



FY2018 Performance Assessment Annual Review for the E-Area Low-Level Waste Facility

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February 2019

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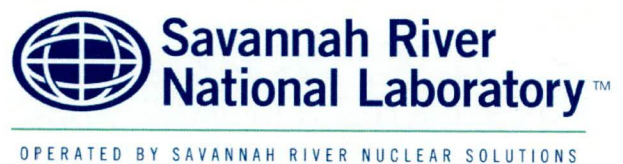
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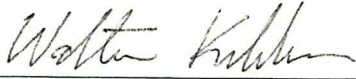
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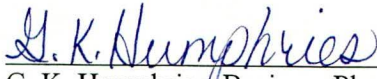


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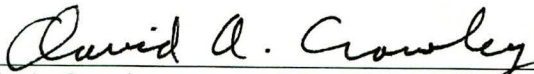
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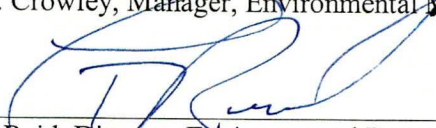


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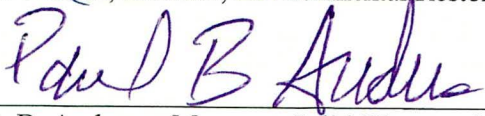
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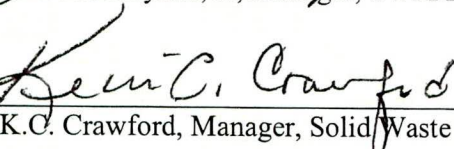
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EXECUTIVE SUMMARY

The FY2018 Performance Assessment (PA) 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 satisfied all the requirements, conditions, and limitations identified in the Disposal Authorization Statement (DAS) and the Radioactive Waste Management Basis (RWMB).

Approximately 5,900 cubic meters of low-level waste was disposed into ELLWF disposal units during FY2018. All disposal units remain in conformance with their disposal limits. There have been no significant changes to the documents making up the RWMB. Inspections of trench covers did not find any major issues. Vadose zone monitoring results show that nine of 86 sampled action-level lysimeters have tritium concentrations exceeding their administrative limits, up from eight exceeding in FY2017. Monitoring of vault and trench sump water shows that all samples were below administrative limits.

In FY2018, an update of the General Separations Area (GSA) groundwater flow model resulted in some changes to predicted groundwater flow directions beneath the eastern portion of ELLWF. The predicted changes could have implications regarding disposal limits. An Unreviewed Disposal Question Evaluation (UDQE) was initiated (Mooneyhan 2018) and will be completed in FY2019. Pending results of the UDQE, interim measures have been implemented, which include restrictions on disposal practices (Germain 2018). These interim measures provide reasonable assurance that PA/CA performance objectives will continue to be met.

In preparation for a revision to the 2008 PA, which is scheduled to begin in FY2019, many tasks have been completed and identified as needed (see Sections 6.0 and 7.0 of this report).

TABLE OF CONTENTS

EXECUTIVE SUMMARY	vi
LIST OF TABLES	viii
LIST OF FIGURES	viii
LIST OF ABBREVIATIONS.....	ix
1.0 Facility Background/History	1
2.0 Changes Potentially Affecting the PA, CA, DAS, or RWMB.....	1
3.0 Waste Receipts.....	2
4.0 Monitoring	5
4.1 Performance Monitoring	5
4.2 Compliance Monitoring	8
5.0 Research and Development.....	12
6.0 Potential Future Work.....	17
7.0 Recommended Changes.....	19
8.0 PA Controls.....	19
9.0 Land Use	20
10.0 Status of Key Issues and Secondary Issues from LFRG Review of the 2008 PA	21
11.0 Declaration of the Continued Adequacy of the PA and DAS	21
12.0 References.....	22
Appendix A . Summary of SA, UDQE, and other Baseline Reports written since the 2008 PA	A-1
Appendix B . Summary of SRS Response on 2008 PA Secondary Issues	B-1

LIST OF TABLES

Table 3-1. Disposed Radionuclide Inventories for ELLWF Disposal Units (FY2018).....	3
Table 3-2. Limiting Sum of Fractions for ELLWF Disposal Units (FY2018).	4
Table 3-3. FY2018 Status of ELLWF Disposal Unit Capacity.	5
Table 4-1. Current PA Monitoring Summary.	9
Table 4-2 Summary FY2017 Tritium Data (pCi/mL) for Action-Level Lysimeters.	10
Table A-1. All SA, UDQE, and Other Baseline Reports since the 2008 PA Revision.....	A-2
Table B-1. Summary of SRS Response on 2008 PA Secondary Issues.....	B-2

LIST OF FIGURES

Figure 4-1. Layout Showing Disposal Units, Current Action-Level Lysimeters, Locations of Administrative Limit Exceedances, and Stormwater Runoff Covers.	11
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LIST OF ABBREVIATIONS

AP	All-Pathways
CA	Composite Analysis
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CIG	Components-in-Grout
DAS	Disposal Authorization Statement
DOE-HQ	Department of Energy – Headquarters
DOE-SR	Department of Energy – Savannah River
DRF	Dose Release Factor
ELLWF	E-Area Low-Level Waste Facility
EPA	Environmental Protection Agency
ERDMS	Environmental Restoration Data Management System
ET	Engineered Trench
EVZMS	Electronic Vadose Zone Monitoring System
FY	Fiscal Year
GSA	General Separations Areas
GW	Groundwater
HELP	Hydrologic Evaluation of Landfill Performance
IEB	Independent Evaluation Board
ICRP	International Commission on Radiological Protection
ILV	Intermediate Level (Waste) Vault
LAWV	Low Activity Waste Vault
LFRG	Low-Level Waste Disposal Facility Federal Review Group
LLW	Low-Level Waste
MCL	Maximum Concentration Limit
mpy	Mils per year
MWMF	Mixed Waste Management Facility
N/A	Not Applicable
NRCDA	Naval Reactor Component Disposal Area
PA	Performance Assessment
PO	Performance Objective
PEST	Parameter ESTimation software
QA	Quality Assurance
R&D	Research and Development
RWMB	Radioactive Waste Management Basis

S&U	Sensitivity and Uncertainty
SA	Special Analysis
SCDHEC	South Carolina Department of Health and Environmental Control
SDF	Saltstone Disposal Facility
SOF	Sum-of-Fractions
SQAP	Software Quality Assurance Plan
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions
SRR	Savannah River Remediation
SRS	Savannah River Site
ST	Slit Trench
STAR	Site Tracking, Analysis & Reporting
SWM	Solid Waste Management
SWMF	Solid Waste Management Facility
TRU	Transuranic
UDQE	Unreviewed Disposal Question Evaluation
UQ-SA	Uncertainty Quantification and Sensitivity Analysis
WITS	Waste Information Tracking System
WAC	Waste Acceptance Criteria
WHAT	Well Hydrograph Analysis Tool
β - γ	beta-gamma
dpm	disintegrations per minute
<i>Kd</i>	sorption coefficient
L	liter
m ³	cubic meters
mL	milliliter
pCi	picocuries

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), Trenches [Slit Trenches (STs), Engineered Trenches (ETs), and Component-in-Grout (CIG) Trenches, and Naval Reactor Component Disposal Areas (NRCDA)s). This annual review evaluates the adequacy of the approved 2008 ELLWF PA, along with the Special Analyses (SAs) approved since the PA was issued, the 2008 Disposal Authorization Statement (DAS) (DOE 2008a), and ELLWF Waste Acceptance Criteria (SRS-1S). The review also verifies that the Fiscal Year (FY) 2018 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 low-level waste management at ELLWF is regulated under Department of Energy (DOE) Order 435.1 (DOE 1999a) 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 1999b) for the operation of the ELLWF and the Saltstone Disposal Facility (SDF). Those portions of that DAS applicable to the ELLWF were superseded by Revision 1 of the DAS on July 15, 2008 (DOE 2008a). The 2008 PA and 2008 DAS were officially implemented by the facility on October 31, 2008 and are the authorization documents for this FY2018 Annual Review.

The ELLWF is a part of the Solid Waste Management Facility (SWMF). SWMF is managed and operated by the SRS Maintenance and Operations prime contractor, Savannah River Nuclear Solutions (SRNS). Within SRNS, the Solid Waste Management (SWM) organization is responsible for operating the SWMF, and the Savannah River National Laboratory (SRNL) is the technical agency responsible for preparing and maintaining the PA. SWMF operations have been performed at SRS for over 60 years. The mission of the SWMF is to provide storage, processing, and shipment of radioactive, hazardous, and mixed waste. 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, which is near the center of SRS.

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

Many of the R&D tasks summarized in recent Annual Reviews (Hiergesell et al. 2016; Crapse et al. 2017; Hang et al. 2018) as well as in this report, have been in preparation for the revision of the 2008 PA (WSRC 2008). These activities are summarized in Section 6.0 Research & Development and listed in Section 7.0 Potential Future Work in these reports. The DOE requires that the PA demonstrate a reasonable expectation that LLW disposal will meet the radiological performance objectives/measures established in DOE Order 435.1.

PA/CA. There were no special analyses (SAs) approved in FY2018. One unreviewed disposal question evaluation (UDQE) was approved in FY2018. The UDQE, SRNL-STI-2013-00393, Revision 1 (Butcher et al 2017), is tabulated in Appendix A, and establishes disposal limits for Engineered Trench 4. A revision to the PA is now being planned, for completion in FY2021. PA development work performed in FY2018 is summarized in Sections 6.0 and 7.0.

In FY2018, an update of the General Separations Area (GSA) groundwater flow model resulted in changes to predicted groundwater flow directions beneath the eastern portion of ELLWF. The predicted changes could have implications regarding disposal limits. A UDQE was initiated (Mooneyhan 2018) and will be completed in FY2019. Pending results of the UDQE, interim measures have been implemented, which

include restrictions on disposal practices (Germain 2018). These interim measures provide reasonable assurance that PA/CA performance objectives will continue to be met.

DAS. SRS continued to conduct ELLWF disposals in accordance with requirements, conditions and limitations set out in the DAS. No baseline document listed in the DAS required revisions in FY2018. LLW disposal facility designs and operational practices continue to conform to the conceptual models used in the PA. Secondary issues identified in the LFRG review team report (DOE 2008b) have been closed and improvements are to be addressed in the next PA. Thus, this annual review affirms the continued adequacy of the DAS in FY2018.

