E-01	7.85E-01	2.77E+01	2.83E-02
Pu-241	9.62E+00	5.38E+00	2.51E+02	2.14E-02
Pu-242	7.69E-02	7.69E-02	1.05E-01	7.32E-01
Pu-244	3.57E-04	3.57E-04	4.86E-04	7.35E-01
Ra-226	5.95E-08	2.31E-07	1.18E-06	1.96E-01
Ra-228	2.21E-06	2.21E-06	3.78E-03	5.85E-04
Se-79	4.18E-02	4.18E-02	1.35E+00	3.10E-02
Sm-151	3.92E-02	3.58E-02	5.67E+01	6.31E-04

Table 4.1-10: Saltstone Disposal Facility SDU Cell 3A Inventory Comparison (Continued)

Radionuclide	Current Inventory [a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032 [a] (Ci)	Evaluated Total Inventory per SDU[b] 10/1/2032 (Ci)	Comparison Ratio
Sn-126	5.67E-01	5.67E-01	5.58E+00	1.02E-01
Sr-90	3.71E+01	2.78E+01	5.31E+04	5.24E-04
Tc-99	5.70E+01	5.70E+01	3.63E+02	1.57E-01
Th-229	1.52E-04	3.56E-04	1.09E-03	3.27E-01
Th-230	2.62E-05	4.02E-05	1.01E-04	3.98E-01
Th-232	2.21E-06	2.21E-06	3.78E-03	5.85E-04
U-232	3.34E-03	2.96E-03	2.73E-03	1.08E+00
U-233	1.95E-01	1.95E-01	3.24E-01	6.02E-01
U-234	1.26E-01	1.27E-01	3.83E-01	3.32E-01
U-235	2.60E-04	2.60E-04	7.08E-03	3.67E-02
U-236	1.39E-03	1.39E-03	1.65E-02	8.42E-02
U-238	4.75E-03	4.75E-03	2.27E-01	2.09E-02
Y-90[c]	3.71E+01	2.78E+01	N/A	N/A
Zr-93	6.08E-02	6.08E-02	1.35E+00	4.50E-02

N/A – Not Applicable. Radionuclide not evaluated in the 2019 SDF PA

[a] Inventories account for decay and ingrowth from SRR-CWDA-2020-00081.

[b] Evaluated inventories from 2019 SDF PA (SRR-CWDA-2019-00001).

[c] Data included for inventory only. Doses for these short-lived radionuclides are implicitly accounted for in the 2019 SDF PA by applying modified dose conversion factors based on assuming secular equilibrium with longer-lived parents (SRR-CWDA-2019-00001, Section 4.4.8.3).

Table 4.1-11: Saltstone Disposal Facility SDU Cell 6 Inventory Comparison

Radionuclide	Current Inventory [a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032 [a] (Ci)	Evaluated Total Inventory per SDU[b] 10/1/2032 (Ci)	Comparison Ratio
Ac-227	4.31E-07	5.65E-07	2.28E-05	2.48E-02
Al-26	4.80E-04	4.80E-04	4.92E+00	9.76E-05
Am-241	7.42E-02	3.95E-01	2.87E+03	1.38E-04
Am-242m	7.39E-05	6.97E-05	1.39E+00	5.01E-05
Am-243	7.38E-04	7.37E-04	1.16E+00	6.35E-04
Ba-137m[c]	1.94E+03	1.47E+03	N/A	N/A
C-14	1.29E+00	1.29E+00	1.07E+02	1.21E-02
Cf-249	3.71E-13	3.63E-13	8.95E-12	4.06E-02
Cf-251	1.27E-14	1.26E-14	3.14E-13	4.01E-02
Cl-36	8.09E-04	8.09E-04	1.81E-01	4.47E-03
Cm-243	3.22E-04	2.42E-04	5.31E-03	4.56E-02
Cm-244	3.46E-02	2.19E-02	2.06E+01	1.06E-03
Cm-245	1.93E-03	1.93E-03	1.56E-02	1.24E-01
Cm-247	6.43E-14	6.43E-14	1.61E-12	3.99E-02
Cm-248	6.71E-14	6.71E-14	N/A	N/A
Co-60	4.21E-04	8.67E-05	1.55E+00	5.59E-05
Cs-135	1.15E-02	1.15E-02	2.44E-01	4.71E-02
Cs-137	2.06E+03	1.56E+03	4.48E+04	3.48E-02
Eu-152	1.26E-04	6.80E-05	1.61E+00	4.22E-05
Eu-154	1.39E-03	5.27E-04	1.49E+01	3.54E-05
H-3	3.31E+00	1.69E+00	6.26E+02	2.70E-03
I-129	8.96E-02	8.96E-02	2.20E+00	4.07E-02
K-40	2.27E-03	2.27E-03	1.81E-01	1.25E-02
Nb-93m	3.05E-01	2.80E-01	1.79E+01	1.56E-02
Nb-94	8.52E-04	8.52E-04	2.76E-02	3.09E-02
Ni-59	6.51E-04	6.51E-04	N/A	N/A
Ni-63	3.22E-02	2.96E-02	4.02E+01	7.36E-04
Np-237	4.00E-02	4.00E-02	2.33E+00	1.72E-02
Pa-231	7.70E-07	9.23E-07	5.87E-05	1.57E-02
Pd-107	3.38E-03	3.38E-03	1.81E-01	1.87E-02
Pt-193	9.13E-01	7.73E-01	1.40E+01	5.52E-02
Pu-238	7.41E+01	6.74E+01	2.93E+04	2.30E-03
Pu-239	1.92E+00	1.92E+00	1.81E+03	1.06E-03
Pu-240	1.92E+00	1.92E+00	3.77E+02	5.09E-03
Pu-241	2.24E+01	1.25E+01	3.44E+03	3.63E-03
Pu-242	2.17E-01	2.17E-01	6.11E-01	3.55E-01
Pu-244	1.01E-03	1.01E-03	2.82E-03	3.58E-01
Ra-226	2.02E-07	1.24E-06	1.30E-05	9.54E-02
Ra-228	8.44E-06	8.44E-06	5.26E-02	1.60E-04
Se-79	7.76E-02	7.76E-02	1.84E+01	4.22E-03
Sm-151	1.10E-01	1.00E-01	7.89E+02	1.27E-04

Table 4.1-11: Saltstone Disposal Facility SDU 6 Inventory Comparison (Continued)

Radionuclide	Current Inventory [a] 9/30/2020 (Ci)	Current Inventory Decayed to 10/1/2032 [a] (Ci)	Evaluated Total Inventory per SDU[b] 10/1/2032 (Ci)	Comparison Ratio
Sn-126	1.34E+00	1.34E+00	7.15E+01	1.87E-02
Sr-90	1.20E+02	8.97E+01	7.40E+05	1.21E-04
Tc-99	1.35E+02	1.35E+02	4.43E+03	3.05E-02
Th-229	2.29E-03	2.87E-03	1.06E-02	2.71E-01
Th-230	1.80E-04	2.20E-04	9.18E-04	2.40E-01
Th-232	8.45E-06	8.45E-06	5.26E-02	1.61E-04
U-232	6.36E-03	5.64E-03	7.25E-03	7.78E-01
U-233	5.49E-01	5.49E-01	2.36E+00	2.33E-01
U-234	3.62E-01	3.65E-01	3.92E+00	9.31E-02
U-235	6.01E-04	6.01E-04	9.57E-02	6.28E-03
U-236	3.83E-03	3.83E-03	2.14E-01	1.79E-02
U-238	1.00E-02	1.00E-02	3.10E+00	3.23E-03
Y-90[c]	1.20E+02	8.98E+01	N/A	N/A
Zr-93	2.49E-01	2.49E-01	1.81E+01	1.38E-02

N/A – Not Applicable. Radionuclide not evaluated in the 2019 SDF PA

[a] Inventories account for decay and ingrowth from SRR-CWDA-2020-00081.

