



FY2023 Performance Assessment Annual Report Review for the E-Area Low-Level Waste Facility



April 2024

SRNS-RP-2024-00027 / SRNL-RP-2024-00028

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Printed in the United States of America

**Prepared for
U.S. Department of Energy**

Keywords: *Trench, LAWV, ILV, CIG,
NRCDA, ELLWF, DOE Order 435.1*

Retention: *Permanent*

FY2023 Performance Assessment Annual Report Review for the E-Area Low-Level Waste Facility

Prepared by Savannah River National Laboratory for Savannah River Nuclear Solutions


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April 2024




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EXECUTIVE SUMMARY

The Savannah River Site (SRS) E-Area Low-Level Waste Facility (ELLWF) consists of six types of disposal units described in the Performance Assessment (PA) (WSRC, 2008): Low-Activity Waste Vault (LAWV), Intermediate-Level Vault (ILV), Trenches [Slit Trenches (STs), Engineered Trenches (ETs), and Component-in-Grout (CIG) Trenches], and Naval Reactor Component Disposal Areas (NRCDAs). The ELLWF is a part of the Solid Waste Management Facility (SWMF). The SWMF is managed and operated by the SRS Management and Operations prime contractor, Savannah River Nuclear Solutions (SRNS). The Solid Waste Management (SWM) organization within SRNS is responsible for operating the SWMF and the Savannah River National Laboratory (SRNL) is the technical agent that SRNS has contracted for preparing and maintaining the PA. SWMF operations have been performed at SRS since 1952. The mission of the SWMF is to provide storage, processing, disposal, and shipment of radioactive, hazardous, and mixed waste. The SWMF is committed to treat, store, and dispose of these waste products in a manner that protects the environment and the health and safety of the facility worker, the co-located worker, and the offsite general public. Wastes handled in the SWMF include low level waste, transuranic waste, hazardous waste, Toxic Substances Control Act waste, and mixed waste (i.e., containing both hazardous and radioactive constituents).

SRS low-level waste management at ELLWF is regulated under Department of Energy (DOE) Manual 435.1-1 (DOE, 2021) and is authorized under a Disposal Authorization Statement (DAS) as a federal permit. The original DAS was issued by Department of Energy-Headquarters (DOE-HQ) on September 28, 1999 (DOE, 1999) for the operation of the ELLWF and the Saltstone Disposal Facility. Those portions of that DAS applicable to the ELLWF were superseded by Revision 1 of the DAS on July 15, 2008 (DOE, 2008). The 2008 PA and 2008 DAS were officially implemented by the facility on October 31, 2008, and are the authorization documents for this Fiscal Year (FY) 2023 Annual Review.

Disposed volume to date of low-level waste placed in ELLWF disposal units is 297,159 cubic meters. In FY2023, 5,135 cubic meters were disposed in ELLWF. All disposal units remain in conformance with their disposal limits (McGill, 2023).

Approximately 90% of action-level lysimeter locations remained below administrative limits in FY2023. A majority of the action-level (AL) lysimeters would need to reach, with some exceeding, their administrative limit in order to exceed a groundwater performance objective (PO) or measure. Because administrative limits are set at 1/4th of the concentration predicted to result in an exceedance in the groundwater, the remaining 10% of the AL lysimeters spread over six trenches are not expected to result in an exceedance at the 100-m point of assessment (POA).

During the Fall 2019 Low-Level Waste Disposal Facility Federal Review Group (LFRG) semi-annual business meeting SRS presented a report for the optimization of the groundwater monitoring program at ELLWF (Kubilius, 2019), which recommended installation of eight new water table wells in the saturated zone around ELLWF. LFRG requested they stay informed of the sampling results from the installed wells. In FY2021, eight water table monitoring wells were installed at various locations around ELLWF. Four of these wells were sampled in FY2022 and all eight of these wells were sampled in FY2023. The results are reported in Table 5-4 of this document.

Trench cover monitoring in FY2022 revealed a tear in the CIG storm water runoff cover. The tear was repaired by the vendor under warranty in FY2023. Other observed defects were minor (e.g., cover depressions, erosion areas, and fasteners) and are not expected to affect the performance of these interim barriers. Inspection of the LAWV walls performed in FY2023 showed no significant cracking or degradation. Finally, all sump water samples were found to be below administrative limits before being discharged. Impacts to surface waters downstream from the ELLWF (i.e., Upper Three Runs,

Savannah River) continue to fall well below DOE public dose limits based on annual compliance monitoring.

The number of proposed changes to data, models and operational plans for the ELLWF since the 2008 PA are enough to warrant a revision. In FY2023, a draft revision to the PA was prepared and submitted to the DOE LFRG for review. Operational restrictions remain in place from a Special Analysis (SA) (Hamm et al., 2018) that evaluated new groundwater flow predictions. These measures ensure that POs will continue to be met (Mayer et al. 2023) and were incorporated in the draft PA revision.

The FY2022 PA Annual Review for the ELLWF affirmed that the disposal facility continued to operate within the bounds of the current PA and Composite Analysis (CA) baseline and the subsequent SA's and satisfied all the requirements, conditions, and limitations identified in the 2008 DAS (DOE, 2008), RWMB (McGill, 2023), and ELLWF Low-Level Waste Acceptance Criteria (SRS-1S, 2023). This annual review affirms that the supporting studies performed in FY2023 do not alter the conclusions of the ELLWF PA (WSRC, 2008) and that there is a reasonable expectation that the ELLWF will meet the POs delineated in DOE Manual 435.1-1 (DOE, 2021).

The Field Element Manager makes the following statement regarding the certification of continued adequacy of the PA, CA, DAS and RWMB:

"I certify to the best of my knowledge that information in this ASR is true, accurate and complete and that any proposed or implemented changes associated with the PA or other technical basis documents provide a reasonable expectation that the performance objectives/measures identified in DOE O 435.1 will be met."

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LIST OF ABBREVIATIONS

AL	Action-Level
CA	Composite Analysis
CIG	Components-in-Grout
CWTS	Consolidated Waste Tracking System
DAS	Disposal Authorization Statement
DOE	Department of Energy
DOE-HQ	Department of Energy – Headquarters
dpm	disintegrations per minute
DU	Disposal Unit
ELLWF	E-Area Low-Level Waste Facility
ET	Engineered Trench
FY	Fiscal Year
GSA	General Separations Area
ILV	Intermediate-Level (Waste) Vault
L	liter
LAWV	Low-Activity Waste Vault
LFRG	Low-Level Waste Disposal Facility Federal Review Group
LLW	Low-Level Waste
m ³	cubic meters
mL	milliliter
MWMF	Mixed Waste Management Facility
N/A	Not Applicable
NRCDA	Naval Reactor Component Disposal Area
PA	Performance Assessment
pCi	picocuries
PIF	Plume Interaction Factor
PO	Performance Objective
POA	Point of Assessment
R&D	Research & Development
RWMB	Radioactive Waste Management Basis
SA	Special Analysis
SCDHEC	South Carolina Department of Health and Environmental Control
SOFs	Sum-of-Fractions
SRNL	Savannah River National Laboratory

SRNS	Savannah River Nuclear Solutions
SRS	Savannah River Site
ST	Slit Trench
SWM	Solid Waste Management
SWMF	Solid Waste Management Facility
SZ	Saturated Zone
UCAQE	Unreviewed Composite Analysis Question Evaluation
UDQE	Unreviewed Disposal Question Evaluation
VOCs	Volatile Organic Compounds
VZMS	Vadose Zone Monitoring System
WAC	Waste Acceptance Criteria
WSRC	Westinghouse Savannah River Company

1.0 Facility Background/History

The Savannah River Site (SRS) E-Area Low-Level Waste Facility (ELLWF) consists of six types of disposal units described in the Performance Assessment (PA) (WSRC, 2008): Low-Activity Waste Vault (LAWV), Intermediate-Level Vault (ILV), Slit Trenches (STs), Engineered Trenches (ETs), Component-in-Grout (CIG) Trenches, and Naval Reactor Component Disposal Areas (NRCDA). This annual review evaluates the adequacy of the approved 2008 ELLWF PA, along with the Special Analyses (SAs) approved since the 2008 ELLWF PA was issued, the 2008 Disposal Authorization Statement (DAS) (DOE, 2008), and the ELLWF Waste Acceptance Criteria (SRS-1S, 2023). The review also verifies that the Fiscal Year (FY) 2023 low-level waste (LLW) disposal operations were conducted within the bounds of the PA/SA baseline and the DAS. Important factors considered in this review include waste receipts, results from monitoring, research and development (R&D) programs, and the adequacy of controls derived from the PA/SA baseline.

SRS LLW management at ELLWF is regulated under Department of Energy (DOE) Manual 435.1-1 (DOE, 2021) and is authorized under a DAS as a federal permit. The original DAS was issued by Department of Energy-Headquarters (DOE-HQ) on September 28, 1999 (DOE, 1999) for the operation of the ELLWF and the Saltstone Disposal Facility. Those portions of that DAS applicable to the ELLWF were superseded by Revision 1 of the DAS on July 15, 2008 (DOE, 2008). The 2008 ELLWF PA and 2008 DAS were officially implemented by the facility on October 31, 2008, and are the authorization documents for this FY2023 Annual Review.