RWMB. The Radioactive Waste Management Basis (RWMB), as updated and approved by Department of Energy – Savannah River (DOE-SR), is adequate for providing the waste controls, processes, and procedures to define the conditions under which the facility may operate with respect to low-level radioactive waste. The RWMB was updated in 2018 (Crawford 2018) to ensure that it is consistent with facility operations and the radioactive waste management order.

3.0 Waste Receipts

Waste acceptance criteria for disposal of LLW at the ELLWF are found in Chapter 5 of the 1S SRS Radioactive Waste Requirements Manual. Chapter 5 identifies the specific Waste Acceptance Criteria (WAC) by waste form, important Waste Information Tracking System (WITS) limits, and a LLW disposal unit decision tree. This LLW WAC procedure is periodically reviewed and updated (SRS-1S, 2014).

As required by the WAC (SRS-1S 2014), 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. Currently, there are over 2,000 approved waste streams in WITS with approximately 125 approved waste streams active as of the end of FY2018. 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 FY2018 (between 9/28/17 and 9/27/18) were compared against the applicable PA/SA-limits for each of the LLW disposal units in ELLWF and met performance objectives. These disposal units included the E-Area Vaults (LAWV, ILV), Disposal Trenches (STs, ETs, and CIG Trenches), 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 WITS. 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 sum of fractions (SOF) administrative limit. The SOFs for disposed radionuclide inventories for all disposal units are less than one.

Because of SRS waste minimization and volume reduction programs, only one LAWV and one ILV are estimated to be needed for low-level radioactive waste disposal over the nominal 25-year operational period (i.e., no more need to be built). After twenty-four years of LAWV operation, approximately 31% of the available volume has been filled with waste that contains approximately 13% of the allowable radionuclide inventory. The LAWV is not expected to be filled during the 25-year planned operational period. After twenty-four years of ILV operation, approximately 58% of the available volume in the nine cells has been filled with waste that contains approximately 10% of the allowable radionuclide inventory. The ILV is also projected not to be filled during the 25-year planned operational period. The radionuclide inventory disposed in each of the ELLWF disposal units in FY2018 is shown in Table 3-1.

The performance measure and exposure pathway producing the highest SOF are given in Table 3-2. Table 3-2 provides the limiting SOFs for the selected performance measures as of 9/27/18. Plume overlap among

units has been taken into account in calculating final limits. For all ELLWF units, the groundwater β - γ 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 performance objective. The dose associated with each disposal unit is below the performance objective limit. Table 3-3 contains a comparison of the actual waste volumes, PA-estimated volumetric disposal capacity and calculated percent-filled for each ELLWF unit.

Table 3-1. Disposed Radionuclide Inventories for ELLWF Disposal Units (FY2018).

Disposal Unit ¹	Disposed Radionuclide Inventory, prior to FY2018 (Curies)	Disposed Radionuclide Inventory, end of FY2018 (Curies)	Percent Increase in FY2018 (%)
LAWV (Cells 3-8)	3.95E+05	4.11E+05	4
ILV	1.88E+06	2.11E+06	12
ST 1 ²	3.98E+01	3.98E+01	0
ST 2 ²	1.64E+02	1.64E+02	0
ST 3 ²	1.25E+02	1.25E+02	0
ST 4 ²	1.42E+02	1.42E+02	0
ST 5 ²	1.27E+05	1.27E+05	0
ST 6	1.56E+02	1.56E+02	0
ST 7	9.64E+01	9.64E+01	0
ST 8	9.41E+01	9.41E+01	0
ST 9	3.40E+02	3.40E+02	<<1 ³
ST 14	3.84E+03	3.84E+03	0
ET 1 ²	2.26E+02	2.26E+02	0
ET 2	3.12E+02	3.36E+02	8
ET 3	1.13E+02	1.37E+02	21
NRCDA (643-7E) ²	8.00E+05	8.00E+05	0
NRCDA (643-26E)	4.18E+05	4.18E+05	0
CIG 1	9.42E+03	9.42E+03	0

¹ Slit Trench unit typically consists of five individual trenches.

² Closed Disposal Units.

³ Inventory received in FY2018 was very low compared to prior disposals in the Disposal Unit.

Table 3-2. Limiting Sum of Fractions for ELLWF Disposal Units (FY2018).

Disposal Unit	Sum of Fractions	Pathway: Time Interval (yrs)	Dose Impact (mrem) (based on most limiting pathway)	Performance Objective (mrem/yr) ³
LAWV	0.13	β - γ ²	0.52	4
ILV	0.09	β - γ : 200-1100	0.36	4
ST 1 ¹	0.85	β - γ : 12-100	3.40	4
ST 2 ¹	0.87	β - γ : 12-100	3.48	4
ST 3 ¹	0.89	β - γ : 12-100	3.56	4
ST 4 ¹	0.99	β - γ : 12-100	3.96	4
ST 5 ¹	0.99	β - γ : 12-100	3.96	4
ST 6	0.82	β - γ : 12-100	3.28	4
ST 7	0.56	β - γ : 12-100	2.24	4
ST 8	0.89	β - γ : 0-12	3.56	4
ST 9	0.84	β - γ : 100-1130	3.36	4
ST 14	0.49	β - γ : 12-100	1.96	4
ET 1 ¹	0.87	β - γ : 12-100	3.48	4
ET 2	0.66	β - γ : 12-100	2.64	4
ET 3	0.38	β - γ : 12-100	1.52	4
CIG 1	0.44	β - γ : 125-1125	1.76	4
NRCDA (643-7E) ¹	0.03	β - γ ²	0.12	4
NRCDA (643-26E)	0.03	β - γ ²	0.12	4

¹ Closed disposal units.² There are no time intervals for the NRCDA's and the LAWV β - γ pathway.³ Most limiting pathway for all units (varies by time) is groundwater protection β - γ (MCL is 4 mrem/yr).

Table 3-3. FY2018 Status of ELLWF Disposal Unit Capacity.

Disposal Unit	Disposed Volume, end of FY2017 (m ³)	Disposed during FY2018 (m ³)	Disposed Volume, end of FY2018 (m ³)	Estimated Capacity (m ³)	Percent Filled FY2017	Percent Filled FY2018
LAWV	9,492	100	9,592	30,600	31	31
ILV	2,454	21	2,475	4,284	57	58
ST 1	14,264	0	14,264	14,264	100	100
ST 2	15,560	0	15,560	15,560	100	100
ST 3	16,953	0	16,953	16,953	100	100
ST 4	19,193	0	19,193	19,193	100	100
ST 5	28,125	0	28,125	28,125	100	100
ST 6	20,848	0	20,848	23,000	91	91
ST 7	10,555	0	10,555	15,900	66	66
ST 8	15,461	0	15,461	16,275	95	95
ST 9	18,088	761	18,849	21,000	86	90
ST 14	12,381	1,232	13,613	19,500	63	70
ET 1	35,660	0	35,660	35,660 ¹	100	100
ET 2	27,171	265	27,436	35,500	77	77
ET 3	13,842	3,500	17,342	27,000	51	64
NRCDA (643-7E)	701	0	701	701	100	100
NRCDA (643-26E)	791	0	791	6,000	13	13
CIG 1	1,834	0	1,834	6,500	28	28

¹ Revised Estimated Disposal Capacity based on new projections in the field.

4.0 Monitoring

4.1 Performance Monitoring

The E-Area Performance Monitoring Program ensures that the monitoring results from the vadose zone, sump water, soil cover, stormwater runoff covers, and vaults are evaluated and that they meet the ELLWF performance objectives. The monitoring program is implemented in accordance with DOE Manual 435.1-1 (DOE 1999a) 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 4-1. The PA Monitoring Plan, last revised in 2012 (Millings 2012) is expected to undergo revision in FY2019, to incorporate ET 3 and new information obtained during recent field characterization (Kubilius and Joyce 2018).

Vadose Zone Monitoring

Groundwater in the vadose zone beneath the ELLWF facility undergoes semiannual performance monitoring to verify that tritium concentrations are not high enough to cause saturated zone groundwater to exceed the tritium MCL outside the facility. Measured vadose zone tritium concentrations are compared to administrative limits, which were established in the ELLWF Monitoring Plan (Millings 2012) and 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 MCL.

The vadose zone monitoring program employs a series of about 300 active lysimeters, which are grouped into 99 lysimeter clusters. In 90 of the clusters, one 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 action-level lysimeters are compared to the administrative limits.

Nine lysimeter clusters do not have an action-level 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 ET 1 (VL-23), two at ET 2 (ET2-VL-4, ET2-VL-8), one at ST 1 (VL-3A), two at ST 2 (ST2-VL-1, ST2-VL-6), one at ST 3 (ST3-VL-7) and one at ST 8 (ST8-VL-3). These nine clusters are still sampled, and the results are reviewed for notable changes.

In FY2018, samples were collected at 86 of the 90 AL lysimeters. The other four lysimeters were dry for both fall and spring sampling periods. Analytical results in FY2018 were below administrative limits at 77 of the 86 of the sampled action-level lysimeters. Table 4-2 provides a summary of FY2018 tritium data. Tritium concentrations in nine action-level lysimeters exceeded administrative limits: two at ET 1, two at ET 2, one at ST 1, and one each at ST 4, ST 7, ST8, and ST 14 (locations shown in Figure 4-1). Another ET 1 action-level lysimeter, at VL-22, had exceeded administrative limits in FY2016, but was dry during FY2017 and FY2018, and could not be sampled.

An analytical result that is greater than the administrative limit does not indicate that groundwater concentrations will exceed the Environmental Protection Agency (EPA) 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 a number of the deepest lysimeters (closest to the aquifer) before there would be a risk of exceeding drinking water standards. The E-Area Monitoring Program provides opportunities for investigation of performance trends well before groundwater radionuclide concentrations would be expected to approach regulatory limits.

All action-level lysimeters which exceeded their administrative limits in FY2018 or earlier are discussed individually below.

Engineering Trench 1. Two of the 14 AL lysimeters sampled in FY2018 exceeded the administrative limit of 101 pCi/mL: those in clusters VL-6-South Center (VL-6-SC) and VL-15. In addition, the AL lysimeter at VL-22 was dry in FY2018, but its most recent sample exceeded the administrative limit.

VL-6-SC. The AL lysimeter first exceeded the tritium administrative limit in FY2014, with a result of 502 pCi/mL, representing a sudden increase from 58 pCi/mL obtained in the previous sampling event. Since 2014, concentrations have been slowly decreasing, reaching 317 pCi/mL in spring 2018. However, concentrations in the shallow lysimeter at VL-6-SC has been on the rise since 2015, so a tritium increase in the near future at the AL lysimeter would not be unexpected.