[b] Evaluated inventories from 2019 SDF PA (SRR-CWDA-2019-00001).

[c] Data included for inventory only. Doses for these short-lived radionuclides are implicitly accounted for in the 2019 SDF PA by applying modified dose conversion factors based on assuming secular equilibrium with longer-lived parents (SRR-CWDA-2019-00001, Section 4.4.8.3).

5. MONITORING

The environmental monitoring and disposal unit inspection programs were developed to be consistent with the 2019 SDF PA. The monitoring data evaluation is presented in this section.

5.1 Reason for Monitoring

Per the requirements in the DAS issued for the SDF (WDPD-20-32), a monitoring plan shall be written, approved, and implemented within one year of issuance of the DAS and updated at least every five years. This monitoring plan includes annual data review and evaluation. Following this annual data review and evaluation, any modifications to this monitoring plan that may be applicable will be noted and the plan updated as necessary. *Performance Assessment Monitoring Plan for the Saltstone Disposal Facility at the Savannah River Site*, SRR-CWDA-2020-00006, Rev. 1 satisfies this monitoring plan requirement.

Monitoring to be performed as part of this plan is intended to meet the requirements of DOE O 435.1 and its associated implementation Manual and Guide. These documents require disposal facilities to monitor for compliance with the conditions of the DAS. In particular, the following must be addressed:

- The site-specific 2019 SDF PA (SRR-CWDA-2019-00001), associated CA (SRNL-STI-2009-00512), and the DSA (WSRC-SA-2003-00001) were used to determine the media, locations, radionuclides, and other substances to be monitored.
- The environmental monitoring program includes measuring and evaluating releases, migration of radionuclides, SDU subsidence, and changes in disposal facility and disposal site parameters, which may affect long-term performance.
- The environmental monitoring program is capable of detecting changing trends in performance to allow application of any necessary corrective action prior to exceeding the PA performance objectives (DOE M 435.1-1).

5.2 SDF Monitoring Plan

Table 5.2-1 summarizes the monitoring implemented to assess the SDF compliance with the pertinent performance objectives as presented in the *Performance Assessment Monitoring Plan for the Saltstone Disposal Facility at the Savannah River Site*, SRR-CWDA-2020-00006. Figure 5.2-1 shows the monitoring locations. [SRNS-TR-2020-00177]

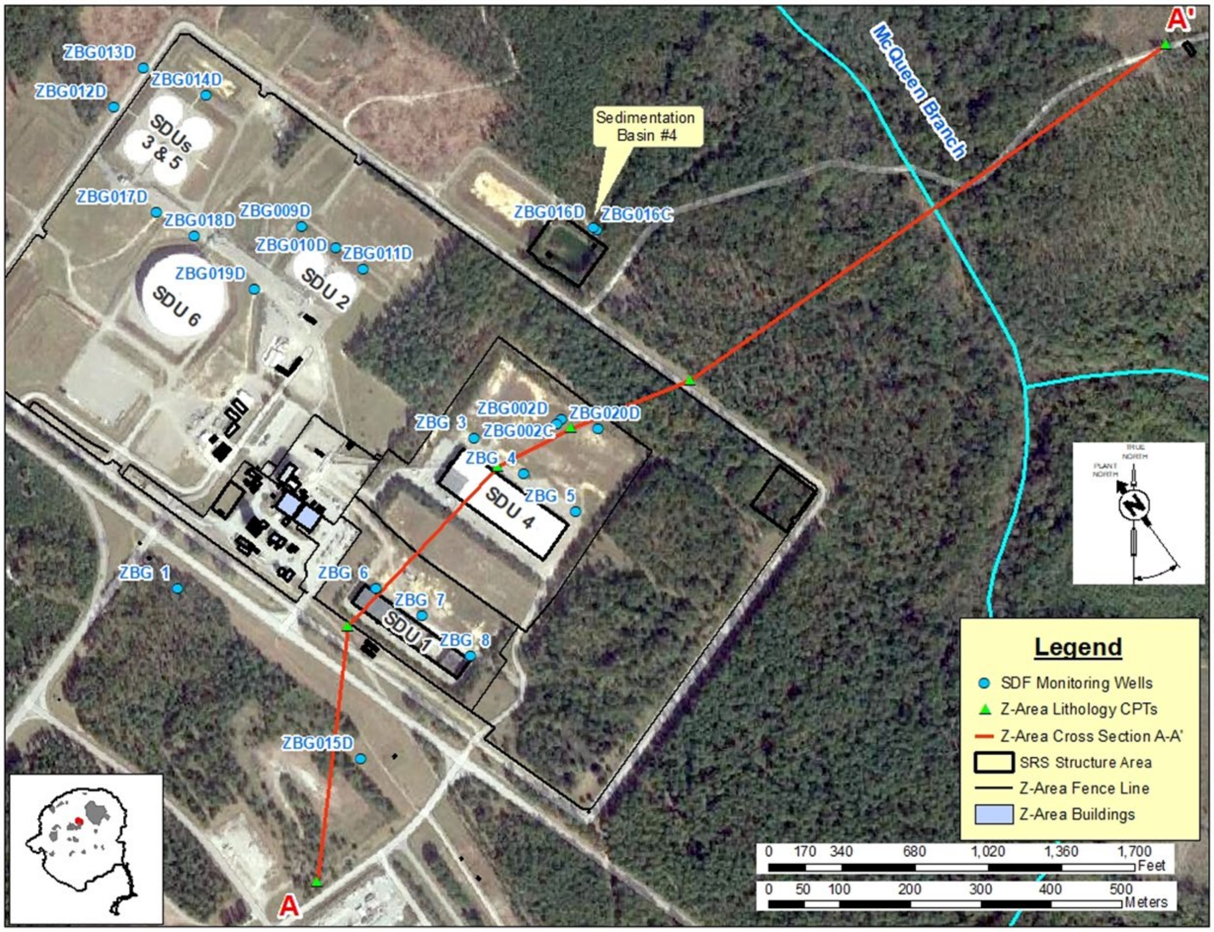
In addition to exposure pathways, certain facility features are relevant to monitoring the release of constituents to the surrounding environment. Per the existing SDF Monitoring Plan, quarterly visual inspection of the SDU integrity is sufficient to indicate conditions that may affect SDU integrity. [SRR-CWDA-2020-00006] The SDF has met this requirement by creating an *Inspection Program Plan for Z-Area Vault 4* (LWO-LWE-2008-00023) for SDU 4 due to its existing condition. In-service inspection of SDU 4 was performed to provide a historical photographic record of the external SDU condition. Inspections are made of SDU 4 to document SDU cell wall coatings and wall conditions, including baseline inspections. SDUs 2, 3, and 5 are buried such that inspections of the roof are performed during routine operator rounds. The roof and walls of SDU 6 are inspected during routine operator rounds.