The ELLWF is a part of the Solid Waste Management Facility (SWMF). SWMF is managed and operated by the SRS Management and Operating prime contractor, Savannah River Nuclear Solutions (SRNS). The Solid Waste Management (SWM) organization within SRNS is responsible for operating the SWMF and the Savannah River National Laboratory (SRNL) is the technical agent that SRNS has contracted for preparing and maintaining the PA. The SWMF operations have been performed at SRS for 71 years. The mission of the SWMF is to variously provide for the storage, processing, disposal, and shipment of radioactive, hazardous, and mixed waste as appropriate. The SWMF is committed to treat, store, and dispose of these waste products in such a manner that the health and safety of the facility worker, the co-located worker, the offsite general public, and the environment are protected. Wastes handled in the SWMF include low level waste, transuranic waste, hazardous waste, Toxic Substances Control Act waste, and mixed waste (containing both hazardous and radioactive constituents). The SWMF consists of E-Area and a portion of H-Area within SRS. The majority of the SWMF processes, including ELLWF, are located in the E-Area near the center of SRS.

2.0 Changes Potentially Affecting the PA, CA, DAS OR RWMB

Table 2-1 below indicates there were no Unreviewed Disposal Question Evaluations or Special Analyses performed during FY2023 that would have affected the PA, CA, DAS or RWMB.

Table 2-1. Potential Changes Affecting the PA, CA, DAS or RWMB.

Disposal Facility/Unit	UDQE/UCAQE or Change control process identification number	Change, Discovery, Proposed Action, New Information description	Evaluation Results	Special Analysis number (if applicable)	PA, CA, DAS or RWMB Impacts
ELLWF	N/A	None	N/A	N/A	None; due to no change control evaluations or other change control process in FY2023 for facility

3.0 Cumulative Effects of Changes

Based on the information described in Section 2.0 and Table 2-1, there were no changes potentially affecting the PA, CA, DAS or RWMB during FY2023.

4.0 Waste Receipts

Waste acceptance criteria for disposal of LLW at the ELLWF are found in Manual1S SRS Radioactive Waste Requirements, Chapter 5 Low-Level Waste procedure. Chapter 5 identifies the specific Waste Acceptance Criteria (WAC) by waste form, general Consolidated Waste Tracking System (CWTS) limits, and a LLW disposal unit decision tree. This LLW WAC procedure is periodically reviewed and updated (SRS-1S, 2023).

As required by the WAC (SRS-1S, 2023), waste generators must fill out a waste stream characterization form for each waste stream and forward it to SWM for approval prior to shipping. This characterization form includes the waste type and description. SWM reviews the characterization form for compliance with the WAC. Each request for disposal is evaluated and decision on disposal unit is made that helps to balance curie limits/ sum of fractions (SOF) vs. volume capacity of the ELLWF. Currently, there are over 2,400 approved waste streams in CWTS with approximately 132 approved waste streams active as of the end of FY2023. All waste types received in the E-Area disposal units were included and analyzed in the PA or supporting SAs.

The disposed radionuclide and volumetric inventories in FY2023 (between 10/1/22 and 9/30/23) were compared against the applicable PA/SA-limits for each of the LLW disposal units in ELLWF and met POs. These disposal units included the E-Area Vaults (LAWV, ILV), the disposal trenches (STs and ETs), and the NRCDA.

The radionuclide inventory limits calculated in the PA/SA are implemented in the WAC. Disposed inventory is tracked as fractions of the individual radionuclide limits in the ELLWF waste tracking system. The sum of these fractions for each disposal unit is controlled to less than or equal to one to ensure compliance with each PA performance measure’s limit. SWM typically operates most low-level waste facilities with a 0.95 SOF administrative limit. In FY2023, the SOFs for disposed radionuclide inventories for all disposal units were less than one.

Because of waste minimization and volume reduction programs at SRS, future inventory estimates indicate that only a single LAWV and a single ILV will be needed for low-level radioactive waste disposal over the operational period (i.e., no new vaults need to be constructed). After 29 years of LAWV operation, approximately 34% of the available volume is filled with waste that contains approximately 15% of the allowable radionuclide inventory. After 29 years of ILV operation, approximately 60% of the available volume in the nine cells is filled with waste that contains approximately 9% of the allowable radionuclide inventory.

In FY2023, 5,135 cubic meters were disposed in ELLWF. Table 4-1 provides the actual volume disposed to date, PA-estimated disposal capacity, percent filled, limiting SOFs for the selected performance measures, and the PA/Composite Analysis (CA) impact as of 9/30/23 for each disposal unit (DU). Final DU inventory limits are established by taking their preliminary inventory limits (i.e., computed in isolation from other neighboring DUs) and factoring in a plume interaction factor (PIF) that explicitly addresses for each DU its plume overlap from neighboring DUs. SOF calculations are based on these final inventory limits and as such implicitly account for all possible plume overlap contributions. The PIF method is constructed to be a conservative estimator of plume overlap. Thus, if individual DU's are compliant, the overall facility is as well. For all ELLWF units, the groundwater beta-gamma performance measure is the controlling pathway at various time intervals depending on the disposal unit. Dose impact was calculated using the most limiting SOF and the corresponding PO. The dose associated with each disposal unit is below the PO limit.

Table 4-1. Waste Receipts

Disposal Unit	Disposed Volume (m ³) to date	PA-Estimated Disposal Capacity (m ³)	Percent Filled (%) Volume	Sum of Fractions*	PA/CA Impact (mrem/yr)
LAWV	10,371	30,600	34	0.15	0.60 of 4
ILV	2,555	4,284	60	0.09	0.36 of 4
ST1 (closed)	14,264	14,264	100	0.85	3.40 of 4
ST2 (closed)	15,560	15,560	100	0.88	3.48 of 4
ST3 (closed)	16,953	16,953	100	0.94	3.76 of 4
ST4 (closed)	19,193	19,193	100	0.95	3.80 of 4
ST5 (closed)	28,125	28,125	100	0.99	3.96 of 4
ST6	20,849	23,000	91	0.82	3.28 of 4
ST7	10,555	15,900	66	0.55	2.20 of 4
ST8	15,461	16,275	95	0.89	3.56 of 4
ST9	20,887	21,000	99	0.90	3.60 of 4
ST14	18,904	19,500	97	0.92	3.68 of 4
ET1 (closed)	35,660	35,660	100	0.87	3.48 of 4
ET2	28,959	35,500	82	0.78	3.12 of 4
ET3 (closed)	29,654	29,654	100	0.81	3.24 of 4
ET4	6,161	35,000	18	0.26	1.04 of 4
NRCDA (643-7E) (closed)	701	701	100	0.03	0.12 of 4
NRCDA (643-26E)	513	6,000	9	0.03	0.12 of 4

Disposal Unit	Disposed Volume (m ³) to date	PA-Estimated Disposal Capacity (m ³)	Percent Filled (%) Volume	Sum of Fractions*	PA/CA Impact (mrem/yr)
CIG 1	1,834	6,500	28	0.44	1.76 of 4

*Sum of Fractions is compared to the PA limit of 1.00.

5.0 Monitoring

The E-Area Performance Monitoring Program is implemented in accordance with DOE Manual 435.1 (DOE 2021) and its objectives are to: 1) monitor trends in performance, 2) evaluate whether a facility is operating and behaving as expected and predicted by the PA, 3) evaluate the conservativeness of the PA conclusions, 4) provide input for refining the PA and building integrity in the PA analyses, and 5) provide a means to evaluate the potential for future regulatory exceedances. A summary of the monitoring performed for the ELLWF is provided in Table 5-1, and the performance modeling results that differ from expected behavior are given in Table 5-2.

The PA Monitoring Plan was last revised in 2012 (Millings, 2012) and a draft revision is planned for FY2024 with the final revision completed following approval of the ELLWF PA revision. The revision will establish new administrative limits for the various waste disposal units based on results from the revised PA. SRS will evaluate whether to implement an updated approach to the overall performance monitoring strategy that adds a saturated zone (water table) monitoring component to the existing vadose zone monitoring program (Kubilius, 2019). With this new approach, groundwater in the water table aquifer beneath ELLWF may be monitored for tritium, iodine and technetium-99 as part of the PA monitoring program.

Table 5-1. Current PA Monitoring Summary.

Area	Monitoring Location	Sampling Frequency	Radionuclide / Other Substance	Administrative Limits
Vadose Zone	Beneath and adjacent to the trenches	Twice per year	Tritium	East ST – 63.8 pCi/mL Center ST – 61.2 pCi/mL West ST – 46.9 pCi/mL ET 1 & 2 – 101.3 pCi/mL ET3 – 43.7 pCi/mL ¹ CIG – 29.6 pCi/mL
Sump Water	Vault Sumps	Prior to pumping when threshold liquid levels are exceeded	Gross Alpha	1.35E+3 pCi/L (or ≥ 3.0 dpm/mL)
			Nonvolatile Beta	7.20E+3 pCi/L (or ≥ 16.0 dpm/mL)
			Tritium	8.0E+8 pCi/L (or ≥ 1.78 E+6 dpm/mL)
	Engineered Trench 2 Sump	Prior to pumping when threshold liquid levels are exceeded	Gross Alpha	1.35E+3 pCi/L (or ≥ 3.0 dpm/mL)
Nonvolatile Beta			7.20E+3 pCi/L (or ≥ 16.0 dpm/mL)	
Groundwater	Not monitored by ELLWF because there is an existing tritium plume beneath parts of ELLWF that is from a different facility which monitors and reports on the groundwater per a RCRA permit. ²			
Vault Concrete	Inspections of vaults; subsidence inspections	Every two years	N/A	N/A
Trench Cover Monitoring	Inspections of trench covers	Four times per year	N/A	N/A

¹ Calculated using peak fraction flux of 0.125 Ci/yr per Ci disposed (Hamm et al., 2013) and inventory limit of 4.2 Ci for the disposal unit (Butcher, 2017).