VL-15. The AL lysimeter had its first exceedance in FY2012, with its concentration jumping suddenly from 40 to 158 pCi/mL. It has exceeded the administrative limit in every sampling since then. The tritium

concentration rose to a maximum of 1163 pCi/mL in November 2015, and it seems to be on a slow decline since then, with a concentration of 856 pCi/mL in spring 2018. Tritium concentrations in the shallower lysimeters are elevated, but declining.

VL-22. The AL lysimeter has been dry during FY2018; it was last successfully sampled in spring 2016. At that time, its tritium concentration was 289 pCi/mL, representing an increase from 246 pCi/mL a year earlier. Shallow lysimeters at VL-22 are elevated, but on a decreasing trend.

Engineering Trench 2. Two of the 14 AL lysimeters sampled in FY2018 exceeded the administrative limit of 101 pCi/mL: those in clusters ET2-VL-5 and ET2-VL-15.

ET2-VL-5. The AL lysimeter first exceeded the tritium administrative limit in spring 2017, with a result of 178 pCi/mL, representing a sharp increase from the previous sampling event. It jumped again in fall 2017, and experienced a further increase in spring 2018, with a concentration of 2822 pCi/mL, the highest level of any AL lysimeter at ELLWF to date. The shallow lysimeter in this cluster reached a maximum in autumn 2016, and it has been declining since. Therefore, a decrease in tritium level at the AL lysimeter sometime in the near future would not be surprising.

ET2-VL-15. This AL lysimeter has been on a somewhat gradual increase since 2015, and it exceeded the administrative limit for the first time in spring 2018, with a result of 189 pCi/mL. Concentrations in shallow lysimeters in this cluster are elevated, but have been declining since 2016. Therefore, a decrease in tritium level at the AL lysimeter sometime in the near future would not be surprising.

Slit Trench 1. In FY2018, one of the 8 AL lysimeters, VL-26-West, exceeded the administrative limit of 61 pCi/mL. Additionally, a second lysimeter, AT-6, exceeded in FY2017, but did not in FY2018.

VL-26-West. This AL lysimeter was the first at ELLWF to exceed its administrative limit. Its concentration has been rising gradually since it was installed in 2003. The first exceedance was in spring 2008 with a result of 67 pCi/L, and it has been rising steadily since. Its highest concentration was in fall 2017, with 515 pCi/mL. The spring 2018 result was 499 pCi/mL. The lysimeter above the AL lysimeter is also elevated, but tritium concentrations there have been declining since 2013, so a decrease in tritium level at the AL lysimeter sometime in the near future would not be surprising.

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. Tritium concentrations in the three subsequent sample events have been lower, being 59 and 56 pCi/mL in the FY2018 samples, less than the administrative limit. It is possible that there may be no further exceedances in the near future.

Other trenches. Four additional AL lysimeters, monitoring four different trenches, exceeded administrative limits in FY2018. They are discussed below.

Slit Trench 4: ST4-VL-5. One of the 2 AL lysimeters in Slit Trench 4, ST4-VL-5, exceeded its administrative limit (61 pCi/mL) in FY2018. 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. During the last 2 or 3 years, concentration appears to be levelling off; it was 90 pCi/mL in both FY2018 samples. Concentrations in shallow lysimeters within the cluster are elevated, but they have been declining since 2016.

Slit Trench 7: ST7-VL-2. One of the 6 AL lysimeters in Slit Trench 7, ST7-VL-2, exceeded its administrative limit (61 pCi/mL) in FY2018. This AL lysimeter slightly exceeded the administrative limits in FY2010 and FY2011, then dipped below it for several years, before exceeding again in FY2017 and FY2018. The tritium concentration in the most recent sample (fall 2017) was 426 pCi/mL. This lysimeter is on an increasing trend. Shallow lysimeters in the cluster are at area background levels. The future course of the AL lysimeter is not known.

Slit Trench 8: ST8-VL-6. One of the 5 AL lysimeters in Slit Trench 8, ST8-VL-6, slightly exceeded its administrative limit (46.9 pCi/mL) in FY2018, with a concentration of 47.0 pCi/mL. This was its first

exceedance since it was installed in fall 2016. The shallow lysimeter at this cluster is elevated and increasing, so additional exceedances may be expected here.

Slit Trench 14: ST14-VL-3. One of the 3 AL lysimeters in Slit Trench 14, ST14-VL-3, exceeded its administrative limit (64 pCi/mL) during both sample events in FY2018. Results were 110 and 93 pCi/mL. This lysimeter was installed in 2016, and it has been sampled four times. It exceeded the limit in the three most recent sampling events. The lysimeter above the AL lysimeter is showing background concentrations of tritium; therefore, the future course of the AL lysimeter is not known.

Trench Cover Monitoring

Inspections of the soil cover over filled sections of operating STs are conducted on a quarterly basis per procedure SW15.6-INP-SWF-03 (SWM 2018a). 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 2018a). Four inspections were conducted in FY2018. In each inspection, no major issues were found with the cover, but minor repairs were made.

Inspections of the Slit Trench storm water runoff covers are performed quarterly (SWM 2018a). 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 FY2018 inspections determined 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.

Vault Concrete Monitoring

Inspection of the LAWV walls was last performed in December 2016 (FY2017) by procedure 724-EAV-50 (SWM 2014) which showed no significant cracking or degradation beyond what was assumed for the PA. This inspection is performed every two years.

Sump Water Monitoring

Water samples are taken from the vaults (LAWV and ILV) and engineered trench sumps. SWM monitors the vault sumps through procedure SW15.1-SOP-LLS-01 (SWM 2018b) and the ET 2 sump through procedure SW15.1-SOP-ESUMP-02 (SWM, 2017). These procedures provide instructions for sampling and pumping the vaults and ET 2 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 2018b and SWM 2017) and dispositioned accordingly. All FY2018 samples were below administrative limits.

4.2 Compliance Monitoring

SRS conducts scheduled compliance monitoring of surface water at several locations downstream of ELLWF, per DOE Order 458.1 (DOE 2011) 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 (AER), and are compared to CA predictions in the CA annual reviews (Halverson & Jannik 2018). The most recent predicted maximum dose to a member of the public, via the liquid pathway + irrigation dose at locations below ELLWF, is published in the 2017 AER (SRS 2018). This value is 0.22 mrem/yr, which is far below the DOE 458.1 dose limit of 100 mrem/yr.

Table 4-1. 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 ET 3 – 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 ≥ 1.78E+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 a 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 (SRNS, 2014a).

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).

Table 4-2 Summary FY2018 Tritium Data (pCi/mL) for Action-Level Lysimeters.

Well ID (Elevation in ft msl)	FY2018 Sampling Events		Well ID (Elevation in ft msl)	FY2018 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)	10	10	ST2-VL-4 (232)	4	3
CIG1-VL-2 (237)	4	4	ST2-VL-7 (231)	14	14
CIG1-VL-3 (233)	7	6	ST2-VL-8 (240)	3	3
CIG1-VL-4 (232)	7	7	VL-32 (231)	4	*
CIG1-VL-5 (238)	4	4	VL-33 (229)	5	5
VL-30-End (240)	4	4	VL-34 (227)	5	5
VL-31 (241)	5	4	VL-35 (227)	3	3
Engineered Trench 1 (Administrative Limit = 101.3 pCi/mL)			Slit Trench 3 (Administrative Limit = 61.2 pCi/mL)		
AT-22-East (233)	4	4	ST3-VL-4 (234)	19	17
AT-23-North (237)	2	2	ST3-VL-5 (236)	20	20
VL-6-South_Center (233)	*	317	ST3-VL-8 (238)	4	4
VL-7-SE_Corner (235.7)	9	9	ST3-VL-10 (240)	4	4
VL-8-East_Center (234.9)	53	51	ST3-VL-12 (243)	*	4
VL-10-North_Center (233)	12	13	Slit Trench 4 (Administrative Limit = 61.2 pCi/mL)		
VL-13 (237)	12	11	ST4-VL-5 (238)	90	90
VL-14 (239)	*	*	ST4-VL-8 (239)	4	3
VL-15 (235)	810	856	Slit Trench 5 (Administrative Limit = 61.2 pCi/mL)		
VL-16 (235)	6	6	ST5-VL-1 (237)	5	5
VL-17 (238)	43	49	ST5-VL-2 (252)	4	4
VL-18 (234)	6	5	ST5-VL-5 (239)	4	4
VL-18-Auger (234)	4	4	ST5-VL-6 (244)	4	3
VL-19 (238)	4	4	ST5-VL-11 (237)	3	3
VL-20 (243)	5	5	ST5-VL-12 (231)	2	2
VL-21 (239)	*	*	ST5-VL-13 (236)	3	3
VL-22 (241)	*	*	Slit Trench 6 (Administrative Limit = 61.2 pCi/mL)		
Engineered Trench 2 (Administrative Limit = 101.3 pCi/mL)			ST6-VL-1 (233)	3	2
ET2-VL-1 (242)	*	4	ST6-VL-2 (241)	4	4
ET2-VL-2 (242)	*	6	ST6-VL-3 (235)	2	*
ET2-VL-3 (245)	*	*	Slit Trench 7 (Administrative Limit = 61.2 pCi/mL)		
ET2-VL-5 (247)	806	2822	ST7-VL-1 (233.5)	2	2
ET2-VL-6 (244)	12	10	ST7-VL-2 (231.7)	426	*
ET2-VL-7 (245)	7	18	ST7-VL-3 (232)	3	3
ET2-VL-9 (242)	2	2	ST7-VL-4 (232)	4	3
ET2-VL-10 (242)	1	1	ST7-VL-5 (229)	2	2
ET2-VL-11 (246)	1	4	ST7-VL-6 (229)	2	2
ET2-VL-12 (240)	2	2	Slit Trench 8 (Administrative Limit = 46.9 pCi/mL)		
ET2-VL-14 (240)	9	7	ST8-VL-1 (235.5)	4	3
ET2-VL-15 (247)	96	189	ST8-VL-2 (227)	3	3
ET2-VL-16 (242)	2	2	ST8-VL-4 (230)	3	2
ET2-VL-18 (242)	5	6	ST8-VL-5 (229)	2	2
ET2-VL-19 (248)	*	7	ST8-VL-6 (238)	29	47
Engineered Trench 3 (Administrative Limit = 43.7 pCi/mL)			Slit Trench 9 (Administrative Limit = 46.9 pCi/mL)		
ET3-VL-1 (221)	2	2	ST9-VL-1 (239)	3	2
ET3-VL-2 (226)	1	1	ST9-VL-2 (229)	2	*
Slit Trench 1 (Administrative Limit = 61.2 pCi/mL)			ST9-VL-3 (240)	3	3
AT-5 (226)	40	*	Slit Trench 14 (Administrative Limit = 63.8 pCi/mL)		
AT-6 (227)	59	56	ST14-VL-1 (240)	5	4
AT-8 (232)	4	3	ST14-VL-2 (239)	5	5
ST1-VL-1 (245)	4	3	ST14-VL-3 (237)	110	93
VL-2 (225)	8	7			
VL-25-West (246)	3	3			
VL-26-West (245)	515	499			
VL-27-West (245)	6	6			