Table 5.2-1: Summary Monitoring Table

Pathway/ Relevant Feature	Media Features/ Inspection	Monitoring Location	Radionuclide/Other Substance	Sampling Frequency	Sampling Method	Analytical Method	Minimum Detectable Activity/Method Detection Limit
WAC Transfer Compliance	Tank 50 content in compliance with Saltstone WAC	Completed evaluation on file in the Control Room	Tank 50 content as provided in the Waste Characterization System prior to transfer to Salt Solution Feed Tank	WAC Evaluation complete prior to transfer from Tank 50 to Salt Solution Feed Tank	N/A	N/A	Tank 50 content in compliance with Saltstone WAC
SDU integrity	Visual and video inspection of SDUs	Periphery and interior, if accessible, of SDUs	N/A	Monthly, at a minimum	Visual inspections, Video camera	N/A	N/A
Monitoring Well integrity	Visual inspection of wells	Well enclosure and well integrity	N/A	Twice per year	Visual inspections	N/A	N/A
Water resource protection	Groundwater	Wells ZBG 1 through ZBG020D	Nitrate/nitrite Gross alpha Nonvolatile beta Beta/photon emitters I-129 Technetium-99 Tritium	Twice per year	Well sampling	As designated in the groundwater monitoring plan (WSRC-TR-2005-00257)	As designated in the groundwater monitoring plan (WSRC-TR-2005-00257)
		Wells ZBG 1 through ZBG020D	Radium-226 Radium-228 Benzene Toluene Tetrachloroethylene Trichloroethylene	Once every two years (odd Fiscal years, e.g., FY2019)	Well sampling	As designated in the groundwater monitoring plan (WSRC-TR-2005-00257)	As designated in the groundwater monitoring plan (WSRC-TR-2005-00257)

N/A - Not Applicable
[SRR-CWDA-2020-00006]

Figure 5.2-1: SDF Existing Monitoring Well Locations for Z Area



SRNS-TR-2020-00177

Table 5.2-2 lists the SDUs present or under construction at the SDF, associated downgradient monitoring wells, associated upgradient background wells, SDU status, and if there have been known historical releases from the SDU. The wells are all identified with "ZBG" identifiers for Z Area Background.

Table 5.2-2: SDUs with Associated Monitoring Wells

SDU Monitored	Monitoring Wells	Associated Background Well	Status	Comments
SDU 1	ZBG 6, 7, 8	ZBG015D	Full[a]	Wells for SDU 4 are also downgradient of SDU 1, known historical releases
SDU 2	ZBG009D, 010D, 011D	ZBG 1	Full	No known releases
SDU 3A/B	ZBG012D, 013D, 014D	ZBG 1	Partial Fill	Cell 3A partially full, Cell 3B empty no known releases
SDU 4	ZBG 3, 4, 5, 002D, 002C, 020D	ZBG015D	Full[a]	Well ZBG 2 abandoned, replaced by ZBG002D, known historical releases
SDU 5A/B	ZBG012D, 13D, 14D	ZBG 1	Full	No known releases
SDU 6	ZBG017D, 18D, 19D	ZBG 1	Partial Fill	No known releases
SDU 7	Not Installed Yet	ZBG 1	Under Construction	
SDU 8	Not Installed Yet	ZBG 1	Under Construction	
SDU 9	Not Installed Yet	ZBG 1	Under Construction	
SDU 10	Not Installed Yet	ZBG 1	Future	
SDU 11	Not Installed Yet	ZBG 1	Future	
SDU 12	Not Installed Yet	ZBG 1	Future	
Sedimentation Basin #4	ZBG016C, 016D	ZBG 1, ZBG015D	Ongoing	Wells installed to monitor potential releases from Sedimentation Basin #4

a - Although these SDUs are in operation standby and are not technically full, there are no current plans for continued disposal into these SDUs.

5.3 Evaluation of Monitoring Data

Previous operational upsets have resulted in minor groundwater contamination being detected downgradient of SDUs 1 and 4. In addition, in 2014, due to concerns of potential groundwater contamination from Sedimentation Basin No. 4, a shallow well (ZBG016D) and a deeper well (ZBG016C) were installed to monitor perched water in the vadose zone and the saturated zone. In 2017, four additional wells (ZBG017D, ZBG018D, ZBG019D, and ZBG020D) were added to the SDF monitoring network. Wells ZBG017D, ZBG018D, and ZBG019D were added to monitor SDU 6, and in the future, SDUs 7 and 8. These wells helped establish background chemistry as SDU 6 was just placed into service in August 2018. Well ZBG020D provides additional downgradient groundwater monitoring of SDU 4. The SDF groundwater monitoring well network and monitoring plan, *Groundwater Monitoring Plan for the Z-Area Saltstone Disposal Facility,* WSRC-TR-2005-00257, are designed to effectively detect any release associated with SDUs in the SDF.

Per, the *Z-Area Saltstone Disposal Facility Groundwater Monitoring Midyear Report for 2020* (SRNS-TR-2020-00177), groundwater samples were collected during 1Q Calendar Year (CY) 2020 from 21 of the 22 wells monitoring the SDF (monitoring well ZBG016D was dry). The Z-Area groundwater well samples were sent to a South Carolina Department of Health and Environmental Control (SCDHEC) certified lab for analyses.

Groundwater monitoring results were compared to Practical Quantitation Limits (PQLs), background concentrations, and Groundwater Protection Standards (GWPS) contained in the *Groundwater Monitoring Plan for the Z-Area Saltstone Disposal Facility,* WSRC-TR-2005-00257. PQLs are indicators of laboratory instrument sensitivity, but are not regulatory limits, nor are they risk-based. The PQL is the lowest concentration of an analyte which can be reliably quantified in a given sample. Background concentrations are based on historical data from two wells (ZBG 1 and ZBG015D) upgradient of the SDF. Data from ZBG015D is used for background comparisons to monitoring data collected at wells downgradient of SDUs 1 and 4. Data from ZBG 1 is used for background comparisons to monitoring data collected at wells downgradient of SDUs 2A, 2B, 3A, 3B, 5A, 5B, and 6. Wells ZBG017D, ZBG018D, ZBG019D, and ZBG020D were sampled after installation in the second quarter of 2017. The second quarter 2017 samples from ZBG017D through ZBG019D helped establish background groundwater chemistry for SDUs 6, 7, and 8.