² Monitored and reported in accordance with the Office of Environmental Quality Control Bureau of Land and Waste Management Hazardous and Mixed Waste Permit SC1 890 008 989 (SCDHEC, 2014). A revision to the PA monitoring plan is scheduled for after the 2022 PA revision is approved that may include a saturated zone monitoring component.

The PA Expected Behavior in Table 5-2 indicates the administrative limit for the disposal unit. Table 5-2 also indicates lysimeters that may have exceeded in past years and current trends. These lysimeters will continue to be monitored as part of the vadose zone monitoring program.

An analytical result that is greater than the administrative limit does not indicate that groundwater concentrations will exceed the Environmental Protection Agency drinking water standard (SRS groundwater protection requirement) at the compliance point. The administrative limit would have to be simultaneously exceeded by a factor of four over a significant portion of the trench in several of the deepest lysimeters (closest to the aquifer) before there would be a risk of exceeding drinking water standards. This is because the administrative limits are set to 1/4th of the concentration that would result in an exceedance of the drinking water standard at the 100-m compliance point as predicted by the PA model (Millings, 2012). Of the 102 AL lysimeters that were sampled, only four exceeded the administrative limit by greater than a factor of four. In FY2023, no individual disposal unit had more than one AL lysimeter that exceeded the administrative limit by a factor of four. When an action-level is first exceeded, data are reviewed to establish temporal trends and to evaluate depth and geographic occurrence (Millings, 2012). A graded hierarchal approach is used to evaluate the collected data versus projected results from the PA. The graded approach may consist of continued monitoring, additional sampling, testing, and research studies implemented through the PA/CA maintenance program.

Table 5-2. Performance Monitoring Results that Differ from the Expected Results.

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results & Trends¹	PA Expected Behavior (Below)	Action Taken	PA/CA Impacts
ELLWF Engineered Trench 1 VL-6-SC	Radionuclide Transport	<ul style="list-style-type: none"> • 165 pCi/mL • Concentrations in the action-level lysimeter decreased in FY2021 from a peak of 786 pCi/mL in FY2020. This decreasing trend continued in FY2023. The lysimeter above the action level lysimeter also shows a decreasing trend. This suggests the concentration in the action level lysimeter may continue to decrease in the future. See Section 5.1.1. 	101.3 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results & Trends ¹	PA Expected Behavior (Below)	Action Taken	PA/CA Impacts
ELLWF Engineered Trench 1 VL-15	Radionuclide Transport	<ul style="list-style-type: none"> • 1330 pCi/mL • VL-15 is on an increasing trend with concentrations in FY2023 reaching 1330 pCi/mL. This is the highest concentration measured to date for this lysimeter. Concentrations in the shallower lysimeters are elevated and generally increasing. This suggests that VL-15 may increase in the future. See Section 5.1.1. 	101.3 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met
ELLWF Engineered Trench 1 VL-17	Radionuclide Transport	<ul style="list-style-type: none"> • 75.4 pCi/mL • VL-17 exceeded the action level for the first time in the fall sampling event for FY2020 when the tritium concentration spiked to 199 pCi/mL. Although this measurement appears to be an outlier, the tritium concentration in this lysimeter has been steadily increasing. All measurements since the FY2020 exceedance have been below the administrative limit including the FY2023 concentration of 75.4 pCi/mL. However, concentrations in this lysimeter have been trending upward. Concentrations in the upper lysimeter peaked in 2014 and declined through 2017 when they began to increase again. This trend continued in FY2023. This suggests this lysimeter may continue to increase in the future. See Section 5.1.1. 	101.3 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results & Trends ¹	PA Expected Behavior (Below)	Action Taken	PA/CA Impacts
ELLWF Engineered Trench 1 VL-22	Radionuclide Transport	<ul style="list-style-type: none"> • 188 pCi/mL • VL-22 reached a peak of 300 pCi/mL in FY2020. In FY2021, concentrations began a decreasing trend which continued in FY2023. Concentrations in the shallow lysimeter had trended downward since FY2016 but began to increase in FY2022. This suggests this lysimeter may increase in the future. See Section 5.1.1. 	101.3 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met
ELLWF Engineered Trench 2 ET2-VL-5	Radionuclide Transport	<ul style="list-style-type: none"> • 1130 pCi/mL • Although elevated, concentrations in this lysimeter have trended downward since the peak of 2822 pCi/mL in FY2018. Recent measurements have been trending slightly downward in magnitude. Concentrations in the shallow lysimeter have also been trending downward. This suggests that ET2-VL-5 may continue to decrease in the future. See Section 5.1.2. 	101.3 pCi/mL	Operational soil cover was extended past ET2-VL-5, ET2-VL-6, and ET2-VL-15 during FY2019. This should reduce infiltration and eliminate funneling of rainwater near the lysimeters. Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results & Trends ¹	PA Expected Behavior (Below)	Action Taken	PA/CA Impacts
ELLWF Engineered Trench 2 ET2-VL-6	Radionuclide Transport	<ul style="list-style-type: none"> • 11.8 pCi/mL • ET2-VL-6 exceeded the administrative limit for the first time in FY2021 when the concentration spiked to 924 pCi/mL. Since FY2021, concentrations have been declining and the FY2023 concentration was below the administrative limit. The shallow lysimeters at this location are at background levels. This suggest that ET2-VL-6 may remain below the administrative limit in the future. See Section 5.1.2. 	101.3 pCi/mL	Operational soil cover was extended past ET2-VL-5, ET2-VL-6, and ET2-VL-15 during FY2019. This should reduce infiltration and eliminate funneling of rainwater near the lysimeters. Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met
ELLWF Engineered Trench 2 ET2-VL-15	Radionuclide Transport	<ul style="list-style-type: none"> • 156 pCi/mL • Concentrations in the action-level lysimeter have shown a decreasing trend since FY2020. This trend continued in FY2023. Concentrations in the upper lysimeter are trending downward. This suggests that concentrations at ET2-VL-15 may continue to decline in the future. See Section 5.1.2. 	101.3 pCi/mL	Operational soil cover was extended past ET2-VL-5, ET2-VL-6, and ET2-VL-15 during FY2019. This should reduce infiltration and eliminate funneling of rainwater near the lysimeters. Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results & Trends ¹	PA Expected Behavior (Below)	Action Taken	PA/CA Impacts
ELLWF Slit Trench 1 AT-5	Radionuclide Transport	<ul style="list-style-type: none"> • 62.7 pCi/mL • AT-5 exceeded the administrative limit for the first time in FY2023. This lysimeter has been slowly trending upwards for several years. Sampling of the shallower lysimeters has been unsuccessful in recent years. See Section 5.1.3. 	61.2 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met
ELLWF Slit Trench 1 AT-6	Radionuclide Transport	<ul style="list-style-type: none"> • 59.7 pCi/mL • AT-6 first exceeded the administrative limit in fall 2016. Since that time, concentrations have hovered around the administrative limit. FY2023 measurements were slightly below the limit. The shallow lysimeters at this location show a decreasing trend but have stabilized in recent sampling events. This suggests that the tritium concentration in AT-6 is likely to continue hovering around the administrative limit. See Section 5.1.3. 	61.2 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met
ELLWF Slit Trench 1 VL-26-West	Radionuclide Transport	<ul style="list-style-type: none"> • 411 pCi/mL • Concentrations in the action-level lysimeter are decreasing. The tritium concentration in the lysimeter above the action level lysimeter has also been trending downward. This suggests the concentration in the action-level lysimeter may continue to decline in the future. See Section 5.1.3. 	61.2 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results & Trends ¹	PA Expected Behavior (Below)	Action Taken	PA/CA Impacts
ELLWF Slit Trench 4 ST4-VL-5	Radionuclide Transport	<ul style="list-style-type: none"> • 152 pCi/mL • Concentrations in the action-level lysimeter have been slowly trending upward. This trend continued in FY2023. The tritium concentration in the shallow lysimeter is also elevated. After peaking in fall 2009, concentrations in the shallow lysimeter declined through fall 2012. Since fall 2020, the concentration has been increasing. This suggests that tritium concentrations in ST4-VL-5 may continue to slowly increase. See Section 5.1.4. 	61.2 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met
ELLWF Slit Trench 7 ST7-VL-2	Radionuclide Transport	<ul style="list-style-type: none"> • 561 pCi/mL • Concentrations in the action-level lysimeter reached a peak of 706 pCi/mL in FY2022 and started to decline in FY2023. The spring 2023 concentration declined to 338 pCi/mL. Concentrations in the upper lysimeters are at background. See Section 5.1.5. 	61.2 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results & Trends ¹	PA Expected Behavior (Below)	Action Taken	PA/CA Impacts
ELLWF Slit Trench 8 ST8-VL-6	Radionuclide Transport	<ul style="list-style-type: none"> • 16.9 pCi/mL • Concentrations in the action-level lysimeter have been declining since the peak of 64.5 pCi/mL measured in fall 2020. This decreasing trend continued in FY2023 with both the fall and spring measurements below the administrative limit. The shallow lysimeter is also on a decreasing trend. This suggests that this lysimeter may remain below the administrative limit. See Section 5.1.6. 	46.9 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met
ELLWF Slit Trench 14 ST14-VL-3	Radionuclide Transport	<ul style="list-style-type: none"> • 164 pCi/mL • Concentrations in the action-level lysimeter reached a peak concentration of 209 pCi/mL in fall 2020. Since that time, concentrations have started declining. This trend continued in FY2023. The shallow lysimeter is trending upward. See Section 5.1.7. 	63.8 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met

¹ Trends discussed in more depth within Section 5.1. Concentrations shown are maximum values for FY2023.