+ All data in pCi/mL

* Yielded no sample

Pink shading = Exceeds Administrative Limit

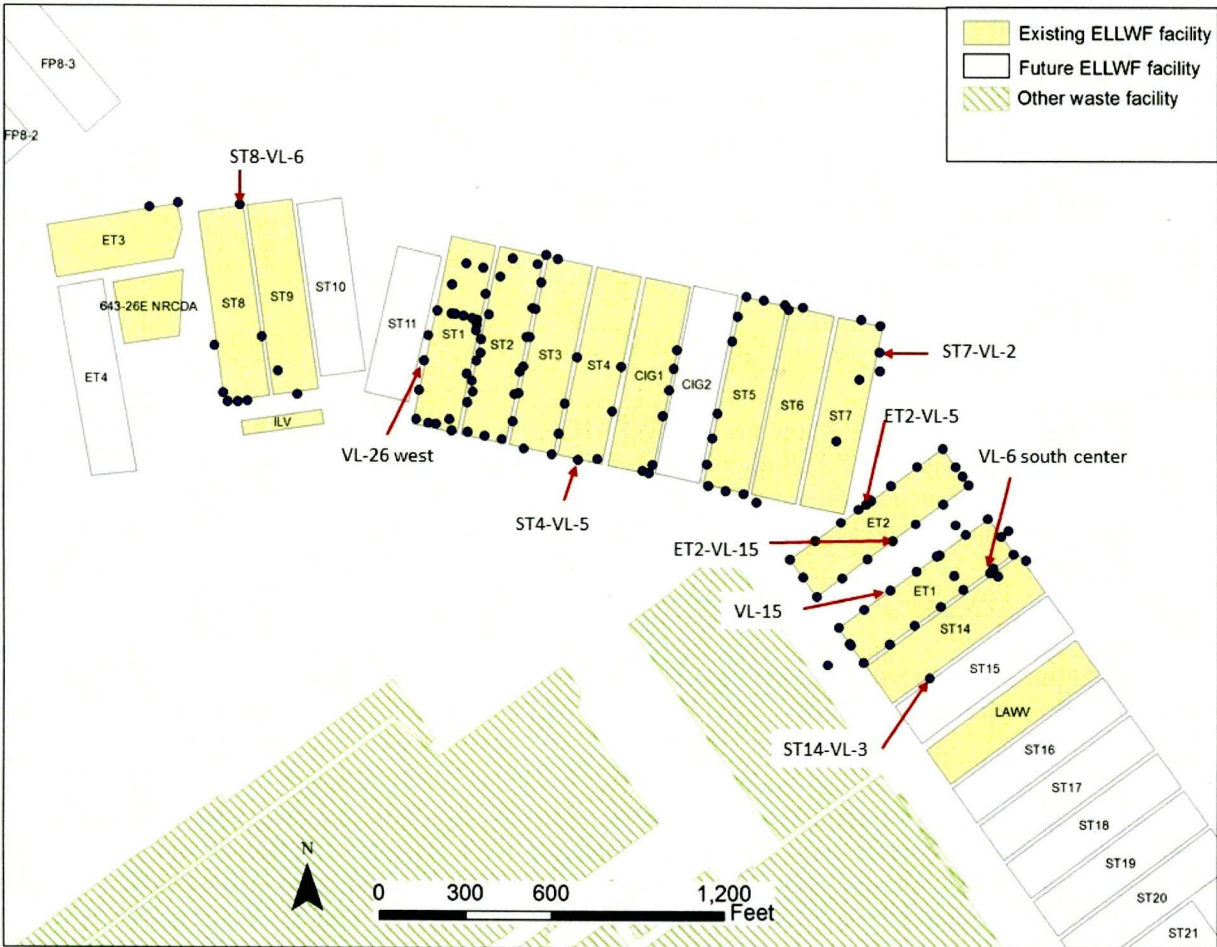


Figure 4-1. Layout Showing Disposal Units, Current Action-Level Lysimeters, Locations of Administrative Limit Exceedances, and Stormwater Runoff Covers.

5.0 Research and Development

In FY2018, the SRNL Environmental Restoration Technology Section produced 10 technical reports, 10 technical memoranda, 11 Software Quality Assurance Plans (SQAPs), and other documentation supporting ELLWF annual PA maintenance, SWM Operations & Engineering, PA Test & Research, and PA Revision Development. The following is a summary of this work.

Annual PA-CA Maintenance

1. FY2017 E-Area LLWF PA Annual Review

The FY2017 PA Annual Review for the ELLWF (Hang et al 2018) affirms that the disposal facility continued to operate within the bounds of the current PA baseline and satisfied all the requirements, conditions, and limitations identified in the DAS. The number of proposed changes to data, models, and operational plans that are used as input to the E-Area PA suggest the need for a new PA revision.

2. Annual PORFLOW and GoldSim Software Procurement Actions

The two primary calculational software packages for PA work are PORFLOW[®] and GoldSim[®]. Annual renewals were completed for both.

PORFLOW[®]. One of the historical limitations of SRNL's PORFLOW licensing was the restriction on the number of active licenses or open "seats" available to modelers at any one time which hampered work progress. Following discussions with the vendor, a change to an unlimited site license was granted which greatly improves modeler productivity. To facilitate PORFLOW simulations that involve saving very large amounts of HISTory data (100s of MB), SRNL worked with the vendor to reduce storage and speed-up I/O, resulting in a new version of the code (6.42.9).

GoldSim[®]. SRNL reassessed the number of GoldSim licenses that are needed for supporting PA work and reduced the number of licenses purchased in the 2018 annual subscription renewal.

SW Operations & Engineering Support

3. PA Requirements for Sealing up LAWV Openings – Guidance to SWM

SWM began investigating closure options/requirements for closure of disposal cells in the LAW Vault that have been filled to capacity with solid low-level waste (LLW) in B-25 boxes. SWM Engineering requested guidance on PA requirements for sealing up LAW Vault openings of individual disposal cells. SRNL reviewed 1994 vault construction design documentation, conducted a phone interview with a retired SRNL subject matter expert, and reviewed notes from a 2017 meeting among SRNL, SWM and Design Engineering to update historical guidance to current engineering specifications. This information was communicated to SWM Engineering in an email (Butcher, 2017).

PA Test & Research

4. SRNL Bamboo Plot Field Evaluation

The use of an invasive species such as *Phyllostachys*-species Bamboo for long-term planting over closed radioactive waste disposal sites has been studied extensively on the Savannah River Site. Based on this and previous assessments of the performance of the SRNL's bamboo test plots over 26 years, and conservative projections of long term (1000-year) performance, bamboo is considered a viable final vegetative cover over SRS closure caps. Recommendations are provided on timing and rate of pine tree encroachment/succession into an SRS Bamboo cover stand and other pertinent considerations over the post closure period for use in estimating infiltration in performance assessment models. (Skibo 2018)

5. Infiltration Rate Estimates through Bahiagrass & Bamboo Vegetative Cover

This memorandum addresses the effects of vegetative cover type (bamboo versus bahia grass) and the timing of pine tree intrusion on intact infiltration rates for the proposed ELLWF closure cap system. It builds upon earlier reports whose purpose is to lay the foundation for the infiltration data package that will be assembled during the next revision of the ELLWF PA. (Dyer 2018a)

6. B-25 Box and SeaLand Container Corrosion Coupon Field Resistivity Measurements

SRNL E-Area LLWF B-25 Box Corrosion Coupon Test Site was established in 2005 to evaluate the corrosion of LLW metal containers. Buried coupons included both painted and unpainted material cut from a B-25 box, a SeaLand container, and SeaLand container reinforcing steel. Solid copper wires were attached to a subset of the buried coupons for electrical resistance measurement above ground as a means to monitor in-situ coupon corrosion over time with increasing resistance readings. The objective of this long-term field experiment was to determine the optimum time to conduct buried-waste stabilization measures (ex. dynamic compaction) prior to installing the final closure cap over the site. Resistance measurements were obtained in March 2017 for buried corrosion coupons at the E-Area Corrosion Monitoring Test Site. The latest resistance measurements are similar to previous readings and do not indicate significant corrosion. This memorandum documents the periodic evaluation of the E-Area Corrosion Monitoring Test Site and presents the resistance measurements obtained from corrosion coupons for the previous twelve years. (Dixon 2018a)

7. B-25 Box and SeaLand Corrosion Coupon Laboratory Testing

Corrosion coupons were recovered from the E-Area B-25 Box Corrosion Coupon Test Site. Recovered coupons included both painted and unpainted material cut from a B-25 box, a SeaLand container, and SeaLand container reinforcing steel. The coupons were evaluated following 12 years of exposure to natural subsurface conditions at SRS. Painted coupons of each material type remained intact and showed general corrosion and pitting at calculated average corrosion rates based on total coupon mass loss ranging from 0.14 to 0.42 mils per year (mpy) with a mean of 0.33 mpy. Conversely, unpainted coupons of all material types experienced more substantial corrosion as evidenced by mass loss and physical deformation. Calculated average corrosion rates based on total coupon mass loss for unpainted coupons of all material types ranged from 0.78 to 1.17 mpy with a mean of 1.04 mpy. The corrosion rates calculated in this analysis support earlier conclusions that the corrosion rate of carbon steel containers will not exceed 2 mpy for the majority of the 100-year period following burial. As expected, insufficient time has elapsed since corrosion coupons were buried to ascertain long term corrosion rates for painted steel containers. This determination cannot be made until painted surfaces become sufficiently delaminated. Additional coupon recovery and evaluation on the pre-established schedule is therefore essential to obtaining long term corrosion rates and reaching conclusions about the timing and effectiveness of future waste stabilization measures. (Dixon 2018b)

8. SRNL Radionuclide Field Lysimeter Experiment Data Report

The SRNL Radiological Field Lysimeter Experiment (RadFLE_x) is a one-of-a-kind test bed facility designed to study radionuclide geochemical processes in the SRS vadose zone at a larger spatial scale (grams to tens of kilograms of sediment) and temporal scale (months to decade) than is readily afforded through laboratory studies. RadFLE_x is a decade-long project that was initiated in 2012 and is funded by six different sources. The objective of this status report is to: 1) report findings to date that have an impact on SRS PA calculations, and 2) provide performance metrics of the RadFLE_x program. The PA results are focused on measurements of transport parameters, such as distribution coefficients (K_d values), solubility, and unsaturated flow values for key PA radionuclides including Np, Pu, Cs, Co and Tc. Because this is an interim report, new information from subsequent research may influence our interpretation of current results. (Kaplan et al 2018)

All this work did not generate significant concern with our current PA baseline, with the exception of the change in GW flow directions observed in the 2018 GSA flow model update from that predicted in the 2008 E-Area PA. This new information is being evaluated in a UDQE investigation (see Section 6.0). All other changes as a result of this work will be addressed in the ongoing PA revision effort.