In 2020, three constituents (nonvolatile beta [NVB], Tc-99, and nitrates) continued to have detected results consistent with expectations with previous years information in four monitoring wells: ZBG002C, ZBG002D, ZBG 4, and ZBG020D. Results for the sampling from FY2020 are summarized in Table 5.3-1. As conductivity is also an indication of potential contamination, its results are also included in Table 5.3-1.

Table 5.3-1: SDF Monitoring Wells with Detected Concentrations in 2020

Saltstone Monitoring Well	NVB (pCi/L)	Tc-99 (pCi/L)	Conductivity (uS/cm)	Nitrate (mg/L)
ZBG002C	21.6	90.0	42	2.25
ZBG002D	71.5	141.0	95	7.47
ZBG 4	4.4	ND	26	0.52
ZBG020D	9.31	ND	25	0.89

ND – Not Detected

<u>Water Table Wells Downgradient of SDU 4</u>

In 1QCY20, groundwater at well ZBG002D showed increases in nonvolatile beta activity (71.5 pCi/L), Tc-99 activity (141 pCi/L), and conductivity (95 µS/cm), while nitrate concentrations declined (2.32 mg/L). These concentrations are relative to the 3QCY19 concentrations for nonvolatile beta activity (18.1 pCi/L), Tc-99 activity (36.8 pCi/L), nitrate concentration (0.35 mg/L), and conductivity (39.0 µS/cm). The 1QCY20 results for ZBG002D are lower than the maximum ZBG 2 concentrations measured in 2015 for nonvolatile beta activity (158 pCi/L), Tc-99 activity (238 pCi/L), nitrate concentration (9.9 mg/L), and conductivity (102 µS/cm).

In 1QCY20, the ZBG020D well samples had slightly lower concentrations of nonvolatile beta activity (9.31 pCi/L), Tc-99 activity (11.4 pCi/L), nitrate concentration (0.89 mg/L), and conductivity (25 µS/cm). These concentrations are relative to the 3QCY19 concentrations for nonvolatile beta activity (16 pCi/L), Tc-99 activity (27.4 pCi/L), nitrate concentration (2.02 mg/L), and conductivity (26.0 µS/cm). These data indicate the highest concentration portion of the groundwater plume is located around wells ZBG002D and ZBG020D. In 1QCY20, Tc-99 and nitrate groundwater concentrations at wells ZBG002D and ZBG020D remained below their respective GWPS. [SRNS-TR-2020-00177]

<u>Nonvolatile Beta Speciation</u>

The 1QCY20 nonvolatile beta results for ZBG002C, ZBG002D and ZBG20D exceeded the 8 pCi/L action level (presented as a GWPS), as shown in Table 5.3-2 for nonvolatile beta, initiating Sr-90 analyses for these well samples. All the Sr-90 sample results were below their Method Detection Limits indicating that Sr-90 was not detected in these samples.

Table 5.3-2: SDF PA Nonvolatile Beta Compliance Monitoring

Saltstone Monitoring Well	Monitoring Type	Monitoring Results	Performance Objective Measure or Other Regulatory Limit	Action Level	Action Taken	PA Impact
ZBG002C	Groundwater Nonvolatile Beta	21.6 pCi/L	8 pCi/L	30 pCi/L	Sr-90 Analyses	None
ZBG002D	Groundwater Nonvolatile Beta	71.5 pCi/L	8 pCi/L	30 pCi/L	Sr-90 Analyses; Tc-99 Analysis	None
ZBG020D	Groundwater Nonvolatile Beta	9.31 pCi/L	8 pCi/L	30 pCi/L	Sr-90 Analyses	None

The ZBG002D nonvolatile beta result (71.5 pCi/L) exceeded the 30 pCi/L threshold for nonvolatile beta, so nonvolatile speciation was required for this sample and the background well ZBG015D sample. Well ZBG002D had the highest sum of beta-emitting radionuclides greater than their PQLs, but the sum of beta-emitting activity level (1.07 mrem) for ZBG002D is below the GWPS (4 mrem). [SRNS-TR-2020-00177]

Any nuclides detected above the associated maximum background concentration of the GWPS will be added to the monitoring list in Table 2 of the groundwater monitoring plan, WSRC-TR-2005-00257. If the follow-up sampling exceeds the maximum background concentration and GWPS, a plan for assessing the lateral and vertical extent of the plume will be developed and submitted to SCDHEC within 60 days. [WSRC-TR-2005-00257]

In 2014, well ZBG002C was installed adjacent to ZBG002D with a screen zone below the Tan Clay Confining Zone (TCCZ) in the Upper Three Runs Aquifer – Lower Aquifer Zone (UTRA-LAZ) to monitor groundwater in the LAZ. In 1QFY20, samples collected in the LAZ at wells ZBG002C and ZBG 4 had levels of nonvolatile beta groundwater concentrations (4.4-21.6 pCi/L) that exceeded the historic maximum nonvolatile beta value (2.17 pCi/L) for background well ZBG015D. The nonvolatile beta data indicates contamination below the TCCZ. The SDF groundwater monitoring well network is adequately monitoring contaminants above and below the TCCZ per the *Z-Area Saltstone Disposal Facility Groundwater Monitoring Midyear Report for 2020* (SRNS-TR-2020-00177).

At well ZBG 6 the 1QFY20 nonvolatile beta result (4.53 pCi/L) exceeds the historic maximum nonvolatile beta value (2.17 pCi/L) for background well ZBG015D. Conductivity and nitrate concentrations have also slowly increased in the groundwater at this well over the past 3 years, but so far Tc-99 has not been detected in any of the ZBG 6 samples.

<u>Z-Area Sedimentation Basin No. 4</u>

Two groundwater monitoring wells (ZBG016C and ZBG016D) have been installed downgradient of Sedimentation Basin No. 4, one to monitor perched water above the TCCZ (ZBG016D) and one to monitor the water table below the TCCZ (ZBG016C). The 1QCY20 data for ZBG016C indicates there not have been any impacts to the groundwater at Sedimentation Basin No. 4. The screen zone for well ZBG016D has been dry since installation, indicating there was no perched water at this location in 1QCY20 (SRNS-TR-2020-00177). Analytical results from the groundwater sampling from 1QCY20 are presented in the *Z-Area Saltstone Disposal Facility Groundwater Monitoring Midyear Report for 2020* (SRNS-TR-2020-00177). The groundwater analytical results to date do not contradict 2019 SDF PA model estimates.

<u>Tc-99</u>

In 1QCY20, the Tc-99 groundwater concentration (141 pCi/L) increased at well ZBG002D and had the maximum Tc-99 result, but the concentration remains below the GWPS (900 pCi/L). Well ZBG002D indicates the location of the highest concentration of the Tc-99 groundwater plume.