5.1 Vadose Zone Monitoring

Groundwater in the vadose zone beneath the ELLWF undergoes semiannual performance monitoring to verify that tritium concentrations are not high enough to cause saturated zone groundwater to exceed the tritium maximum concentration limit at or beyond the facility point of assessment (POA). Measured vadose zone tritium concentrations are compared to administrative limits, which were established in the ELLWF Monitoring Plan (Millings, 2012) and amended by Kubilius (2019). The administrative limits are based on PA predictions (WSRC, 2008). The administrative limit for a given trench is 25% of the tritium concentration in the vadose zone which, if it occurred beneath the entire areal footprint of the trench, would cause groundwater tritium concentrations at the 100-meter boundary to reach the maximum concentration limit (20 pCi/mL). These conservative limits are used as indicators for whether further investigation is necessary. Due to the conservative assumptions used to calculate the administrative limits, it is important to note that reaching or exceeding the limit does not mean that the drinking water standard will be exceeded at the compliance point.

In FY2023, nine new lysimeter stations (2 lysimeters per station) were installed on the perimeter of ET3, ST8, and ST9. These stations included ET3-VL-6, ET3-VL-7, ET3-VL-10, ET3-VL-11, ET3-VL-12, ET3-VL-13, ST8-VL-7, ST9-VL-4, and ST9-VL-5 (Figure 5-1). Two lysimeters were installed at each station. Lysimeter placement was based on borehole lithology and was comparable to the existing lysimeter stations. The deepest lysimeter at each of the new lysimeter stations was designated as the action-level lysimeter.

With the addition of the FY2023 lysimeters, the vadose zone monitoring program now consists of 327 suction lysimeters at 111 stations surrounding 14 waste trenches (Figure 5-1). Vadose zone moisture is collected from the lysimeters on a semi-annual basis and analyzed for tritium. At 102 of 111 lysimeter stations, a deep lysimeter is designated as an action-level (AL) lysimeter (Halverson and Millings, 2017). This is usually the deepest (i.e., closest to the water table) active lysimeter in the cluster. Tritium concentrations in AL lysimeters are those that are compared to the administrative limits (Millings, 2012; Kubilius 2019).

Nine lysimeter clusters do not have an AL lysimeter; one cluster (MWMF-VL-1) is a “background” cluster not associated with a trench, and eight clusters have no active lysimeter at an appropriate elevation: one at ET1 (VL-23), two at ET2 (ET2-VL-4, ET2-VL-8), one at ST1 (VL-3A), two at ST2 (ST2-VL-1, ST2-VL-6), one at ST3 (ST3-VL-7) and one at ST8 (ST8-VL-3). These nine clusters are still sampled, and the results are reviewed for notable changes.

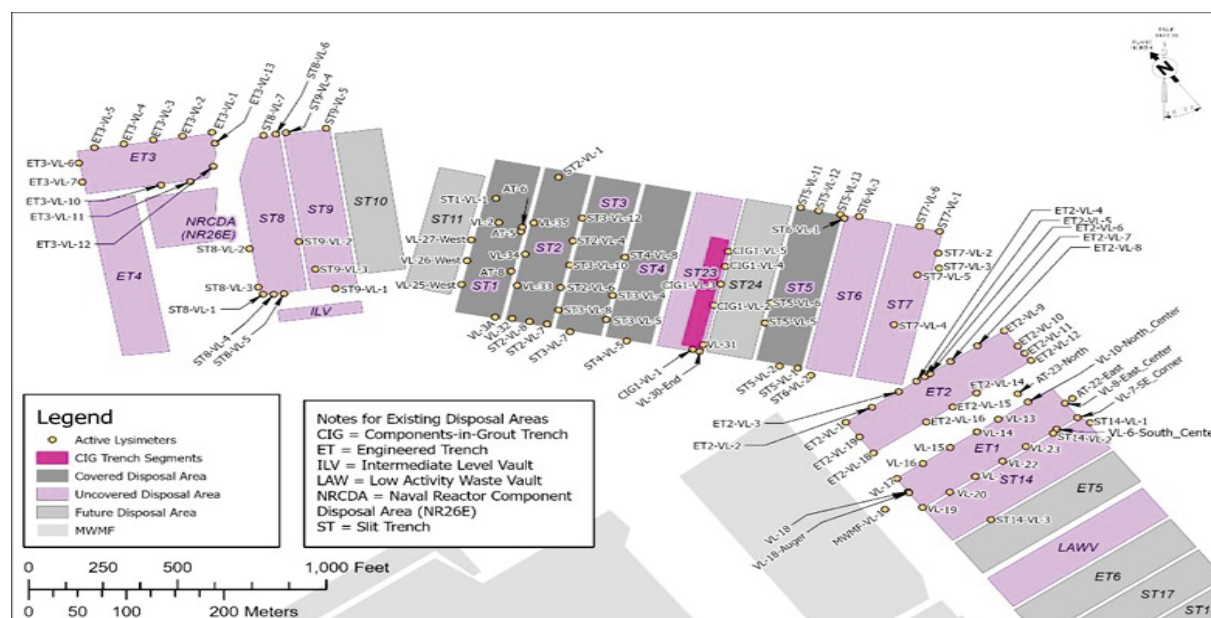


Figure 5-1. Layout showing disposal units, active lysimeters, and stormwater runoff covers.

In FY2023, samples were collected at all 102 AL lysimeters. Analytical results in FY2023 were at or below administrative limits at 92 of the 102 sampled AL lysimeters. Table 5-2 provides a summary of FY2023 tritium data for each of the ten AL lysimeters above administrative limits (where the PA Expected Behavior is the administrative limit for that DU). Table 5-3 provides summary data for all AL lysimeters. Tritium concentrations in ten AL lysimeters exceeded administrative limits: three at ET1, two at ET2, two at ST1, and one each at ST4, ST7, and ST14 (locations shown in Figure 5-2). Nine of ten lysimeters above the administrative limit have been above the limit at least once in previous sampling events. Lysimeter AT-5 (226), located at ST1, slightly exceeded its administrative limit for the first time in FY2023.

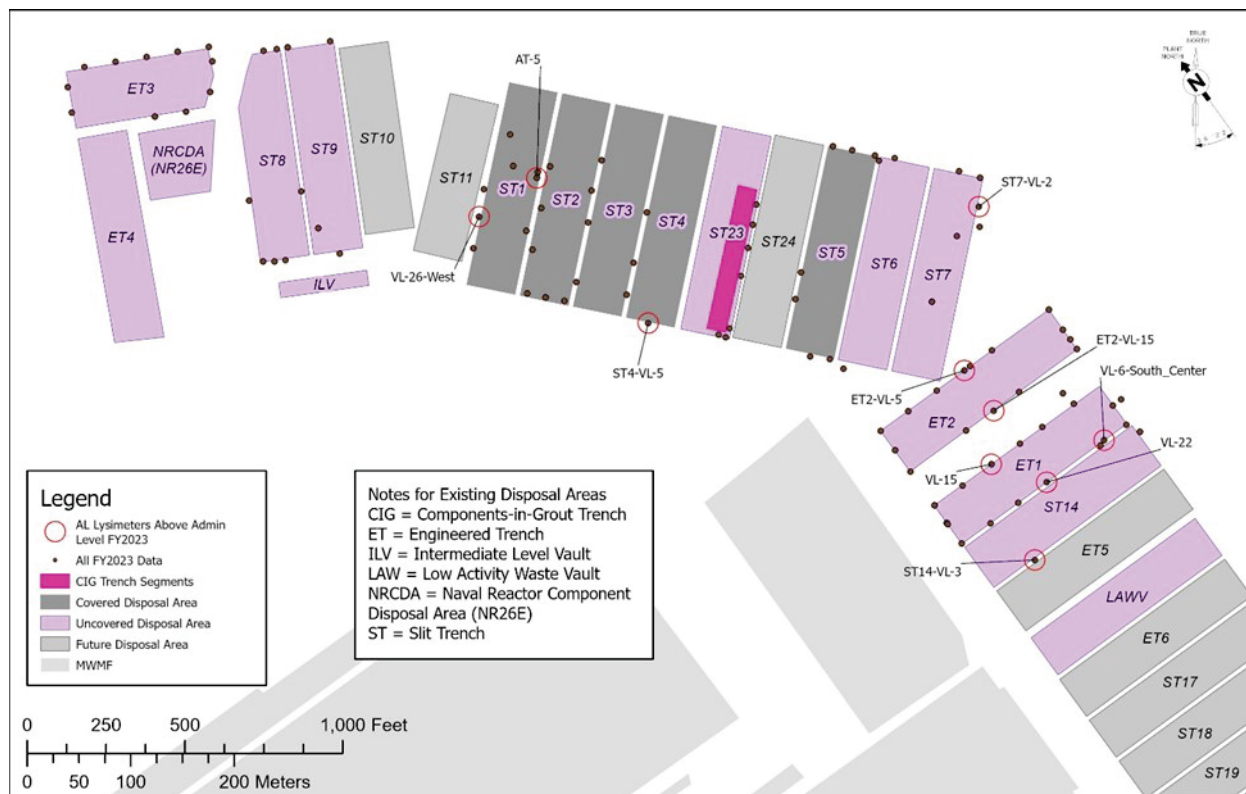


Figure 5-2. Layout showing action-level lysimeters with administrative limit exceedances.

Table 5-3 Summary FY2023 Tritium Data (pCi/mL) for Action-Level Lysimeters.