PA Revision Development

9. Infiltration

Conceptual Model. A conceptual modeling framework based on the proposed ELLWF closure cap design is presented for conducting Hydrologic Evaluation of Landfill Performance (HELP) model simulations of intact and subsided cap infiltration scenarios for the next E-Area PA. Four infiltration scenarios representing the proposed E-Area closure cap design comprise ten intact infiltration model cases spanning 2% to 4% slope and 150-foot to 600-foot slope length. If necessary for computational efficiency, the number of intact infiltration model cases can be reduced to a few. The F-Area Tank Farm closure cap infiltration model is based on a single upper bounding case of 2% slope and 585-foot slope length, which can also serve as a bounding case for the proposed ELLWF closure cap. (Dyer 2017a)

Water Mass Balance. In preparation for the next revision of the ELLWF PA, a mass balance model was developed in Microsoft Excel to confirm correct implementation of intact- and subsided-area infiltration profiles for the proposed closure cap in the PORFLOW vadose-zone model. The infiltration profiles are based on the results of HELP model simulations for both intact and subsided cases. (Dyer 2017b)

Probabilistic Subsidence Model. A probabilistic model employing a Monte Carlo sampling technique was developed in Python to generate statistical distributions of the upslope-intact-area to subsided-area ratio ($Area_{U_{Ai}}/Area_{S_{Ai}}$) for closure cap subsidence scenarios that differ in assumed percent subsidence and the total number of intact plus subsided compartments. The plan is to use this model as a component in the probabilistic system model for the E-Area PA, contributing uncertainty in infiltration estimates. (Dyer & Flach 2017)

Infiltration Uncertainty. This memorandum builds upon earlier reports whose purpose is to lay the foundation for the infiltration data package that will be assembled during the next revision of the ELLWF PA. To facilitate uncertainty analysis during the next revision of the E-Area PA, a method has been developed to generate uncertainty distributions for intact- and subsided-area infiltration rates for the GoldSim probabilistic system model. The method combines sensitivity analysis of cover system infiltration rate using the HELP model with nonlinear regression of the resulting infiltration rate versus time profiles to obtain a bounding set of log-logistic growth curves for pessimistic, best estimate, and optimistic cases.

The scenarios and infiltration rates in this technical memo are intended to illustrate the proposed method for managing uncertainty in infiltration rates in the E-Area PA system model. (Dyer 2018b)

E-Area Infiltration Estimates. To support future UDQEs, SAs and PAs for ELLWF, the HELP model and a newly developed, Python-based, probabilistic model employing a Monte Carlo sampling technique were used together to generate infiltration degradation curves for a 10,000-year simulation period for both intact and low-percent-subsidence closure-cap scenarios. The infiltration data will be used in PORFLOW transport model simulations of the ELLWF trench units. (Dyer & Flach 2018)

10. Atmospheric Pathway

Air & Radon Screening. For the air pathway, a revised screening methodology was developed based on refinement of previous E-Area PA screening approaches (Dyer 2017c). The revised methodology has three sequential screening steps for each radioisotope: (1) volatility test using the Periodic Table of the Elements, (2) stability test based on half-life, and (3) stability test based on volatility as measured by the Henry's Law constant for the assumed dominant gaseous species or vapor pressure in the case of tritiated water. Of the 1252 radioisotopes listed in the International Commission on Radiological Protection Publication 107, only the 10 that satisfied all three steps of the revised screening methodology will be included in the Atmospheric Release Model. They are: Ar-37, Ar-39, Ar-42, C-14, H-3, Hg-194, Hg-203, Kr-81, Kr-85, and Xe-127.

For the radon pathway, a revised screening methodology was developed that also has three sequential steps: (1) identify all decay chains that terminate at Rn-222, (2) screen out parents that decay through U-238 because of its 4.5-billion-year primordial half-life, and (3) eliminate remaining parents whose half-life is shorter than one day. Of the 86 possible decay chains leading to Rn-222, six decay chains consist of 15 unique radioisotopes that will be incorporated into the Atmospheric Release Model. The 15 radioisotopes are: U-238, Th-234, Pa-234m, Pu-238, U-234, Th-230, Ra-226, Cf-246, Cm-242, Am-242m, Am-242, Np-238, Np-234, Pa-230, and Rn-222. (Dyer 2017c)

Atmospheric Release Model Improvements. The 2011 Atmospheric Release Model which calculates the air pathways limits for E-Area LLWF was updated using a revised modeling timeline and approved radionuclide data, material property values, and dose-release factors. This release model utilizes GoldSim® Monte Carlo simulation software to evaluate the flux of gaseous radionuclides as they volatilize from E-Area disposal facility waste zones, diffuse into the air-filled soil pores surrounding the waste, and emanate at the land surface. In the process of performing the updates, a number of other improvements were made to the model. The updates and modifications are addressed in this report. (Wohlwend 2017)

11. Aquifer Model

Aquifer Grid Resolution. This memorandum provides technical justification for recommended horizontal and vertical grid resolution for aquifer transport, in preparation for the next E-Area PA revision. (Flach, 2018a)

Plume Interaction. In the 2008 E-Area PA, each final disposal limit was constructed as the product of a preliminary disposal limit and a plume interaction factor. The mathematical development in this report demonstrates that performance objectives are generally expected to be satisfied with high confidence under practical PA scenarios using this method. However, radionuclides that experience significant decay between a disposal unit and the 100-meter boundary, such as H-3 and Sr-90, can challenge performance objectives, depending on the disposed-of waste composition, facility geometry, and the significance of the plume interaction factor. Pros and cons of analyzing single disposal units or multiple disposal units as a group in the preliminary disposal limits analysis are also identified. (Flach 2018b)

Groundwater Calibration Targets. The work described in this report is part of an effort to update the GSA regional groundwater (GW) flow calibration targets to incorporate additional well data, emphasizing Z-Area, and consideration of Mixed Waste Management Facility (MWMF) GW plume monitoring data. This work utilizes a modified version of the Excel-based Well Hydrograph Analysis Tool to evaluate the water level measurements obtained from the Environmental Restoration Data Management System database. (Wohlwend 2018)

12. Sensitivity & Uncertainty

PA Error Analysis. This technical memorandum 1) reviews how mean squared error between a model prediction and reality can be separated into systemic bias / epistemic uncertainty and stochastic uncertainty / aleatory uncertainty components, 2) reviews how stochastic uncertainty can be approximately decomposed into contributions from each input parameter, 3) defines two sensitivity analysis concepts, 4) distinguishes between error analysis and stochastic uncertainty analysis, and 5) discusses efficient use of resources based on sensitivity analysis. (Flach & Wohlwend 2017)

GoldSim Aquifer Model Calibration. The E-Area LLWF Probabilistic Aquifer Model uses GoldSim® Monte Carlo simulation software to evaluate transport of a tracer species as it travels from the water table below the disposal unit footprint, through the aquifer, to the Point of Assessment at the 100-meter boundary. This report documents development and calibration of this model as well as implementation of plume interaction. The Probabilistic Aquifer Model is a key component of the effort to include uncertainty quantification and sensitivity analysis in the next revision of the E-Area PA. The Aquifer Model and associated optimized geometric parameters will be implemented in the future GoldSim® system model that will simulate subsurface flow and radionuclide transport from the ground surface to the 100-meter POA. (Wohlwend & Flach 2018)

13. Update to Geochemical Database

A new version of the Geochemical database, v3.1, was produced implementing previous decisions on use of equilibrium versus transient Kd values and precision of Kd values. (Butcher 2018)

14. Software QA Updates

SQAP's were prepared for the programs listed below following guidelines and minimum content requirements specified in the SRS *IQ Quality Assurance (QA) Manual*, Procedure (QAP) 20-1, "Software Quality Assurance".

Mesh2d SQAP Rev1. Mesh2d is a Fortran90 program originally designed to generate two-dimensional structured grids of the form $[x(i), y(i, j)]$ where $[x, y]$ are grid coordinates identified by indices (i, j) . x -coordinates depending only on index i implies strictly vertical x -grid lines, whereas the y -grid lines can undulate. Mesh2d also assigns an integer material type to each grid cell, $mtyp(i, j)$, in a user-specified manner. Both the SQAP (Hang 2017a) and user's manual (Flach 2017) were updated.

AvgVal SQAP. *AvgVal* is a Fortran 90 program designed to find the average value of a piecewise linear function over an interval to support PA and SA related work. (Hang 2017b)

PlotConc SQAP. *PlotConc* is a Fortran 90 program which extracts concentrations from a 2D transport PORFLOW archive file and creates a Tecplot data file to support PA and SA related work. (Hang 2017c)

PlotConc3d SQAP. *PlotConc3d* is a Fortran 90 program designed to extract concentrations from a 3D structured grid transport simulation, PORFLOW archive file and create a Tecplot data file to support PA and SA related work. (Hang 2017d)

PlotConc3dU SQAP. *PlotConc3dU* is a Fortran 90 program designed to extract concentrations from a 3D unstructured grid, transport simulation, PORFLOW archive file and create a Tecplot data file to support PA and SA related work. (Hang 2017e)

PlotFlow2d SQAP. *PlotFlow2d* is a Fortran 90 program designed to extract information from a 2D structured grid, flow simulation PORFLOW archive file, and create a Tecplot data file to support PA and SA related work. (Hang 2017f)

PlotFlux SQAP. *PlotFlux* is a Fortran 90 program designed to extract information from a PORFLOW flux file and create PORFLOW and Tecplot data files to support PA and SA related work. (Hang 2018a)

PlotHist SQAP. *PlotHist* is a Fortran 90 program designed to extract information from a PORFLOW history file and create a Tecplot data file to support PA and SA related work. (Hang 2018b)

PlotStat SQAP. *PlotStat* is a Fortran 90 program designed to extract information from a PORFLOW statistics file and create a Tecplot data file to support PA and SA related work. (Hang 2018c)

MakeWhole SQAP. *MakeWhole* is a Fortran 90 program designed to insert "Include" file contents into the main data file to support PA and SA related work. (Hang 2018d)

PORFLOW 6.42.9 Testing Report. This report is a continuation of the series of PORFLOW QA documents testing and validating previous versions of PORFLOW. In this report we have updated the test cases where necessary to account for new features in PORFLOW 6.42.9 and to ensure those features perform as described in the documentation. (Whiteside 2018)

6.0 Potential Future Work

Presented in this section are anticipated PA maintenance, monitoring and operations support, PA revision planning tasks, and supporting R&D activities that are planned to be started or completed in FY2019. This anticipated future work is subject to available funding and resources.