The sample from well ZBG002C also had a Tc-99 result (70 pCi/L) above detection in 1QCY20, which is consistent with the nonvolatile beta result from the same well sample and historical data. Previous and 1QCY20 Tc-99 data from wells ZBG002C and ZBG 4 indicate Tc-99 contamination has migrated through the TCCZ, but at concentrations below the GWPS. [SRNS-TR-2020-00177]

As demonstrated by the 2017 through 2020 data at wells ZBG002D and ZBG020D, it is not uncommon for the Tc-99 results to be higher than the nonvolatile beta results for the same samples, as some Tc-99 is volatilized by the drying step in the nonvolatile beta analytical method. In contrast, the Tc-99 analytical method does not include a drying step, thus avoiding any volatilization of Tc-99. [SRNS-TR-2020-00177]

<u>Nitrates</u>

At SRS nitrogen in the groundwater is primarily in the form of nitrate, because the groundwater is typically well oxygenated, especially in the UTRA – Upper Aquifer Zone (UAZ). In 1QCY20, the sample from well ZBG002D had the highest nitrate groundwater concentration (7.47 mg/L), while the sample from well ZBG019D had the second highest groundwater concentration (3.37 mg/L) for nitrates in 1QCY20. The ZBG019D nitrate sample result and the ZBG002D nitrate sample result did not exceed the GWPS (10 mg/L). However, the results for ZBG017D and ZBG002D samples did exceed the PQLs and maximum concentrations from background wells ZBG 1 and ZBG015D (2.03 and 1.30 mg/L, respectively). In 1QCY20, the nitrate sample concentration for well ZBG002D increased to 7.47 mg/L from 2.32 mg/L in 3Q19. [SRNS-TR-2020-00177]

The elevated nitrate groundwater concentration at well ZBG019D may be from an upgradient source because SDU 6 was placed in service in August 2018, and the upgradient well ZBG 1 has a history of elevated nitrate concentrations. However, the maximum nitrate value at background well ZBG 1 was 2.03 mg/L in 2006. Alternatively, the elevated groundwater nitrate concentrations at well ZBG017D could be, in part, from the release of the National Science Foundation-approved dye (Rhodamine WT) after the leak tests at SDU 6, as the dye contains nitrogen. Wells ZBG017D and ZBG009D, which are near ZBG019D, also have had elevated nitrate concentrations. The 1QCY20 samples from ZBG009D, ZBG017D and ZBG0019D did not have detectable levels of Tc-99, and the nonvolatile beta results are below PQLs, which indicates the source of the nitrates is not from saltstone material. [SRNS-TR-2020-00177]

In 1Q20, nitrate groundwater concentrations increased to 0.99 mg/L at well ZBG 6, which is greater than the PQL, but less than the maximum nitrate background value (1.30 mg/L) at ZBG015D and the GWPS (10 mg/L). [SRNS-TR-2020-00177]

<u>Tritium</u>

Low concentrations of tritium are present in nearly all SDF monitoring wells, including the two background wells and does not appear to be related to activities associated with the SDF. [SRNS-TR-2020-00177] The maximum tritium concentration was 2.46 pCi/mL at background well

ZBG015D in 1QCY20. This concentration is below the historic maximum (4.02 pCi/mL) for background well ZBG015D and below the GWPS (20 pCi/mL). The older background well ZBG 1 has indicated steadily decreasing tritium concentration trends from 19.0 pCi/mL in 1987 to 1.11 pCi/mL in 1QCY20. All of the SDF monitoring wells appear to be following this trend. Data from the background wells ZBG 1 and ZBG015D indicate the tritium in Z-Area is from an up-gradient source.

Summary

In summary, groundwater concentrations in the UAZ downgradient of SDU 4 continued to decrease from 3Q15, when the highest historical concentrations were measured, and match expectations based on previous year's results. Downgradient of SDU 4, contaminants (specifically, Tc-99, nonvolatile beta, and nitrates) have begun to move downward into the LAZ, but concentrations remain below their respective GWPS. There also have been no impacts to groundwater from Sedimentation Basin No. 4. Overall, no new contamination was identified at the SDF during 1QCY20 and no constituents monitored exceed their respective GWPSs, with the exception of the nonvolatile beta action levels. Additional sampling, required by the action level exceedances, resulted in no constituents exceeding their respective GWPS.

6. RESEARCH AND DEVELOPMENT

Several studies from FY2020 have continued research on properties considered critical to the performance of saltstone and are described in the sections below and summarized in Table 6.0-1. A more in-depth discussion of on-going and future studies can be found in the *Savannah River Site Liquid Waste Facilities Performance Assessment Maintenance Program FY2020 Implementation Plan*. [SRR-CWDA-2020-00018]

Table 6.0-1: Summary of FY2020 R&D Activities

R&D Document Number	Results/Discussion	PA/CA Impacts
SRR-CWDA-2020-00008	**Radionuclide Leaching Characteristics from Saltstone Monolith** Dynamic Leaching Method (DLM) testing continued for one of the SDU Cell 2A samples (experiment began in March 2016). Initially the concentration of Tc-99 in the SDU 2A core leachate was fairly consistent around a value of 2E-07 mol/L but dropped to around 5E-08 mol/L once the pH of the leachate dropped below 11 and has remained there since. The consistency of the Tc-99 concentrations measured in the leachate, both before and after the pH drops below 11, supports the current modeling approach that Tc-99 release from saltstone is initially solubility controlled. DLM testing continued in FY2020 on four saltstone simulants (began in April and May of 2019) spiked with both Tc-99 and I-129 and synthesized using Lehigh Ground Granulated Blast Furnace Slag (GGBFS). Two of the saltstone simulants were prepared using the historical saltstone formulation (i.e., 45 wt% GGBFS, 45 wt% Class F Fly Ash (FA), and 10 wt% ordinary Portland cement (OPC)) while the other two were prepared using the cement-free formulation (i.e., 60 wt% GGBFS and 40 wt% FA) proposed in the *Cement-Free Formulation Down-Select Report*. [SRR-CWDA-2019-00003] Results from these experiments, as well as reduction capacity testing performed on non-spiked samples, suggest that the cement-free saltstone formulation is comparable in performance, from a PA perspective (i.e., leaching and saturated hydraulic conductivity), to the historically used 45 wt% GGBFS, 45 wt% FA, and 10 wt% OPC saltstone formulation. Furthermore, the cement-free saltstone formulation's fresh properties (e.g., heat of hydration, bleed water, set time, etc.) were all found to meet the processing and short-term storage requirements of the SPF. These findings were recently captured in the *Cement-Free Saltstone Down-Selection Report Follow-up* (SRR-CWDA-2020-00008) that states "the down-selected cement-free formulation… exhibits acceptable and comparable near- and long-term performance… to the standard GGBFS/FA/OPC 45/45/10 composition."	Cured and leaching properties of cement-free saltstone were found to be comparable to the historical 45:45:10 saltstone formulation. Hence, transitioning to the cement-free formulation for saltstone production should have little to no impact from a PA perspective.