Well ID (Elevation in ft msl)	FY2023 Sampling Events		Well ID (Elevation in ft msl)	FY2023 Sampling Events	
	Fall ⁺	Spring ⁺		Fall ⁺	Spring ⁺
CIG Trench (Administrative Limit = 29.6 pCi/mL)			Slit Trench 2 (Administrative Limit = 61.2 pCi/mL)		
CIG1-VL-1 (236)	16	15	ST2-VL-4 (232)	2	3
CIG1-VL-2 (237)	3	3	ST2-VL-7 (231)	11	11
CIG1-VL-3 (233)	5	6	ST2-VL-8 (240)	4	4
CIG1-VL-4 (232)	22	24	VL-32 (231)	4	6
CIG1-VL-5 (238)	3	2	VL-33 (229)	*	4
VL-30-End (240)	4	3	VL-34 (227)	4	4
VL-31 (241)	4	3	VL-35 (227)	3	2
Engineered Trench 1 (Administrative Limit = 101.3 pCi/mL)			Slit Trench 3 (Administrative Limit = 61.2 pCi/mL)		
AT-22-East (233)	4	3	ST3-VL-4 (234)	24	21
AT-23-North (237)	2	2	ST3-VL-5 (236)	22	21
VL-6-South_Center (233)	165	148	ST3-VL-8 (238)	3	3
VL-7-SE_Corner (235.7)	10	8	ST3-VL-10 (240)	3	3
VL-8-East_Center (234.9)	45	36	ST3-VL-12 (243)	3	3
VL-10-North_Center (233)	7	7	Slit Trench 4 (Administrative Limit = 61.2 pCi/mL)		
VL-13 (237)	8	10	ST4-VL-5 (238)	152	150
VL-14 (239)	19	19	ST4-VL-8 (239)	3	3
VL-15 (235)	1330	1220	Slit Trench 5 (Administrative Limit = 61.2 pCi/mL)		
VL-16 (235)	5	3	ST5-VL-1 (237)	34	40
VL-17 (238)	75	67	ST5-VL-2 (252)	3	2
VL-18 (234)	5	5	ST5-VL-5 (239)	3	3
VL-18-Auger (234)	4	4	ST5-VL-6 (244)	3	2
VL-19 (238)	4	3	ST5-VL-11 (237)	2	1
VL-20 (243)	5	*	ST5-VL-12 (231)	4	3
VL-21 (239)	13	12	ST5-VL-13 (236)	2	2
VL-22 (241)	188	174	Slit Trench 6 (Administrative Limit = 61.2 pCi/mL)		
Engineered Trench 2 (Administrative Limit = 101.3 pCi/mL)			ST6-VL-1 (233)	2	2
ET2-VL-1 (242)	4	4	ST6-VL-2 (241)	3	3
ET2-VL-2 (242)	3	3	ST6-VL-3 (235)	2	2
ET2-VL-3 (245)	4	5	Slit Trench 7 (Administrative Limit = 61.2 pCi/mL)		
ET2-VL-5 (247)	1130	966	ST7-VL-1 (233.5)	2	1
ET2-VL-6 (244)	12	10	ST7-VL-2 (231.7)	561	338
ET2-VL-7 (245)	11	10	ST7-VL-3 (232)	3	2
ET2-VL-9 (242)	3	2	ST7-VL-4 (232)	3	3
ET2-VL-10 (242)	3	3	ST7-VL-5 (229)	2	2
ET2-VL-11 (246)	2	3	ST7-VL-6 (229)	2	2
ET2-VL-12 (240)	3	3	Slit Trench 8 (Administrative Limit = 46.9 pCi/mL)		
ET2-VL-14 (240)	15	13	ST8-VL-1 (235.5)	20	24
ET2-VL-15 (247)	156	131	ST8-VL-2 (227)	2	2
ET2-VL-16 (242)	2	2	ST8-VL-4 (230)	3	3
ET2-VL-18 (242)	5	5	ST8-VL-5 (229)	3	3
ET2-VL-19 (248)	38	31	ST8-VL-6 (238)	10	17
Engineered Trench 3 (Administrative Limit = 43.7 pCi/mL)			ST8-VL-7 (220)	*	5
ET3-VL-1 (221)	3	3	Slit Trench 9 (Administrative Limit = 46.9 pCi/mL)		
ET3-VL-2 (226)	4	4	ST9-VL-1 (239)	2	3
ET3-VL-3 (222)	4	3	ST9-VL-2 (229)	3	3
ET3-VL-4 (224)	1	2	ST9-VL-3 (240)	6	6
ET3-VL-5 (222)	30	28	ST9-VL-4 (216)	*	4
ET3-VL-6 (219)	*	4	ST9-VL-5 (220)	*	5
ET3-VL-7 (220)	*	2	Slit Trench 14 (Administrative Limit = 63.8 pCi/mL)		
ET3-VL-10 (222)	*	10	ST14-VL-1 (240)	3	4
ET3-VL-11 (221)	*	5	ST14-VL-2 (239)	10	9
ET3-VL-12 (223)	*	3	ST14-VL-3 (237)	164	141
ET3-VL-13 (218)	*	4			
Slit Trench 1 (Administrative Limit = 61.2 pCi/mL)			+ All data in pCi/mL		
AT-5 (226)	63	62	* No sample collected		
AT-6 (227)	59	60	Pink shading = Exceeds Administrative Limit		
AT-8 (232)	3	3			
ST1-VL-1 (245)	3	3			
VL-2 (225)	7	7			
VL-25-West (246)	3	3			
VL-26-West (245)	411	371			
VL-27-West (245)	6	5			

All AL lysimeters which exceeded their administrative limits in FY2023 or earlier are discussed individually below.

5.1.1 Engineered Trench 1

There are 17 AL lysimeters associated with Engineered Trench 1 and all were successfully sampled in FY2023. Three of the 17 AL lysimeters exceeded the tritium concentration administrative limit of 101.3 pCi/mL: those in clusters VL-6-South Center (VL-6-SC), VL-15, and VL-22. These same three lysimeters were above the limit in FY2022. VL-17 exceeded the administrative limit in FY2020 but has been below the limit in each subsequent sampling event.

VL-6-SC. This AL lysimeter first exceeded the tritium administrative limit in FY2014, with a result of 502 pCi/mL, representing a substantial increase from 58 pCi/mL obtained in the previous sampling event. This prompted a detailed data review for VL-6-SC including disposal records, local hydrogeology, and rainfall data (Millings et al., 2014). Nothing remarkable was found in these data that could definitively explain the elevated tritium concentrations in VL-6-SC. From 2014 through 2019, concentrations in the AL lysimeter were generally decreasing, reaching 312 pCi/mL in spring 2019.

However, the tritium concentration spiked in FY2020 to a peak of 786 pCi/mL. Since FY2020, concentrations have been trending downwards and this trend continued in FY2023 as the tritium concentration decreased to 165 pCi/mL. The tritium concentration in the shallow lysimeter had been decreasing since reaching a peak in FY2019 (1026 pCi/mL). However, in spring 2023, the concentration in the shallow lysimeter increased (142 pCi/mL). Concentrations in adjacent lysimeters remain below the action level (VL-7 and VL-23). ST14-VL-2 is the closest lysimeter station to VL-6-SC (less than 10 ft). After trending upwards for several sampling events, the tritium concentration in the AL lysimeter at ST14-VL-2 is trending downwards (9.8 pCi/mL) and is below the action-level for both ET 1 (101.3 pCi/mL) and ST 14 (63.8 pCi/mL).

VL-15. Tritium concentrations in this AL lysimeter have been increasing since FY2008 with the first exceedance of the administrative limit occurring in FY2012. It has exceeded the administrative limit in every successful sampling event since FY2012. The increasing trend continued in FY2023 as the concentration reached 1330 pCi/mL, which is the highest concentration measured to date in this AL lysimeter. An increasing trend was also observed for the shallow lysimeter. It appears that tritium concentrations in the AL lysimeter follow the same pattern as the shallower lysimeter but are lagged and slightly reduced. Therefore, concentrations are expected to continue increasing in the AL lysimeter. Concentrations in adjacent lysimeters VL-14 (18.9 pCi/mL) and VL-16 (4.6 pCi/mL) are well below the administrative limit (101.3 pCi/mL).

VL-17. The AL lysimeter exceeded the action level for the first time in the fall sampling event for FY2020 when the tritium concentration peaked at 199 pCi/mL. VL-17 has been below the administrative limit in each sampling event since FY2020. For FY2023, the concentration was 75 pCi/mL, which is below the administrative limit (101.3 pCi/mL). However, concentrations in this lysimeter are slowly trending upwards. Concentrations in the upper lysimeter peaked in 2014 and declined through 2017 when they began to increase again. This suggests the AL lysimeter may continue to increase in the future.

VL-22. The tritium concentration measured in the AL lysimeter was 188 pCi/mL compared to 230 pCi/mL in FY2022. Concentrations in this lysimeter have been declining since reaching a peak of 300 pCi/mL in FY2020. The shallow lysimeter at VL-22 reached a peak in FY2015 and declined steadily through FY2020 before increasing in subsequent sampling events. The concentration trend of the AL lysimeter is comparable to the shallow lysimeter but is reduced and lagged. Therefore, the concentration in the AL lysimeter may begin to increase in the future.