One UDQE investigation is anticipated to be completed and approved in FY2019:

- GW flow directions in the lower portion of the ELLWF notably changed in the 2018 GSA flow model from that predicted in the 2008 E-Area PA. Updated flow directions in the model produce a higher degree of plume overlap for the East Slit Trench Group, Engineered Trenches 1 and 2, and the LAWV. A UDQE was initiated in FY2018 using the latest models and data to assess unquantified conservatism in disposal unit inventory limits by accounting for plume interaction based on estimated radionuclide closure inventories (source term) and a predetermined sequencing of trench operations (timing) to determine if current limits are protective of DOE Order 435.1 performance objectives.

The following is a list of PA Maintenance and Monitoring Activities anticipated to be performed in FY2019 subject to available funding and resources:

- Conduct FY2018 E-Area LLWF PA Annual Review and monitoring evaluation (this report).

- Conduct sampling and analysis of Vadose Zone lysimeters and update the EVZMS database.
- Prepare report on results of depth-discrete GW sampling within E-Area to assess the possibility of distinguishing contaminant migration from the ELLWF from the upgradient MWMF.
- Consider installing saturated-zone groundwater performance monitoring wells in proximal locations downgradient of ELLWF
- Update the E-Area PA Monitoring Plan to incorporate changes in the monitoring system and any proposed new aspects.

The E-Area PA revision has been authorized for a FY2019 start. The following is a list of key PA Revision tasks scheduled for FY2019 subject to available funding and resources:

- Layout PA program and execution strategy. Procure subcontract support for selected subject matter experts.
- Finalize and document new SRNL Dose Toolkit for calculating limits and doses.
- Reassess approach to handling GW plume interaction among disposal units in setting disposal limits.
- Complete development and document a radionuclide screening application. Perform and document the radionuclide screening to refine the list of radionuclides needed for detailed PA calculations.
- Finalize the automated GW calculation scheme to reduce the potential for errors and improve efficiency in future SAs and the next PA. Document work flow as a roadmap for all modelers and analysts to ensure consistency in approach (i.e., written protocols, commands used in scripts, separate notes, etc.).
- Test and validate that the new closure cap design results in acceptable performance for disposal units within the current 100-acre site. Expand new closure cap design to Plot 8 in the second 100-acres.
- Finalize infiltration estimates for trenches, vaults and pads. Prepare revision to infiltration parameters data package report.
- Finalize PA model timelines considering timing of facility events (e.g., facility closure) and implementation of the DOE Order performance period to ensure consistency in analysis across all disposal units and exposure pathways in the next PA.
- Setup, test and document final Slit and Engineered Trench PORFLOW model(s). Establish models and methods for handling special waste forms in trenches.
- Setup, test and document hybrid CIG-Slit Trench PORFLOW model.
- Setup, test and document LAWV PORFLOW model.
- Setup, test and document ILV PORFLOW model.
- Setup, test and document a NRCDA PORFLOW model. Start the PA GW analysis for the 643-7E (closed) and 643-26E (operating) NRCDA's.
- Prepare and document first-pass high-level summary of safety functions and uncertainty quantification and sensitivity analysis (UQ-SA) parameters
- Develop and calibrate VZ GoldSim Trench and NRCDA models for use in UQ-SA calculations.
- Calibrate the GoldSim aquifer model to new PORFLOW tracer results.
- Create a working system model for performing sensitivity & uncertainty analyses.

- Update the Material Properties Data Package report and develop a new Material Properties Database. Update and maintain the Radionuclide and Geochemical Databases on the SRNL PA network file server.
- Prepare and document the list of commercial software, and SRNL scripts and modeling tools for use in the PA revision.

The following is a list of supporting studies anticipated to be performed in FY2019 subject to available funding and resources:

- Conduct quarterly sampling and analysis of the SRNL RadFLEx.
- Conduct annual resistivity measurements on buried metal coupons at the B-25 Box Corrosion Coupon Study Field Site.

7.0 Recommended Changes

No facility changes are recommended as a result of this Annual Review.

8.0 PA Controls

This PA Annual Review has shown that LLW operations conducted in FY2018 were within the performance envelope analyzed in the PA/SA baseline. Operations were conducted in accordance with the requirements of the 2008 ELLWF DAS (DOE 2008a). The PA/SA controls including the UDQE/SA program and PA Maintenance Plan have been designed with an internal check and balance system to verify that the controls are adequate to ensure compliance. These built-in mechanisms have demonstrated the program's ability to identify potential problems that can then be addressed to ensure that the program remains within the PA/SA limits. The adequacy of the PA/SA controls is summarized in the following statements:

- The SA and UDQE program continues to evaluate proposed actions, changes, and new information to determine if these activities are within the boundaries analyzed in the approved PA/SA baseline. A list of all SA's and UDQE's completed since the 2008 E-Area PA Revision is included in Table A-1. There were no SA's performed in FY2018. One UDQE was approved in FY2018, SRNL-STI-2013-00393, Rev. 1, which added disposal limits for Engineered Trench 4.
- Periodic assessments of waste generators' waste certification programs are included in the scope of the SRS Independent Evaluation Board (IEB) assessments. The mission of the IEB Department includes promoting safety, continuous improvement and operational excellence by reviewing and providing oversight of company-wide programs and SRNS nuclear facilities.
- The IEB conducted three facility and five program evaluations of waste generator programs during FY2018. Common minor deficiencies included procedures/plans not current with the latest requirements/conditions in the field, package/container marking and labeling, and minor waste characterization issues. Corrective actions have been identified and are being tracked to closure through the site corrective action database.
- Receipt inspections of waste at the Solid Waste Facilities are conducted to ensure compliance with the WAC in the SRS 1S Manual (SRS-1S). This is accomplished by using the WITS database to check waste receipts to ensure that the PA and Documented Safety Analysis requirements are met. Corrective actions are established for any non-conformance identified during waste receipts to prevent recurrences.

- In accordance with DOE Order 435.1, the ELLWF is designed, operated and maintained in a manner that is protective of human health and the environment. As part of the regulatory agreement for receipt of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) LLW, DOE and EPA agreed that operational storm water runoff covers would be placed over ELLWF ST disposal units that have reached design capacity (i.e., curie and/or volume capacity limits) as an enhancement to the current protective measures and that this action would be documented in an Interim Record of Decision. The agreement increases regulatory participation in the final closure decisions for the entire ELLWF. In all other respects, the DOE continues to operate the ELLWF in accordance with DOE requirements under its Atomic Energy Act authority. Consequently, the ST disposal units have been determined to be acceptable for the receipt of CERCLA LLW (EPA, 2008). Slit Trenches 1 through 5 are closed and have operational storm water runoff covers.
- Integrated management evaluation (trending) is conducted by SWM to gauge waste certification program effectiveness and to ensure compliance with all applicable regulatory requirements. Statistical and qualitative comparative risk analysis of performance data mined from the Site Tracking, Analysis & Reporting database is conducted and the results are combined with evaluation of generator self-assessments to track functional area performance trends. Conclusions and paths forward to mitigate negative performance trends (if evident) are documented in an annual functional area performance report (Murdoch 2018). No adverse waste certification performance trends were noted for FY2018.
- Key PA and SA Inputs and Assumptions, when applicable, are protected in operational procedures and on-site drawings.
- The RWMB is reviewed annually (Crawford, 2018) and updated as needed to reflect current operations and waste management practices to ensure that performance objectives are protected (McGill 2018).
- The PA Maintenance Plan is updated as needed to confirm the adequacy of the PA and to increase confidence in results. The last update was performed in FY2016 (Butcher 2016).
- The PA Monitoring Plan has been reviewed to ensure that it was adequate for monitoring facility operations and disposal units for compliance with the performance objectives. The last update was performed in FY2012 (Millings 2012). This review indicates the need for a revised PA Monitoring Plan, which is scheduled for FY2019.
- The PA Closure Plan has been reviewed against the latest closure design, strategies, and timeline. The last update was performed in FY2009 (Phifer et al. 2009) following 2008 ELLWF PA approval. This review indicates the need for a PA Closure Plan revision. This update is planned following completion and approval of the next PA revision in FY2021 to be consistent with the new PA baseline.

9.0 Land Use

The SRS Land Use Plan (SRNS 2014b) states the following: “SRS will maintain its current physical boundary under the ownership of the federal government in perpetuity, except where lease or transfer to the private/public sector entities in accordance with applicable laws/regulations aligns with DOE objectives and enhances economic development in the surrounding region.” Land use controls and institutional controls are expected to continue in perpetuity for the ELLWF ensuring no member of the public would have unrestricted access. Nonetheless, the ELLWF PA has used the point of maximum calculated dose outside a 100-m buffer zone surrounding the disposed waste as the point of assessment consistent with the requirements of DOE 435.1. For the intruder calculations, the assumed period of active Institutional Control was limited to 100 years. No SA’s, UDQE’s or supporting studies considered alternative land use strategies in FY2018.

10.0 Status of Key Issues and Secondary Issues from LFRG Review of the 2008 PA

All key and secondary issues from the LFRG review of the 2008 PA have been resolved and are understood to be closed with final DOE-HQ approval of the FY2014 Annual Review. Three issues were closed by committing to address the issues in the next PA. A summary of the LFRG issues with the current status is provided in Table B-1.

11.0 Declaration of the Continued Adequacy of the PA and DAS

This annual review affirms that the supporting studies performed in FY2018 do not alter the conclusions of the ELLWF PA (WSRC 2008) and that there is a reasonable expectation that the ELLWF will meet the performance objectives delineated in DOE Order 435.1. New groundwater flow predictions resulted in the initiation of a UDQE (Mooneyhan 2018), and interim measures have been introduced to maintain assurance that performance objectives will continue to be met (Germain 2018). The number of proposed changes to data, models and operational plans for the ELLWF since the 2008 PA are sufficient to warrant a revision. Therefore, a revised PA is in preparation, with completion scheduled for FY2021. 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.