Table 6.0-1: Summary of FY2020 R&D Activities (Continued)

R&D Document Number	Results/Discussion	PA/CA Impacts
SRRA021685-000012 SRRA021685-000013	**Long-Term Radiological Lysimeter Program** Ongoing lysimeter effluent testing, in conjunction with solid phase analysis of the lysimeter cores and source material, provides less ambiguous assignment of transport mechanisms, including the distribution coefficient (K_d) values. In FY2020, 15 new lysimeters, containing plutonium, neptunium, iodine, or radium sources were installed at the Radionuclide Field Lysimeter Experiment (RadFLEx) facility at SRS. The purpose of these additional experiments is to help address data gaps for radionuclides that are dose drivers in PA modeling. In FY2020, partition coefficients were measured for gamma-emitting isotopes (Cs-137, Co-60, Ba-133, and Eu-152) sorbed to SRS vadose zone sediment after long-term exposure to the outside environment. The K_d values were quantified through a series of desorption experiments and revealed that there is a potential for radionuclide-soil affinity to increase with aging (i.e., K_d increases with contact time). The K_d values measured in this study (SRRA021685-000012) will aid in updating the Geochemical Data Package used for PA modeling at SRS.	Kd values measured in gamma desorption study (SRRA021685-000012) may be used in future PA modeling for Cs, Co, Ba, and Eu or chemical analogues of those elements. In general, the measured K_ds are favorable compared to the values currently used in PA modeling.

Note: K_d is defined as the quantity of a solute sorbed by a solid, per unit weight of solid, divided by the quantity of the solute dissolved in the water per unit volume of water.

6.1 Radionuclide Leaching Characteristics from Saltstone Monolith

The purpose of this study is to characterize the leaching behavior of saltstone samples spiked with Tc-99 and I-129 in addition to saltstone cores retrieved from SDU Cell 2A. Test methods to be employed include a standardized semi-dynamic leaching test, U.S. Environmental Protection Agency (EPA) Method 1315, *Mass Transfer Rates of Constituents in Monolithic or Compacted Granular Materials Using a Semi-Dynamic Tank Leaching Procedure*, and a dynamic leaching test that was developed as part of this scope. [EPA_Method_1315] The dynamic leaching method (DLM) uses a flexible-wall permeameter apparatus that is more commonly used for measuring the saturated hydraulic conductivity (SHC) of saltstone. The intent is to force leachate through the interior of the saltstone monolith to mimic the eventual ingress of water into saltstone and subsequent pore volume exchange to establish the dynamic leaching behavior of saltstone contaminants. This task will provide empirical leaching (diffusion and solubility) data for Tc-99, I-129, and potentially other saltstone contaminants that can be used as direct inputs to the saltstone PA models. In addition, the development of a dynamic leaching test will provide new information regarding the leaching of saltstone associated with multiple pore volume exchanges. Table 6.1-1 summarizes the saltstone samples that have been prepared and tested to date. Table 6.1-2 provides a summary of the EPA Method 1315 data.

Table 6.1-1: Contaminant Leaching Study Summary

SREL FY Report	Batch Sample [a]	GGBFS Reduction Capacity (μeq/g) [f]	Saltwaste Solution Simulant [g]	Spike	EPA 1315	EPA Method 1315 Notes	DLM	DLM Notes	DLM Status as of FY2020
SREL-R-14-0006	H45:45:10 [b]	861	ARP-MCU	I-127, Re	Yes	1-month cure (x1); 3-month cure (x1)	Yes	5 short-term experiments to develop DLM method.	Removed
SREL-R-15-0003	H45:45:10 [b]	861	ARP-MCU	I-127, Re	Yes	3-month cure (x1); 6-month cure (x1)	No	N/A	N/A
SREL-R-15-0003	H45:45:10	713	ARP-MCU	Tc-99	Yes	3-month cure (x1); 6-month cure (x1)	Yes	6-month cure (x1)	Removed
SREL-R-16-0003	H45:45:10	713	ARP-MCU	Tc-99	Yes	3-month cure	No	N/A	N/A
SREL-R-16-0003	L45:45:10	1,600	ARP-MCU	Tc-99	Yes	3-month cure (x1); 6-month cure (x2)	No	N/A	N/A
SREL-R-16-0003	SDU 2A - Sample A [c]	Not Measured	Tank 50 Actual	N/A	Yes	21-month cure (x1)	Yes	21-month cure (x1)	Running
SREL-R-16-0003	SDU 2A - Sample B [d]	Not Measured	Tank 50 Actual	N/A	Yes	21-month cure (x1)	Yes	21-month cure (x1)	Removed
SREL-R-16-0003	SDU 2A - Sample C [e]	Not Measured	Tank 50 Actual	N/A	Yes	21-month cure (x1)	No	N/A	N/A
SRRA099188-000005	H45:45:10	713	ARP-MCU	I-129	Yes	1.5-month cure (x1)	No	N/A	N/A
SRRA099188-000005	L45:45:10	Not Measured	ARP-MCU	I-129	Yes	1.5-month cure (x1)	Yes	6-month cure (x1); 13-month cure (x1)	Removed
SRRA099188-000005	L45:45:10	Not Measured	ARP-MCU	Tc-99	No	N/A	Yes	3-month cure (x2)	Removed
SRRA099188-000010	L45:45:10	870	SWPF	Tc-99, I-129	Yes	9-month cure (x1)	Yes	10-month cure (x1); 11-month cure (x1)	Running
SRRA099188-000010	L60:40	870	SWPF	Tc-99, I-129	Yes	9-month cure (x1)	Yes	10-month cure (x2)	Running

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

Table 6.1-2: Effective Diffusivities (D_e) and Leachability Index (LI) for EPA Method 1315 Experiments

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

a Refer to Table 6.1-1 for additional information on batch samples.

b Two different batches of H45/45/10 saltstone were used in EPA Method 1315 tests, one spiked with Re/I-127, and the other spiked with Tc-99 (see Table 6.1-1). For convenience the data from these experiments has been consolidated into one row.

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

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

With respect to EPA Method 1315, Tc-99 leaching rates for the spiked saltstone samples appeared to be sensitive to curing duration and the reduction capacity of the ground granulated blast furnace slag (GGBFS) used in making the grout. Due to supply cessation of a historically utilized GGBFS, an alternate, or "new", GGBFS source was sought and approved for use in processing future saltstone batches at SRS. [SRR-CWDA-2015-00072] Longer curing times and higher reduction capacity for the as-received GGBFS resulted in lower effective diffusivities. Reduction capacity can vary between different GGBFS sources due to differences in the concentrations of components, in particular sulfur and iron, which are known reductants. As anticipated leaching rates and effective diffusivities from the simulant samples for poorly sorbing contaminants like NO_3^- were much higher than for Tc-99. Interestingly, the effective diffusivity measured for nitrate is comparable to that of iodine, suggesting that iodine is poorly retained in the saltstone matrix. [SRRA099188-000005]

In regard to DLM testing, data reproducibility has proven difficult given the heterogeneity of the saltstone matrix. Despite this variability, the data collected to date has proven valuable in providing both qualitative and quantitative findings. In particular:

- Although I-129 is not strongly bound to the saltstone matrix, the DLM data suggests that the radionuclide does have some affinity for the waste form and a non-zero K_d value. [SRR-CWDA-2018-00045]
    - This retention was later quantified by means of an iodine K_d value estimated using a GoldSim-based optimization model. [SRR-CWDA-2018-00045] The K_d value derived from this approach was subsequently implemented into the 2019 SDF PA. [SRR-CWDA-2019-00001]
- The concentration of Tc-99 in the DLM leachate remains fairly constant above pH 11. Once the pH falls below 11, the Tc-99 concentration transitions to a lower steady-state value. The consistency of the Tc-99 concentrations measured in the leachate, both before and after the pH drops below 11, supports the idea that Tc-99 release from saltstone is initially solubility controlled. [SRRA099188-000003]
    - The concentration data provided from these DLM experiments allowed for the solubility values used in modeling Tc-99 release from saltstone to be updated for implementation in the 2019 SDF PA. [SRR-CWDA-2018-00046; SRR-CWDA-2019-00001]
- Comparison of the DLM data collected from both the Tc-99 spiked saltstone simulants and SDU 2A core, with theoretical solubility curves for Tc solid phases, suggests that under reducing conditions Tc release from saltstone is solubility-controlled by one or more hydrated Tc(IV)-oxide solid phases ($TcO_2 \cdot x(H_2O)$). [SRRA099188-000003]

- In February of 2019, four new DLM experiments began. Two different dry-feed formulations were used in synthesizing the saltstone simulants studied: the historically used 45:45:10 mix (i.e., 45 wt% GGBFS, 45 wt% FA, and 10 wt% OPC) and a 60:40 cement-free mix (i.e., 60 wt% GGBFS, 40 wt% FA). Both simulants were spiked with Tc-99 and I-129 and prepared using a salt solution simulant representative of Tank 50's chemical composition once the Salt Waste Processing Facility (SWPF) begins operations. [SRR-CWDA-2018-00033]
  - These new DLM experiments were designed to better understand what impact the down-selected 60:40 cement-free formulation (SRR-CWDA-2019-00003) would have on saltstone's hydraulic (i.e., SHC) and transport (i.e., release rates) properties.
  - Results to date suggest that the 60:40 cement-free formulation is comparable in performance, from a PA perspective, to the historically used 45:45:10 saltstone.

Plans for FY2021 center around three specific categories: 1) continuation of the FY2019 DLM experiments along with the addition of a new SDU 2A core DLM experiment, 2) saltstone degradation over time, and 3) the effects of curing time on saltstone properties relevant to the PA.

6.2 Long-Term Radiological Lysimeter Program

Understanding the long-term behavior of radionuclides in F-Area and H-Area Tank Farms (FTF and HTF) and the SDF is essential for PA models that project this behavior out over thousands of years. To this end, a multi-year study is being performed at the Radionuclide Field Lysimeter Experiment Facility (RadFLEx) to evaluate radionuclide fate and transport from sources emplaced in lysimeters that are exposed to the outside environment. The study will provide additional information about long-term geochemical and transport phenomena that will be used to support the waste release and transport models used in the SDF, FTF, and HTF PAs.

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

Radionuclide sources are prepared in the laboratory in two physical forms: 1) filter "pita pockets" and 2) cementitious pucks. For the filter pita pockets, a liquid radionuclide source is spiked onto a 47mm glass fiber filter and then covered with a second glass fiber filter. The filters are then stitched together using Teflon thread with the radionuclide source sandwiched between the two. Since the glass fiber filters are chemically inert and have limited physical interference, the filter pita pocket sources are representative of soil contamination. Cementitious pucks (1.25 inches diameter, 0.5

inches thick) are prepared in the laboratory both with and without GGBFS. Radionuclide sources are spiked into the salt solution simulant used in making the cementitious pucks.

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

- Np breakthrough for both Np(IV) and Np(V) sources has been observed in lysimeter effluent. Np(V) release is two to four orders of magnitude higher than that observed for Np(IV). This data supports the idea that Np(V) mobility is controlled primarily by sorption of the radionuclide to the surrounding environment while Np(IV) release is solubility controlled.
- The concentration of Pu in lysimeter effluents is on the order of E-15 to E-13 mol/L, close to the solubility limits for Pu(IV) hydroxide phases. This data strongly supports the idea that Pu migration is solubility limited.
    - The concentration of Pu in lysimeter effluents is below the detection limit for the standard Inductively Coupled Plasma Mass Spectrometry (ICPMS) measurement and a low-level radioanalytical technique was used to perform these measurements.
- The spatial distribution of Pu in two field lysimeters that were removed and dissected for analysis, the first with a colloidal PuO_2(s) source and the second with an emplaced Pu(V)$NH_4(CO_3)$(s) source, both demonstrated greater downward migration than previously observed for $PuCl_3$, $Pu(NO_3)_4$, and $Pu(C_2O_4)_2$ bearing lysimeters. Researchers have proposed multiple working hypotheses to explain the enhanced transport observed for the PuO_2(s) and Pu(V)$NH_4(CO_3)$(s) lysimeters.
    - Working Hypothesis #1: Transport of Pu as PuO_2(s) colloids. The Pu(V)$NH_4(CO_3)$(s) source transforms to a PuO_2(s) phase similar to the one found in Lysimeter 44 (colloidal PuO_2(s) source, SRRA021685-000008). The Pu colloids allow for enhanced transport of the radionuclide.
    - Working Hypothesis #2: Transport is due to differing solubility values in the Pu source material. Evidence from the literature strongly suggests that the oxidized Pu present in Pu(V)$NH_4(CO_3)$(s) will rapidly reduce to Pu(+IV), perhaps as a PuO_2(s) phase similar to that found in Lysimeter 44 (colloidal PuO_2(s) source, SRRA021685-000008). Some of the Pu(+IV) present in the PuO_2(s) phase oxidizes over time to the more mobile Pu(+V) oxidation state and is transported a short distance through the soil prior to being re-reduced and once again forming a PuO_2(s) phase. The plutonium continues to undergo cycles of re-oxidation followed by re-reduction thereby allowing it to slowly traverse down the lysimeter column. This mechanism is analogous to the one proposed for mobilization of Np observed in the NpO_2(s) lysimeter (Lysimeter 32, SRRA021685-000011).
- Desorption experiments using Pu contaminated soils retrieved from the PuO_2(s) and Pu(V)$NH_4(CO_3)$(s) lysimeters provided conditional desorption distribution coefficients of $\log K = 4.4 \pm 0.3$ mL/g and $\log K = 3.2 \pm 0.2$ mL/g, respectively. There was no apparent difference between unfiltered and ultra-filtered samples during the desorption experiments

indicating that either 1) colloids are not present in these samples as hypothesized or 2) colloids sorb strongly to the soil and do not desorb.

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

In FY2020, fifteen new lysimeters, containing plutonium, neptunium, iodine, or radium sources were installed at RadFLEx. For FY2021, effluent samples will continue to be collected quarterly from the field lysimeters (both the historical lysimeters emplaced in FY2012 and the new lysimeters emplaced in FY2020) and transported to Clemson University for analysis. Monthly sampling and analysis will be performed for lysimeters where radionuclides have previously been detected in the leachate (e.g., Lysimeter 30 and Lysimeter 32 which utilize a Np(V) and a Np(IV) source, respectively).