As a result of the exceedances noted for the ET1 sampling locations, a study was undertaken to assess whether the elevated concentrations challenged the PA conclusions (Flach and Whiteside, 2016). Because ET1 and ET2 were analyzed together in the 2008 PA, they were evaluated together in this study. The 2008 PA model conservatively assumed hypothetical waste disposal timing and distribution based on both trenches opening and being filled simultaneously. However, the average disposal dates for ET1 and ET2 differ by more than eight years, which will result in some plume separation. Because the as-disposed-of waste conditions for ET1 and ET2 were different than assumed in the PA, the model was revised to reflect the actual disposal conditions. The results of the study showed that simulated and vadose zone plume concentrations are reasonably consistent and that the phased operation of ET1 and ET2 is likely to ensure that performance objectives are met. This conclusion was later confirmed by the SA of the impact of the updated GSA flow model on E-Area groundwater performance (Hamm et al. 2018).

5.1.2 Engineered Trench 2

There are 15 AL lysimeters associated with Engineered Trench 2 and all were successfully sampled in FY2023. Two of the 15 AL lysimeters, ET2-VL-5 and ET2-VL-15, exceeded the tritium concentration administrative limit of 101.3 pCi/mL. Both of these lysimeters exceeded the limit in FY2022. ET2-VL-6 was above the administrative limit in FY2022 but was below the limit in both FY2023 sampling events.

ET2-VL-5. This AL lysimeter first exceeded the tritium administrative limit in spring 2017, with a result of 178 pCi/mL. It increased again in both fall 2017 and spring 2018. The spring 2018 concentration of 2822 pCi/mL is the highest level of any AL lysimeter at ELLWF to date. The FY2023 concentration was 1130 pCi/mL which is slightly less than recent sampling events. After decreasing from the high of 2822 pCi/mL, the tritium concentration in the AL lysimeter appears to be declining slightly. The tritium concentration in the shallow lysimeter at ET2-VL-5 has been declining since fall 2020. As part of normal operations, the operational soil cover over the waste was extended beyond ET2-VL-5 in FY2019. This action will reduce infiltration and funneling of water in the vicinity of ET2-VL-5.

ET2-VL-6. This lysimeter exceeded the administrative limit for the first time in fall 2020. The concentration in this lysimeter began increasing in fall 2018 and spiked to a concentration of 924 pCi/mL in spring 2021. Since spring 2021, the tritium concentration has been declining and was below the administrative limit in FY2023 (11.8 pCi/mL).

ET2-VL-15. Tritium concentrations at this AL lysimeter began increasing in 2015 and reached a peak of 231 pCi/mL in the fall 2019 sampling event. Since fall 2019, the tritium concentration has been generally declining. The tritium concentration in this lysimeter was 156 pCi/mL in fall 2022 and 131 pCi/mL in spring 2023. The shallow lysimeters in this cluster are elevated but have generally been declining since 2016. This suggests the concentration in the AL lysimeter may continue to decrease. As with ET2-VL-5, the operational soil cover was extended beyond this lysimeter location during FY2019.

5.1.3 Slit Trench 1

In FY2023, two of the eight AL lysimeters in Slit Trench 1, VL-26-West and AT-5, exceeded the tritium concentration administrative limit of 61.2 pCi/mL. AT-5 slightly exceeded the limit for the first time in FY2023. AT-6, which has hovered around the administrative limit in recent years, was below the limit in FY2023.

AT-5. This AL lysimeter exceeded the administrative limit for the first time in fall 2022 with a concentration of 62.7 pCi/mL and was slightly over the limit again in spring 2023 (61.7 pCi/mL). The tritium concentration in AT-5 (226) has been slowly trending upwards since FY2011. The lysimeter immediately above the AL lysimeter was last successfully sampled in FY2020 and has been dry since. Concentrations in this lysimeter were elevated but appeared to be trending downwards with the last successful sample.

AT-6. The tritium concentration in the AL lysimeter at AT-6 rose gradually from about 2011, and it exceeded the administrative limit in fall 2016 with a concentration of 76 pCi/mL. Since then, tritium concentrations have hovered around the administrative limit of 61.2 pCi/mL but had not exceeded the limit again until spring 2021 with a concentration of 62.1 pCi/mL. For FY2023, the tritium concentration was 59.7 pCi/mL, which is slightly below the administrative limit. The tritium concentration in this lysimeter appears to have plateaued and is hovering around the administrative limit. The tritium concentrations in the shallow lysimeters at AT-6 are generally trending downward but have stabilized in recent sampling events. This suggests the tritium concentration in the AL lysimeter is likely to continue to hover around the administrative limit.

VL-26-West. This AL lysimeter was the first at ELLWF to exceed its administrative limit. This lysimeter was installed in 2003 and the first action level exceedance was in spring 2008 with a result of 67 pCi/mL. The tritium concentration increased gradually through 2017 reaching 515 pCi/mL. Since 2017, the concentration has been on a slight downward trend. This downward trend continued in FY2023 with a concentration of 411 pCi/mL in the fall 2022 sampling event and 371 pCi/mL in the spring 2023 sampling event. The lysimeter above the AL lysimeter is also elevated, but tritium concentrations there have been declining since 2015. The decreasing trend in the shallower lysimeter suggests that concentrations in the AL lysimeter have plateaued and may decrease in the future. Previous investigations into VL-26-West have included additional sampling events, reviews of geology and disposal history (Millings, 2009), modeling (Smith, 2010), and a field study (Millings et al., 2010). Data from these studies indicate that the tritium emanating from ST1 near VL-26-West is localized and should have minimal effect on groundwater near the trench.

5.1.4 Slit Trench 4

ST4-VL-5. One of the two AL lysimeters in Slit Trench 4, ST4-VL-5, exceeded its tritium concentration administrative limit (61.2 pCi/mL) in FY2023. This AL lysimeter had elevated tritium levels when installed in 2008, and concentrations have increased since then. It has exceeded the administrative limit continuously since fall 2011. In FY2023, the concentration was 152 pCi/mL. Concentrations in the shallower lysimeters within the cluster are elevated but have been generally trending upward since fall 2020. This suggests the tritium concentration in the AL lysimeter may continue to slowly increase.

5.1.5 Slit Trench 7

ST7-VL-2. One of the six AL lysimeters in Slit Trench 7, ST7-VL-2, exceeded its tritium concentration administrative limit (61.2 pCi/mL) in FY2023. This AL lysimeter slightly exceeded the administrative limit in FY2010 and FY2011, then was below it for several years. Beginning in FY2017, it has been above the administrative limit for each subsequent sampling event. Concentrations in the AL lysimeter reached a maximum in fall 2021 of 706 pCi/mL before declining to 338 pCi/mL in spring 2023. Shallow lysimeters in the cluster are at background levels (~5-10 pCi/mL).

5.1.6 Slit Trench 8

None of the five AL lysimeters at Slit Trench 8 exceeded the tritium concentration administrative limit (46.9 pCi/mL) in FY2023. In FY2022, ST8-VL-6 was above the administrative limit but was below the limit in FY2023. The shallow lysimeter at this cluster is elevated but the tritium concentration is decreasing. Based on the trend in the shallow lysimeter and the results from the FY2023 sampling, the concentration in the AL lysimeter is expected to remain below the administrative limit in the future.

5.1.7 Slit Trench 14

ST14-VL-3. One of the three AL lysimeters in Slit Trench 14, ST14-VL-3, exceeded its tritium concentration administrative limit (63.8 pCi/mL) in FY2023 with a concentration of 164 pCi/mL (fall 2022). In spring 2023 the tritium concentration decreased slightly (141 pCi/mL). This lysimeter was installed in

2016, and it has exceeded the limit since 2017. The tritium concentration has been decreasing since fall 2020. The lysimeter immediately above the AL lysimeter has been trending upwards.

5.2 Sampling of ELLWF Water Table Wells

During the Fall 2019 Low-Level Waste Disposal Facility Federal Review Group (LFRG) semi-annual business meeting SRS presented a report for the optimization of the groundwater monitoring program at ELLWF (Kubilius, 2019). The report recommended installation of eight new water table wells in the saturated zone around ELLWF. LFRG requested that they be notified of the sampling results from the installed water table wells. Also, Observation #2 from the LFRG review of the FY2020 Annual Summary Report (ASR) noted that the compliance monitoring table “would be more effective if it also included data from other results, e.g., other non-volatile Beta results, as SRNL-RP-2009-00534 noted there are other radionuclides (primarily Tc-99 and I-129).” The observation was noted again in the LFRG review of the FY2021 ASR. The observation was closed with SRS response to the observation noting that water table wells were to be installed in FY2021 and sampling results would be reported when available. In FY2021, eight water table monitoring wells were installed at various locations around ELLWF (Figure 5-3). These wells were sampled in FY2023, and the results are reported in Table 5-4 of this document.

Groundwater is monitored and reported in accordance with the Office of Environmental Quality Control Bureau of Land and Waste Management Hazardous and Mixed Waste Permit SC1 890 008 989 (SCDHEC, 2014). A revision to the PA monitoring plan is scheduled for after the 2022 PA revision is approved that may include a saturated zone monitoring component.