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Appendix A. Summary of SA, UDQE, and other Baseline Reports written since the 2008 PA

Table A-1. All SA, UDQE, and Other Baseline Reports since the 2008 PA Revision

Type	Title	Authors	Document Number	Rev	Date	Results
SA	Special Analysis: Revised Disposal Limits for the Low Activity Waste Vault	Smith, Hamm	SRNL-STI-2014-00289	0	Sep-14	The H-3 all-pathways (AP) limit was reduced by 50%. However, the H-3 AP limit is very high relative to the controlling beta-gamma (β - γ) pathway limit which is two-orders of magnitude lower. Disposal limits for all other LAWV radionuclides and dose pathways remain the same or increase.
SA	Special Analysis: Revised Groundwater Protection and All-Pathways Limits for E-Area Low-Level Waste Facility Trenches	Swingle	SRNL-STI-2012-00466	0	Aug-12	New limits were implemented for Slit Trenches 6 through 21 and ET 1 and 2 based on the different sizes, geometry and orientation of slit trench units (as assessed in the 2008 PA). Earlier interim measures imposed to ensure that operation of the trench units would not inadvertently exceed the new limits prior to their implementation were removed.
SA	Special Analysis for Slit Trench Disposal of the Reactor Process Heat Exchangers	Hamm, Collard, Aleman, Gorenssek, Butcher	SRNL-STI-2012-00321	0	Jun-12	This SA evaluated to determine if alterations were made to certain external nozzles on 19 heat exchangers to mitigate various potential leak paths, if acceptable Sum of Fractions (SOFs) could be achieved through the use of a "special" waste form with unique PA Slit Trench limits. This SA provided the technical basis for this new "special" waste form and provided the inventory PA limits for H-3 and C-14 for these 19 heat exchangers.
SA	Special Analysis Air Pathway Modeling of E-Area Low-Level Waste Facility	Hiergesell, Taylor	SRNL-STI-2011-00327	0	Aug-11	For atmospheric releases from the ELLWF, plume overlap does not cause the total dose to the Maximally Exposed Individual at the SRS boundary during Interim Closure or post-Closure periods to exceed the PA performance objective.
SA	Special Analysis for Slit Trench Disposal of the Heavy Water Components Test Reactor	Hamm, Smith	SRNL-STI-2010-00574	0	Oct-10	A special waste form model was developed for the HWCTR taking into account corrosion processes in releasing neutron activation products from the metal surfaces and the development of leaks in the vessel. Dose impacts were calculated for ten key isotopes resulting in new special waste form limits for six risk-driving radionuclides.

Type	Title	Authors	Document Number	Rev	Date	Results
SA	Special Analysis of Tritium Disposal Limits for E-Area Slit Trench 4	Collard, Hamm, Smith	SRNL-STI-2010-00263	0	May-10	The modeling conclusively demonstrated the tritium inventory from two waste packages inadvertently placed in ST 4 is well within new tritium groundwater limits established in this SA.
SA	Special Analysis Disposal of Tritium-Containing IP-2 Boxes in the E-Area Low Level Waste Facility Intermediate Level Vault	Swingle	SRNL-STI-2008-00453	0	Dec-08	This SA establishes a new waste-form-specific Air Pathway Limit for a portion of the Defense Programs' classified tritium waste. The impact of plume interaction was not significant with respect to the disposal action evaluated in this SA. The maximum dose calculated by the model developed for this analysis calculates an anticipated dose to the Maximally Exposed Individual (MEI) that is only about 2% of the DOE air pathway performance objective.
SA	Special Analysis of Operational Stormwater Runoff Covers over Slit Trenches	Collard, Hamm	SRNL-STI-2008-00397	0	Dec-08	An SA was performed which demonstrated that placement of covers over STs will slow the subsequent release and transport of radionuclides in the vadose zone in the early time periods (from time of placement until about 100 years). Release and transport of some radionuclides in the vadose zone beyond 100 years were somewhat higher than for the case without covers. The SOFs were examined for the current waste inventory in ST 1 and 2 and for estimated inventories at closure for ST3 through ST7. In all cases SOFs were less than one indicating that there should be no unacceptable impacts on operations from placing covers for the cover alternatives that were analyzed.
UDQE	Unreviewed Disposal Question Evaluation: Waste Disposal in Engineered Trenches 3 and 4.	Butcher, Hamm, Flach	SRNL-STI-2013-00393	1	Dec-17	Revision 1 of this UDQE determines that ET4 can be located in the ST13 footprint, and it can be operated to the current ST13 disposal limits. This assumes that there will be no non-crushable containers, no waste in side slopes, and no special waste forms. Additionally, a small change in ET3 dimensions, as a result of new asbuilt information, was found to be negligible, and can be ignored.

Type	Title	Authors	Document Number	Rev	Date	Results
UDQE	Unreviewed Disposal Question Evaluation: Impact of New Information since 2008 PA on Current Low-Level Solid Waste Operations	Flach, Smith, Hamm, Butcher	SRNL-STI-2013-00011	1	Sep-14	<p>Revision 1 of this UDQE addresses the following new PA items and data identified since completion of the original UDQE report in 2013:</p> <ul style="list-style-type: none"> - New Kd values for iodine, radium and uranium, - Elimination of cellulose degradation product (CDP) factors, - Updated radionuclide data, - Changes in transport behavior of mobile radionuclides, - Potential delay in interim closure beyond 2025, and, - CIG plume interaction correction. <p>Consideration of new information relative to the 2008 PA baseline generally indicates greater confidence that PA performance objectives will be met than indicated by current sum-of-fractions (SOF) metrics. For Slit Trench 9, the previous prohibition of non-crushable containers in revision 0 of this UDQE has reduced the projected final SOF for Slit Trench 9 less than the WITS Administrative Limit (i.e. 95% of SOF limit).</p> <p>With respect to future disposal unit operations in the East Slit Trench Group, consideration of new information for Slit Trench 14 reduced the current SOF for limiting All-Pathways 200-1000 year period by an order of magnitude and by one quarter for Beta-Gamma 12-100 year period pathway. On balance, updates to Kd values and dose factors and elimination of CDP factors (generally favorable) more than compensated for the detrimental impact of a more rigorous treatment of plume dispersion. These observations suggest that future operations in the East Slit Trench Group can be conducted with higher confidence using current inventory limits, and that limits could be increased, if desired, for future low-level waste disposal units.</p> <p>The same general conclusion applies to future ST's in the West Slit Trench Group based on the Impacted Final SOFs for existing ST's in that area..</p>

Type	Title	Authors	Document Number	Rev	Date	Results
UDQE	Unreviewed Disposal Question Evaluation: Waste Disposal in Engineered Trench #3	Hamm, Smith, Flach, Hiergesell, Butcher	SRNL-STI-2013-00393	0	Jul-13	This UDQE evaluated that the use of ST 12 limits as surrogates for the new ET 3 disposal unit will provide reasonable assurance that DOE 435.1 performance objectives and measures (USDOE, 1999a) will be protected. Therefore, new ET 3 inventory limits as determined by a SA were not required.
UDQE	Unreviewed Disposal Question Evaluation: Disposal of High Inventory Container in Slit Trench 8	Tempel	SRNS-RP-2013-00196	0	Jun-13	During implementation of new LLW disposal limits (SA, Swingle, 2012), one LLW container previously disposed in ST 8 now exceeded one of the 5% SOF container inventory limits based on the new reduced limits. Due to the size of the container (equivalent to six B-25's in length) and the favorable disposal location within that trench, as well as the low disposed inventory and conservative geographical distribution of that inventory within the ST 8 footprint, it was determined that there would be no adverse impact on the existing LLW PA
UDQE	Unreviewed Disposal Question Evaluation: Impact of New Information since 2008 PA on Current Low-Level Solid Waste Operations	Flach	SRNL-STI-2013-00011	0	Feb-13	The projected closure SOFs were determined to be less than the administrative limit for all active disposal units except ST 9. An administrative control was placed on ST 9 that prevents acceptance of non-crushable containers through disposal unit closure. Implementation of this administrative control reduces the projected final SOF for ST 9 to a value that is less than the Administrative Limit.
UDQE	Unreviewed Disposal Question Evaluation: Center Slit Trenches One through Five Operational Covers Reanalysis	Smith, Swingle	SRNL-STI-2011-00257	0	May-11	The accelerated placement of stormwater runoff covers for ST 1 through ST 5 produced acceptable Slit Trench performance. Additionally, covering ST 5 separately from ST 6 and 7, which will be operationally closed at a later date, does not adversely affect performance of the operationally closed trenches.
UDQE	Unreviewed Disposal Question Evaluation: Issues Associated with the Disposal of the Heavy Water Components Test Reactor	Smith, Swingle	SRNL-STI-2011-00203	0	Mar-11	This SA evaluated changes in slit trench width range and disposal time intervals. No new disposal limits were calculated as part of this UDQE and a new SA is not required.

Type	Title	Authors	Document Number	Rev	Date	Results
UDQE	Unreviewed Disposal Question Evaluation: Disposal of Tall Used Equipment Storage Boxes in Slit Trench Numbers 8, 9, and 10	Flach, Jones	SRNL-STI-2010-00799	0	Nov-10	This UDQE analyzed the maximum possible trench depth available for tall box disposals while still maintaining a 35-ft distance from the bottom of the trench to the top of the water table. The proposed disposal parameters were determined to be reasonably bounded within the existing PA modeling approach, and to not warrant additional modeling.
UDQE	Unreviewed Disposal Question Evaluation: Installation of Additional Concrete Anchors in the Floor of LAW Vault Cell 11 to Support an Extension of the Temporary Airlock Enclosure	Jones, Phifer	SRNL-TR-2010-00196	0	Aug-10	The installation of additional concrete anchors in the floor of LAW Vault Cell 11 will not adversely affect operation of LAW Vault Cell 11 and is within the current PA conceptual envelope.
UDQE	Unreviewed Disposal Question Evaluation: Transcription Error in Appendix C of the 2008 E-Area Low Level Waste Facility Performance Assessment	Swingle	SRNL-RP-2009-00273	0	Feb-09	None of the ST disposal units currently exceed their SOF limit of 1.0. Actual operation of the disposal units in the E-Area Low Level Waste Facility will continue based on inventory limits at the time of waste disposal so as to avoid exceeding PA/SA limits. Therefore, ELLWF operation is maintained within the PA.
UDQE	Unreviewed Disposal Question Evaluation: Disposal of Tall Used Equipment Storage Boxes Number 5 and Number 42 in Slit Trench Number 8	Jones, Wilhite, Butcher	SRNL-TR-2009-00236	0	Aug-09	Each of the potential differences from assumed parameters caused by the additional height of the boxes was determined to be reasonably bounded by the existing PA modeling approach. Additional modeling was determined not to be necessary.
UDQE	Unreviewed Disposal Question Evaluation: E-Area Low-Level Waste Facility Completion Project	Jordan, Flach	SRNL-TR-2009-00207	0	Jun-09	This UDQE evaluating the proposed action of opening disposal areas within the ELLWF will support a follow-on SA that will be conducted to determine final PA limits and associated key inputs and assumptions that will need to be approved before the areas can receive low-level waste for disposal. As a whole, the amount of radionuclide disposal capacity available for the plot areas is limited due to the existing upstream disposal areas.