7. PLANNED OR CONTEMPLATED CHANGES

Sections 7.1 through 7.7 discuss planned work that are part of PA maintenance and monitoring activities. The DOE has performed a number of additional activities to support the 2019 revision to the SDF PA. The 2019 SDF PA includes model revisions, UWMQE analysis recommendations (i.e., General Separations Area [GSA] model updates), lessons learned, and incorporation of the latest input values as developed through ongoing studies (see Sections 6 and 7.6), as well as other recent literature reviews and analyses, as appropriate.

7.1 Revise the Closure Plan

As stipulated in the SDF DAS (WDPD-20-32), and as part of the PA maintenance program, the SDF Closure Plan is reviewed annually to determine if additional revision is required. If a revision is required, then an update to the SDF closure plan will be submitted to DOE for approval.

The *Closure Plan for the Z-Area Saltstone Disposal Facility*, SRR-CWDA-2020-00005, was updated in FY2020 to capture changes in the recently revised 2019 SDF PA. This Closure Plan provides information for planning, initial design, and basis for PA assumptions related to the final closure configuration of the SDF.

7.2 Revise the SDF Monitoring Plan

As stipulated in the SDF DAS (WDPD-20-32), and as part of the PA maintenance program, the SDF Monitoring Plan is reviewed annually to determine if additional revision is required. If a revision is required, then an update to the SDF Monitoring Plan will be submitted to DOE for approval.

An updated *Performance Assessment Monitoring Plan for the Saltstone Disposal Facility at the Savannah River Site*, SRR-CWDA-2020-00006, was issued in FY2020 to capture changes in the recently revised 2019 SDF PA and to incorporate ongoing activities as required by the DAS. [WDPD-20-32]

7.3 Special Analyses

As discussed in Section 2.1.1, the latest SDF SA (FY2016 SDF SA) was issued in the first quarter of FY2017. A SA or PA revision was recommended to address the potential impacts of the 2016 GSA model updates per SRR-UWMQE-2017-00004; these impacts were addressed as part of the 2019 SDF PA. Section 7.5 discusses the decision to create a SDF PA revision.

As of the end of FY2020, an SA was being prepared to evaluate two proposed cementitious materials (SDU concrete Mix 3B and cement-free saltstone). These proposed materials are being considered for future operations at the SDF. SDU Mix 3B is being considered as an alternative SDU concrete mix that may reduce the risk of crack formation. The cement-free saltstone mix is being considered as an option to increase saltstone production efficiency. Once the SA has been issued and approved, the draft results suggest that both materials may be used in future construction and disposal operations at the SDF. The SA is scheduled to be issued in FY2021.

7.4 Unreviewed Waste Management Question Evaluations

A formal system to evaluate disposal practice changes and proposed actions is in place at the SDF. The process consists of providing screening and if necessary UWMQEs of proposed activities and new information. The Unreviewed Waste Management Question (UWMQ) process will continue to be required throughout the life of the facility. This process is implemented via Manual S4 Procedure ENG.46 Revision 4. There were no UWMQEs issued in FY2020.

7.5 Revise the Performance Assessment

In FY2020 a revision to the SDF PA was approved (SRR-CWDA-2019-00001). The timing of this PA revision was associated with four main drivers:

1. The design and layout of the SDF SDUs had undergone major changes since the last PA revision.
2. The breadth of research and development activities in recent years had provided new information and increased the confidence in key transport modeling inputs and assumptions.
3. Three Special Analyses had been conducted since the 2009 SDF PA and this information has been incorporated into the new PA revision, 2019 SDF PA.
4. DOE-STD-5002-2017 states that PAs should be revised at a minimum every ten years and the previous SDF PA was completed in 2009.

As part of PA implementation, related documents were updated to ensure that any performance-affecting assumptions or requirements within the updated PA will be protected. Such documents included, for example, the WAC, Closure Plan, and SDF Monitoring Plan.

7.6 Studies

PA-related testing and research activities are being performed as part of the on-going maintenance activities aimed at reducing uncertainty in the 2019 SDF PA model or are verification sampling and analysis of materials properties used in the 2019 SDF PA. As ongoing research provides new information or reduces uncertainty, this information will be evaluated (via the UWMQ and SA process) against the information used as a basis for the 2019 SDF PA modeling.

Below is a brief list of testing and research activities currently planned for FY2021.

- Radionuclide Leaching Characteristics from Saltstone Monolith (Simulated and Actual SDU Samples)
- Long-term Radiological Lysimeter Program
- Performance Assessment Monitoring

7.7 Performance Assessment Monitoring

Per the requirements in the DAS issued for the SDF (WDPD-20-32), a monitoring plan shall be written, approved, and implemented within one year of issuance of the DAS and updated at least every five years. This monitoring plan includes annual data review and evaluation. Following this annual data review and evaluation, any modifications to this monitoring plan that may be applicable will be noted and the plan updated, as necessary.

8. STATUS OF DAS CONDITIONS, KEY AND SECONDARY ISSUES

In FY2020 there were three DAS conditions in effect for SDF (per WDPD-20-32):

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

Condition 3 pertains to implementation of the 2019 SDF PA and was completed in FY2020. Conditions 1 and 2 were applied in response to one Secondary Issue (SDF-S06-PA12-02), which is the only remaining open issue. The Low Level Waste Disposal Facility Federal Review Group (LFRG) review of the 2019 SDF PA initially identified 2 Key Issues and 11 Secondary Issues; with the exception of SDF-S06-PA12-02, all of the other Key Issues and Secondary Issues were addressed and closed prior to issuing the 2019 SDF PA. The remaining open issue, SDF-S06-PA12-02: Preliminary Cap Design Does Not Include Adequate Erosion Analysis, will be closed once an adequate erosion analysis has been completed for the proposed closure cap, and any potential impacts from future erosion are evaluated. The proposed due date for SDF-S06-PA12-02 is February 22, 2022.

In FY2020, WDA initiated the erosion analysis to address SDF-S06-PA12-02 and this work is continuing into FY2021. FY2020 SDF operations comply with the DAS. [WDPD-20-32]

9. COMPOSITE ANALYSIS SUMMARY

The annual evaluation of the SRS CA (SRNL-STI-2009-00512) is covered by a separate report prepared by the Savannah River National Laboratory (SRNL). The latest evaluation as of the issuance of this review was issued in February 2020 for FY2019 (SRNL-STI-2020-00054). Based on the assessment presented within this annual review and collective engineering judgement, the conclusions of the CA remain valid and there is reasonable assurance that SRS will meet the performance objectives delineated in DOE O 435.1.

10. CERTIFICATION OF CONTINUED ADEQUACY OF THE PA, CA, DAS, AND RWMB AND CONCLUSION

The current performance evaluation conducted on SDU 1, SDU 4, SDU Cells 2A/2B, SDU Cells 3A/3B, SDU Cells 5A/5B, and SDU 6 indicates SDF operations through FY2020 were within the performance expectation of the 2019 SDF PA and comply with the DAS, the RWMB, and DOE O 435.1 requirements.

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