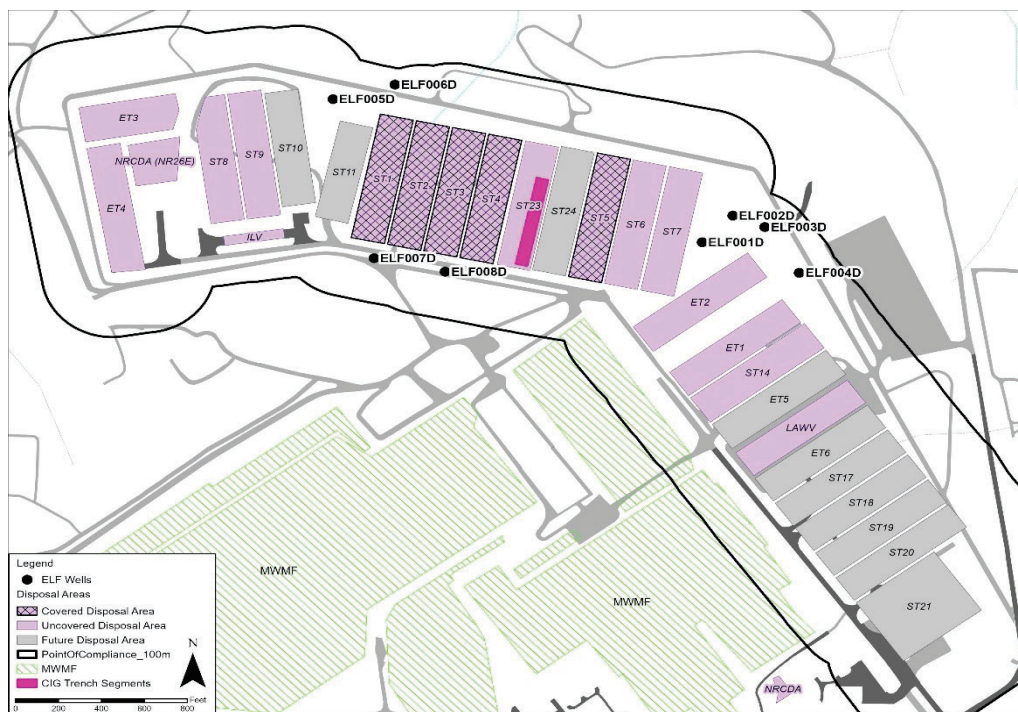


Figure 5-3. ELLWF Water Table Wells

Table 5-4. Summary FY2023 Tritium Data (pCi/mL) for ELLWF Water Table Wells.

Well	Tritium (pCi/mL)	TCE (ug/L)	PCE (ug/L)	1,1-DCA (ug/L)	I-129 (pCi/L)	Tc-99 (pCi/L)
ELF001D	15.6	ND	ND	ND	ND	ND
ELF002D	7.98	ND	ND	ND	ND	ND
ELF003D	3.52	ND	ND	ND	ND	ND
ELF004D	4.06	ND	ND	ND	ND	ND
ELF005D	44.9	2.94	0.54	0.44	ND	ND
ELF006D	1440	2.66	0.51	6.51	ND	ND
ELF007D	122	8.73	1.94	1.48	ND	ND
ELF008D	625	6.80	1.86	2.22	ND	ND

5.3 Trench Cover Monitoring

Inspections of the soil cover over filled sections of operating STs and ETs are conducted on a quarterly basis per procedure SW15.6-INP-SWF-03 (SWM, 2023a). A few localized depressions and erosion areas were noted in these inspections. SWM addressed each area of concern with grading equipment and soil fill.

Inspections of the CIG storm water runoff cover are performed on a quarterly basis (SWM, 2023a). Four inspections were conducted in FY2023. In August 2022, during the quarterly inspection, a tear was found at a seam that had been previously repaired. The cover was repaired by the vendor under warranty in FY2023.

Inspections of the Slit Trench water barriers are performed quarterly (SWM, 2023a). Ongoing maintenance issues were addressed with concrete fasteners. A few concrete fasteners for the stainless-steel anchor strips had been found to be broken off at the head of the fasteners. These fasteners were replaced with more durable concrete anchors. In addition, SWM has continued to monitor two depressions that had formed underneath the covers due to subsidence of the waste in FY2012. One depression is approximately ten feet in diameter and the other depression is approximately five feet in diameter. Both are up to approximately eighteen inches deep. The FY2023 inspections determined that these two depressions had not changed in size or in depth. The covers were still intact with no fatigue issues above these two depression areas. SWM will continue to monitor these depressions for changes in conditions.

5.4 Vault Concrete Monitoring

Inspection of the LAWV walls was last performed in October 2022 (FY2023) by procedure 724-EAV-50 (SWM, 2020) which showed no significant cracking or degradation beyond what was assumed for the PA. This inspection is performed every two years.

5.5 Sump Water Monitoring

Water samples are taken from the vault (LAWV and ILV) and engineered trench sumps. SWM monitors the vault sump through procedure SW15.1-SOP-LLS-01 (SWM, 2023b) and the ET2 sump through procedure SW15.1-SOP-ESUMP-02 (SWM, 2017). These procedures provide instructions for sampling and pumping the vaults and ET2 sumps. The sumps are checked for liquid levels and if liquid level thresholds are exceeded, then the contents are sampled for evaluation against the administrative limits (SWM, 2017, SWM, 2023b) and dispositioned accordingly. All FY2023 samples were below administrative limits.

5.6 Surface Water Compliance Monitoring

SRS conducts scheduled compliance monitoring of surface water at several locations downstream of ELLWF, per DOE Order 458.1 (DOE, 2020) and the CA monitoring plan (Crapse et al., 2011). Results and projected radiation doses to the public are published in the SRS Annual Environmental Report and are compared to CA predictions in the CA annual reviews (Watkins, 2023). The most recent predicted maximum dose to a member of the public, via the liquid pathways (includes doses from drinking water, fish and invertebrate consumption, recreational activities, and irrigation) at locations below ELLWF, is published in the 2022 Annual Environmental Report (SRNS, 2023) and shown in Table 5-5. This value is 0.17 mrem/yr, which is far below the DOE 458.1 dose limit of 100 mrem/yr.

Table 5-5. Compliance Monitoring.

Disposal Facility/Unit	Monitoring Type	Monitoring Results & Trends	Performance Objective Measure or other Regulatory Limit	Action Level	Action Taken	PA/CA Impacts
ELLWF	Surface Water	0.17 mrem	<100 mrem	NA	None	None

5.7 Monitoring Conclusions

The majority of AL lysimeter locations, approximately 90%, remained below administrative limits in FY2023. A majority of the AL lysimeters would need to reach, with some exceeding, their administrative limit in order to exceed a groundwater PO or measure. Because administrative limits are set at 1/4th the concentration predicted to result in an exceedance in the groundwater, the remaining 10% of the AL lysimeters spread over 7 trenches are not expected to result in an exceedance at the 100-m POA. The source of these exceedances in the overlying waste zone and potential impacts have been previously evaluated (Halverson and Millings, 2017; Hang et al., 2018; Kubilius et al., 2019) and trends in these lysimeters continue to be monitored.

Trench cover inspections during FY2022 revealed a tear in the CIG storm water runoff cover that had been previously repaired. The cover was repaired by the vendor under warranty in FY2023. Other observed defects were minor (i.e., cover depressions, erosion areas, broken fasteners) and not expected to affect performance of these barriers. In some cases, repairs were made (i.e., trench cover concrete fasteners). In other cases, conditions will continue to be monitored for progression of existing defects or new defects.

Finally, sump water samples were all found to be below administrative limits before being discharged. Impacts from surface waters downstream from the E-Area LLWF (Upper Three Runs, Savannah River) continue to fall well below DOE public dose limits based on annual compliance monitoring.

6.0 Research and Development

In FY2023, SRNL produced five technical reports and memoranda supporting ELLWF annual PA maintenance, SWM Operations & Engineering, and PA Test & Research. Table 6-1 lists a summary of this work. No impact to the PA or CA from the activities. All activities are PA Maintenance and were performed to verify PA/CA assumptions. The supporting studies performed in FY2023 do not alter the conclusions of the ELLWF PA (WSRC, 2008)

Table 6-1. Research and Development Activities.

Document Number	Results	PA/CA Impact
SRNL-STI-2023-00086, Revision 0	<p align="center">Installation of Lysimeters Near Engineered Trench 3, Slit Trench 8, and Slit Trench 9</p> <p>Nine new lysimeter stations were installed at the E-Area Low Level Waste Facility (ELLWF). Six lysimeter stations were installed near Engineered Trench 3 (ET3), one installed near Slit Trench 8 (ST8), and two installed near Slit Trench 9 (ST9) as shown in Figure ES-1. Two lysimeters were installed at each station. Lysimeter placements were based on borehole lithology and were comparable to existing nearby lysimeter stations. The deepest lysimeter at each of the new lysimeter stations was designated as the action-level lysimeter.</p>	None
SRNL-L3220-2023-00019, Revision 0	<p align="center">Technical Memorandum, “Recommended Changes to the Lysimeter Sampling Schedule”</p> <p>The purpose of this memo is to make final recommendations on the lysimeter sampling frequency and to identify the lysimeters to be removed from the ELLWF lysimeter sampling program. It was recommended that AL lysimeters be sampled twice per year to fulfill the requirements of the PA Monitoring Plan for sampling of vadose zone water. Additionally, it is recommended that the sampling frequency of non-AL lysimeters be reduced to once per year (preferably in the spring). The change in sampling frequency of non-AL lysimeters is justified because these results are not required to be reported in the PA ASR and are used primarily to investigate trends observed in the data from AL lysimeters. Importantly, these two recommendations do not modify the monitoring requirements of the PA Monitoring Plan and do not necessitate a revision of the plan to incorporate these changes. This memo also identified 50 lysimeters that routinely fail to produce a sample. It was also recommended that these “dry” lysimeters be removed from the sampling program.</p>	None
SRNL-L3200-2023-00001, Revision 0	<p align="center">Technical Memorandum, “Re: Fall 2022 Lysimeter Tritium Data”</p> <p>The purpose of this memo was to provide the Fall 2022 tritium data for the E-Area Vadose Zone Monitoring System and to summarize the tritium concentrations and trends in the Action Level lysimeters. Analytical results in Fall 2022 were at or below the administrative limits at 82 out of 92 sampled locations. There were 10 AL lysimeters above the administrative limits. There was 1 dry AL lysimeter in Fall 2022.</p>	None
SRNL-L3220-2023-00018, Revision 0	<p align="center">Technical Memorandum, “Re: Spring 2022 Lysimeter Tritium Data”</p> <p>The purpose of this memo was to provide the Spring 2023 tritium data for the E-Area Vadose Zone Monitoring System and to summarize the tritium concentrations and trends in the Action Level lysimeters. Analytical results in Spring 2023 were at or below the administrative limits at 91 out of 102 sampled locations. There were 10 AL lysimeters above the administrative limits. There was 1 dry AL lysimeter in Spring 2023.</p>	None