Type	Title	Authors	Document Number	Rev	Date	Results
UDQE	Unreviewed Disposal Question Evaluation: Engineered Trench Sump Closure and Replacement	Wilhite, Butcher, Phifer, Reed	SRNL-TR-2009-00042	0	Mar-09	This UDQE considered several mitigating actions that will be taken. These mitigating actions are to crack the sump bottom so that water flow is not impeded, to control the sump backfill to ensure that emplaced waste will not settle below the trench floor, to restrict the radionuclide content of waste emplaced over the sump because the concrete sides of the sump will not be cracked, which can result in focused water flow, and, to seal the pipe connecting ET 2 with ET 1. Implementation of these mitigating actions brings the ET 1 configuration in alignment with the concept analyzed in the 2008 PA and is therefore in compliance with the DAS.
UDQE	Unreviewed Disposal Question Evaluation: Slit Trench Waste with High Inventory Limit Consumption and Mischaracterized Waste	Collard	SRNL-STI-2008-00520	0	Dec-08	Evaluation found that the new limits established in the approved storm water runoff cover SA (Collard and Hamm, 2008) reduce inventory limit consumption by these containers for specific cover placement times evaluated in the analysis. The evaluation also provided the option of reducing the allowable SOF by 5% for specific groundwater performance measures and time intervals to provide limit protection.
UDQE	Unreviewed Disposal Question Evaluation: High Curie Content Waste Container in the E-Area Low Level Waste Facility Intermediate Level Vault	Swingle	SRNL-TR-2008-00316	0	Dec-08	Review of the development of the groundwater protection limits for the 2008 E-Area PA shows that this high-SOF container in the IL Vault will not result in a "hot spot" in the groundwater alpha concentration. Therefore, this container does not compromise the assumptions made for development of the revised PA and is within compliance of the DAS.

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Appendix B. Summary of SRS Response on 2008 PA Secondary Issues

Table B-1. Summary of SRS Response on 2008 PA Secondary Issues

LFRG PA Criteria	LFRG Issue Number	Description of Secondary Issue	Status	Documentation	Closure Method
3.1.1 Facility / Site Characteristics					
3.1.1.1	7.2.2.5	Documentation of conceptual models	Complete	See LFRG issue 7.2.2.5 under Criteria 3.1.5 Conceptual Model	See 3.1.5
3.1.3 Performance Objectives / Measures					
3.1.3.1 3.1.3.3	7.2.1	Cumulative Air Pathway Doses	Complete	SA: <i>Air Pathway Modeling of E-Area Low-Level Waste Facility</i> , (Hiergesell and Taylor, 2011) July 2011	Closed per DOE approval of FY2011 Annual Review
3.1.5 Conceptual Model					
3.1.1.1 3.1.5.1 3.1.5.2 3.1.5.3	7.2.2.1	Inadequate documentation and supporting key aspects of development of 1) hydrogeological conceptual models, and 2) site conceptual models	Complete	Information provided to the Review Team during the PA review was added to Section 4.1 and App. G of the PA	Closed per DOE approval of the 2008 PA
	7.2.2.2	Alternate hydrogeological models not discussed; Discussion of field measurement data needed to justify steady state groundwater flow	Complete	Additional information provided in Sections 1.2 and 1.4 of App. G of the PA.	Closed per DOE approval of the 2008 PA
	7.2.2.3	Minimal monitoring data provided in PA to support conceptual model for vadose zone and groundwater pathway	Complete	<i>Mineralogical, Hydrogeochemical, and Environmental Isotope Data Supporting the E-Area Low-Level Waste PA</i> , (Flach et al., 2011), June 2011; Additional information provided to the Review Team during the PA review and included in App. G of the PA	Closed per DOE approval of FY2011 Annual Review
	7.2.2.4	Integrated discussion of conceptual models used for source term release needed	Complete	Information provided to the Review Team during the PA review was added to Section 4.1 of the PA	Closed per DOE approval of the 2008 PA
	7.2.2.5	Hydro-geochemical, mineralogical and environmental isotope data relevant to the conceptual model are not presented	Complete	<i>Mineralogical, Hydrogeochemical, and Environmental Isotope Data Supporting the E-Area LLW PA</i> , (Flach et al., 2011), June 2011	Closed per DOE approval of FY2011 Annual Review
3.1.6 Mathematical Models					
3.1.6.1	7.2.3.1	Need to include a discussion of HELP modeling results	Complete	<i>Data Package for HELP Models Used in the E-Area LLW Facility PA</i> , (McDowell-Boyer et al., 2011), Oct. 2010; Information provided to the Review Team during the PA review was added to the Background of the PA	Closed per DOE approval of FY2011 Annual Review
	7.2.3.2	Insufficient documentation of all components of the site model for the vadose and saturated zone (five specific items to be addressed)	Complete Pending PA Revision	Items 1, 3, 4 and 5: <i>PORFLOW Qualification for use in E-Area Low-Level Waste Facility Performance Assessment</i> , (McDowell-Boyer and Flach, 2011)*, July 2011; Item 2: Information was included in App. G of the PA Item 2: Information was included in App. G of the PA	Closed per DOE approval of FY2011 Annual Review

LFRG PA Criteria	LFRG Issue Number	Description of Secondary Issue	Status	Documentation	Closure Method
				*GSA Model Improvements will be incorporated into the next revision of the PA.	
	7.2.3.3	Discussion should expand on key hydraulic and transport properties used for the saturated aquifer system with descriptions of their basis and justification	Complete	Discussion of basis for inputs to the saturated zone model was provided in App. G of the PA; Additional details are provided in <i>PORFLOW Qualification for use in E-Area LLW Facility Performance Assessment</i> , (McDowell-Boyer and Flach, 2011); Justification is further detailed in documents referenced in the PA: <i>Hydraulic Property Data Package for the E-Area and Z-Area Vadose Zone Soils, Cementitious Materials, and Waste Zones</i> , (Phifer et al., 2006), Sept. 2006 and <i>Geochemical Data Package for PA Calculations Related to the SRS (U)</i> , (Kaplan, 2006), Feb. 2006	Closed per DOE approval of FY2011 Annual Review
	7.2.3.4	Apparent inconsistency between the average and effective porosity and key assumption needs resolution	Complete	Clarification is provided in <i>Hydraulic Property Data Package for the E-Area and Z-Area Vadose Zone Soils, Cementitious Materials, and Waste Zones</i> , WSRC-STI-2006-00198, Sept. 2006	Closed per DOE approval of the 2008 PA
	7.2.3.5	More information is needed on development and calibration of vadose zone and groundwater models (re. NRCDA model)	Complete	A description was added to Section 5.6.4.5 of the PA describing the analytical GOLDSIM application used to simulate the resulting 100-m well concentrations	Closed per DOE approval of the 2008 PA
	7.2.3.6	Documentation for GoldSim framework, the underlying models, and computational steps used should be further developed. The definition of and basis for input parameter distributions and forcing terms used in GoldSim requires more documentation.	Complete See 3.1.8	See 3.1.8 Sensitivity and Uncertainty	Closed per DOE approval of FY2014 Annual Review See 3.1.8
3.1.6.2	7.2.5	Explicit descriptions of various infiltration case results for STs are required, particularly for non-sorbing or poorly sorbing radionuclides. A detailed discussion of development of SOFs is needed.	Complete	A description of how the four base-case simulations were used and interpreted for ST and ET disposal limits was added to Sections 1.6.2, 1.6.3 and 1.6.4 of the final PA.	Closed per DOE approval of the 2008 PA
	7.2.6	Additional documentation is needed for the uncertainty in inventories of H-3, C-14, I-129 and Tc-99 and the conservatism built into the inventory data	Complete	Information provided to the Review Team during the PA review was added to the PA, App. C. Additional information is provided in <i>Methods for Estimating Inventory Uncertainty in SRS PAs</i> , (Cook et al., 2011), May 2011	Closed per DOE approval of FY2011 Annual Review
3.1.6.4	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.	Complete Pending PA Revision	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.	Closed per DOE approval of the FY2014 Annual Review.

3.1.8 Sensitivity and Uncertainty					
3.1.8.1 3.1.8.2	7.1.1	Additional S&U work required to increase confidence in the waste concentration limits and SOFs (through deterministic or probabilistic S&U 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).	Complete Pending PA Revision	<p>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.</p> <p>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. (<u>Taylor and Hiergesell, 2013</u>)</p> <p>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. (<u>Hiergesell & Taylor, 2014</u>)</p> <p>These improvements will be incorporated into the next revision of the PA.</p>	Closed per DOE approval of FY2014 Annual Review.
3.1.9 Results Integration					
3.1.9.2	7.1.2	Justification of data for non-sorbing radionuclides (specifically Tc-99)	Complete	<p>During the factual accuracy review, this item was downgraded from a key issue to a secondary issue based on <i>A Review of Technetium Kd Values for SRS Sediments</i>, (Kaplan, 2007), Dec. 2007. In addition, a field and lab study was completed that supports the non-zero Kd for Tc-99, <i>Range and Distribution of Technetium Kd Values in the SRS Subsurface Environment</i>, <u>Kaplan et al., 2008</u>, Oct. 2008. Also, the 2006 geochemical data package was updated, <i>Geochemical Data Package for PA Calculations Related to the SRS</i>, (Kaplan, 2010), March 2010.</p>	Closed per DOE approval of FY2011 Annual Review

Note: Document numbers that are underlined indicate that this document was not available at the time of LFRG review and DOE approval of the PA. All documents will be provided upon request.