Document Number	Results	PA/CA Impact
SRNS-RP-2023-00140/SRNL-STI-2023-00008	<p align="center">FY2022 Performance Assessment Annual Review for the E-Area Low-Level Waste Facility</p> <p>This annual review for the E-Area Low-Level Waste Facility (ELLWF) affirms that the disposal facility continued to operate within the bounds of the current PA and Composite Analysis (CA) baseline and the subsequent SA's and satisfied all the requirements, conditions, and limitations identified in the 2008 DAS, RWMB, and ELLWF Low-Level Waste Acceptance Criteria. This report affirms that the supporting studies performed in FY2022 do not alter the conclusions of the 2008 ELLWF PA and that there is a reasonable expectation that the ELLWF will meet the performance objectives delineated in DOE Manual 435.1-1.</p>	None

7.0 Planned or Contemplated Changes

The 2022 PA revision, which will update the ELLWF PA technical baseline, was submitted to LFRG in FY2023. This comprehensive update is warranted by the cumulative number of changes to the existing PA technical baseline as contained in 15 UDQE's and 10 SA's approved since the 2008 PA. A 2016 PA strategic planning document set out recommendations and a roadmap for the current revision. Numerous updates to models, assumptions, approaches and key PA datasets are being evaluated as part of this new baseline. SA SRNL-STI-2018-00624 (Hamm et. al., 2018) employed a version of these improvements existent at that time and demonstrated a sizeable amount of operating margin with respect to POs. This provides increased confidence that the ongoing PA revision will produce acceptable groundwater limits.

A planned revision to the monitoring plan may implement a change to the PA groundwater monitoring program that adds a saturated zone component to the existing vadose zone monitoring system. The details of these changes were documented in the FY2021 ASR (LaBone, et al., 2022).

As part of the revised PA monitoring plan, tritium administrative limits for the AL lysimeters that comprise the VZMS will be re-calculated. The administrative limits for tritium are calculated using the inventory limit for each disposal unit, the peak activity concentration to the groundwater determined by PA modeling, disposal unit geometry, and estimated infiltration rates (Millings, 2012).

A summary of these planned changes is provided in Table 7-1.

Table 7-1. Planned or Contemplated Changes.

Planned or contemplated change	Change Basis	PA/CA Impact	Schedule
Update of ELLWF PA technical baseline	A FY2016 PA planning document surveyed the 2008 PA as well as PA's across the DOE Complex, reviewed ELLWF operational plans and history, evaluated changes in the ongoing DOE O 435.1 update, and identified new PA data and model simulation techniques to develop a strategy and lay out recommendations for the 2022 PA revision. Based on this roadmap, the E-	New radionuclide disposal limits and operational constraints, and update to estimated dose impacts at facility closure	After 2022 PA Approval a detailed schedule for PA Implementation will be developed

Planned or contemplated change	Change Basis	PA/CA Impact	Schedule
	<p>Area PA revision was developed to employ the following new models and updated key PA datasets in a new technical baseline: updated GSA flow model; new conceptual closure cap design; updated infiltration estimates; new trench, NRCDA, ILV and LAWV models; latest geochemical parameters; updated hydraulic parameters; new comprehensive radionuclide screening model, safety functions and relevant features-events-processes screening, and exposure pathway screening; and a new dose model based on updated radionuclide-dose parameters and dose methodology. (Butcher and Phifer, 2016)</p>		
<p>Revision to Administrative Limits for Action Level Lysimeters</p>	<p>Administrative limits are calculated based on PA modeling. Specifically, these conservative limits are based on disposal unit inventory limits, peak activity concentrations to groundwater for tritium, disposal unit geometry, and estimated infiltration rates. These input parameters will change with the PA revision. Therefore, new administrative limits will be calculated based on the 2022 PA revision once approved.</p>	<p>New administrative limits for AL lysimeters.</p>	<p>After 2022 PA Approval a detailed schedule for PA Implementation will be developed</p>
<p>Optimization of Groundwater Monitoring Program at the E-Area Low-Level Waste Facility</p>	<p>A FY2019 report describes results of a SZ characterization campaign which was conducted in 2017, and proposes changes to the ELLWF PA Monitoring Plan, including: 1) reducing the frequency of vadose zone lysimeter sampling from semi-annually to annually; 2) omitting sampling of about 40 (of 300) lysimeters that are deemed unnecessary due to either being historically dry or because they are one of several lysimeters at a station; 3) installing up to eight new performance monitoring wells in the saturated zone downgradient of ET 1 and 2 and ST 1; and 4) considering future compliance monitoring at surface water stations in Upper Three Runs or Crouch Branch. (Kubilius and Joyce, 2018)</p>	<p>Update to the monitoring plan</p>	<p>After 2022 PA Approval a detailed schedule for PA Monitoring Plan Revision will be developed</p>

8.0 Status of DAS Conditions, Key and Secondary Issues

All key and secondary issues from the LFRG review of the 2008 ELLWF PA have been resolved and are understood to be closed with final DOE-HQ approval of the FY2014 Annual Review. Two issues were closed by committing to address the issues in the next PA and are listed in Table 8-1. This annual review affirms that the ELLWF has satisfied all the requirements, conditions and limitations identified in the DAS and that a revision to the DAS is not needed at this time.

Table 8-1. Status of DAS Conditions, Key and Secondary Issues

Disposal Facility/ Unit	Key/ Secondary Issue or DAS Condition number	Issue Description	Issue Closure Method	Disposition Documentation & Date Completed	PA, CA, DAS Impact or Status
ELLWF	7.2.4	Greater consistency is needed in the level of detail of technical approaches and results for each facility in Ch. 1-5 (recommend including figures and diagrams of the general technical approaches and calculational steps that led to performance measures and disposal limits). Evaluate information within App. A of Part B for relevance.	Closed per DOE approval of the FY2014 Annual Review.	All figures in the Appendices underwent a general review before the final PA was issued. The labeling on the specific figures referenced in the last paragraph of this issue was corrected in the final PA. These actions addressed the concerns about mislabeling. For the remaining details of this issue, re-examining and rewriting Chapters 1 through 5 of the PA in order to achieve greater consistency for all disposal units represent significant revision. As such, improvements will be incorporated into the next revision of the PA.	Complete Pending PA Revision Approval
ELLWF	7.1.1	Additional sensitivity and uncertainty work required to increase confidence in the waste concentration limits and SOFs (through deterministic or probabilistic sensitivity and uncertainty analysis). In the near term, focus should be on components most likely to compromise Performance Objectives (the non-sorbing radionuclides disposed in STs and ETs).	Closed per DOE approval of FY2014 Annual Review.	This item was downgraded from a key issue to a secondary issue based on additional sensitivity analyses performed and documented in the final PA during the factual accuracy review. Additional work to improve the 1-D GoldSim ELLWF trench models, benchmark to PORFLOW, and update the S/U analysis was completed in 2010 with subcontractor support. The initial benchmarking report was updated in FY2013, <i>Benchmarking Exercises to Validate the Updated ELLWF GoldSim Trench Models</i> , SRNL-STI-2010-0737, Rev. 1, November 2013. (Taylor and Hiergesell, 2013)	Complete Pending PA Revision Approval

Disposal Facility/ Unit	Key/ Secondary Issue or DAS Condition number	Issue Description	Issue Closure Method	Disposition Documentation & Date Completed	PA, CA, DAS Impact or Status
				In 2014 SRNL prepared a report that compiles and summarizes the collective GoldSim trench model improvements, benchmarking work, and S/U analysis update, <i>Update to the Uncertainty Analysis for the E-Area Low-Level Waste Facility Trenches</i> , SRNL-STI-2013-00660, Rev. 0, May 2014. (Hiergesell and Taylor, 2014) These improvements will be incorporated into the next revision of the PA.	

9.0 Certification of the Continued Adequacy of the PA, CA, DAS and RWMB

This annual review affirms that the disposal facility continued to operate within the bounds of the current PA and CA baselines and satisfied all the requirements, conditions, and limitations identified in the 2008 DAS (DOE 2008), RWMB (McGill, 2023), and ELLWF Waste Acceptance Criteria (SRS-1S, 2023). This annual review affirms that the supporting studies performed in FY2023 do not alter the conclusions of the 2008 ELLWF PA (WSRC, 2008) and that there is a reasonable expectation that the ELLWF will meet the POs delineated in DOE Order 435.1. The number of proposed changes to data, models and operational plans for the ELLWF since the 2008 ELLWF PA were deemed sufficient to warrant a revision. In FY2023, a revised PA was submitted to LFRG for review. The Field Element Manager makes the following statement regarding the certification of continued adequacy of the PA, CA, DAS and RWMB:

“I certify to the best of my knowledge that information in this ASR is true, accurate and complete and that any proposed or implemented changes associated with the PA or other technical basis documents provide a reasonable expectation that the performance objectives/measures identified in DOE O 435.1 will be met.”

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