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ADMINISTRATIVE DOCUMENT PROCESSING AND APPROVAL

DOCUMENT TITLE: Annual Status Report (FY 2017): Performance Assessment for the Disposal of Low-Level… East	**OWNING ORGANIZATION/FACILITY:** EP&SP/Risk & Modeling Integration
Document Number: DOE/RL-2017-57	**Revision/Change Number:** 0

DOCUMENT TYPE *(Check Applicable)* [ ] Plan [x] Report [ ] Study [ ] Description Document [ ] Other

DOCUMENT ACTION *(Check One)* [x] New [ ] Revision [ ] Cancellation

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DATE: Apr 10, 2018

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C. Title
Annual Status Report (FY 2017): Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds

D. Proposed Internet Address

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Aly, Alaa H via IDMS data file att.
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1. Title for Conference or Meeting ______
2. Group Sponsoring ______
3. Date of Conference ______
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5. Will Information be Published in Proceedings? (●) No ( ) Yes
6. Will Material be Handed Out? (●) No ( ) Yes

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APPROVED
By Mary P. Curry at 12:10 pm, Apr 10, 2018

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- <workflow name="(MPC) Normal - DOE/RL-2017-57_R0_200E_LLWBG" id="221961239">
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<task name="Manager Approval" id="41" date-due="20180410T1606" date-done="20180405T1620" performer="Alaa H Aly" performer-id="141440097" username="h9198318" disposition="Approve" authentication="true" />
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DOE/RL-2017-57
Revision 0

Annual Status Report (FY2017): Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

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DOE/RL-2017-57
Revision 0

Annual Status Report (FY2017): Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds

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Date Published
February 2018

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APPROVED
By Mary P. Curry at 12:10 pm, Apr 10, 2018

Release Approval   Date

Printed in the United States of America

Executive Summary

This annual review provides the projected dose estimates of radionuclide inventories disposed in the active 200 East Area Low-Level Waste Burial Grounds (LLBGs) since September 26, 1988. The estimates are calculated using the original dose methodology developed in the performance assessment (PA) analysis (WHC-SD-WM-TI-730[1]). The estimates are compared with performance objectives defined in U.S. Department of Energy (DOE) requirements (DOE O 435.1 Chg 1,[2] and companion documents DOE M 435.1-1 Chg 1[3] and DOE G 435.1-1[4]). All performance objectives are currently satisfied, and operational waste acceptance criteria (HNF-EP-0063[5]) and waste acceptance practices continue to be sufficient to maintain compliance with performance objectives. Inventory estimates and associated dose estimates from future waste disposal actions are unchanged from previous years' evaluations, which indicate potential impacts well below performance objectives. Therefore, future compliance with DOE O 435.1 Chg 1 is expected.

Within the active burial grounds, low-level waste and mixed low-level waste may be disposed in the dedicated U.S. Navy reactor compartment trench in the 218-E-12B Burial Ground (Trench 94). Naval reactor compartment disposal at Trench 94 will continue until the waste stream is completely exhausted. During this reporting period (fiscal year 2017, from October 1, 2016, through September 30, 2017), two reactor compartments were disposed in Trench 94.

Multi-year experiments are summarized for this reporting period to quantify the efficacy of concrete waste forms in retaining key radionuclides (e.g., uranium-238, technetium-99, and iodine-129) while undergoing weathering. As demonstrated through the multi-year experimental results of saturated leaching tests, as well as unsaturated diffusion tests,

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[1] WHC-SD-WM-TI-730, 1996, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0071840H.

[2] DOE O 435.1 Chg 1, 2001, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives-documents/400-series/0435.1-BOrder-chg1.

[3] DOE M 435.1-1 Chg 1, 2001, *Radioactive Waste Management Manual*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives-documents/400-series/0435.1-DManual-1-chg1.

[4] DOE G 435.1-1, 1999, *Implementation Guide for use with DOE M 435.1-1*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/0435.1-EGuide-1ch1/view.

[5] HNF-EP-0063, 2017, *Hanford Site Solid Waste Acceptance Criteria*, Rev. 17, CH2M HILL Plateau Remediation Company, Richland, Washington.

concrete encasement of waste disposed at Hanford Site solid waste burial grounds under unsaturated and atmospheric (carbonated) conditions will provide a significant delay in radionuclide release into the subsurface.

Continued groundwater monitoring of the 200 East Area LLBGs indicates no groundwater contamination due to LLBG waste. Current assumptions about future land use at the Hanford Site are consistent with PA analysis assumptions of a post-closure facility that will not be degraded by human activity. The LLBGs are located in an area identified for waste management and containment of residual contamination. This area will remain after final environmental remediation and the proposed shrinkage of Hanford Site boundaries to small areas within the 200 East Area and 200 West Area in the Central Plateau (DOE/EIS-0391[6]). Overall, there are no substantive changes to primary PA assumptions and no changes to the PA analysis conclusion; therefore, compliance with DOE O 435.1 Chg 1 is being maintained.

[6] DOE/EIS-0391, 2012, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)*, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: http://energy.gov/nepa/downloads/eis-0391-final-environmental-impact-statement.

Contents

Appendices

Figures

Tables

Terms

AEA	*Atomic Energy Act of 1954*
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CY	calendar year
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
FY	fiscal year
LLBG	low-level burial ground
LLW	low-level waste
LLWMA	low-level waste management area
MCL	maximum contaminant level
MLLW	mixed low-level waste
PA	performance assessment
R&D	research and development
RCRA	*Resource Conservation and Recovery Act of 1976*
TC & WM EIS	Tank Closure and Waste Management Environmental Impact Statement
TOC	total organic carbon

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1 Changes Potentially Affecting the Performance Assessment

This chapter outlines all potential or actual changes, discoveries, proposed actions and new information identified during the reporting period of fiscal year (FY) 2017 (from October 1, 2016 to September 30, 2017) for the 200 East Area Low-Level Burial Grounds (LLBGs) with the potential to impact the performance assessment (PA) (WHC-SD-WM-TI-730, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*; HNF-2005, *Addendum to the Performance Assessment Analysis for Low-Level Waste Disposal in the 200 East Area Active Burial Grounds*). No significant changes were found during the reporting period, as summarized in Table 1.

Table 1. Potential Changes Affecting the Performance Assessment

Disposal Facility/Unit	UDQE/UCAQE or Change Control Process Identification Number	Change, Discovery, Proposed Action, New Information Description	Evaluation Results	Special Analysis Number (if applicable)	PA Impacts
216-E-10	None	None	N/A	N/A	None
216-E-12B	None	None	N/A	N/A	None

N/A = not applicable
PA = performance assessment
UCAQE = unreviewed composite analysis question evaluation
UDQE = unresolved disposal question evaluation

2 Cumulative Effects of Changes

In accordance with DOE M 435.1-1 Chg 1, *Radioactive Waste Management Manual*, the purpose of this chapter is to identify any cumulative effects of changes in facility operations, waste receipts, waste form behavior, monitoring data, research and development (R&D) data, or land-use decisions during the reporting period that have affected PA assumptions and conclusions. If such changes exist, potential impacts are assessed, and recommended changes that are needed to address the impact of the reported changes are identified.

Chapter 1 outlines that no changes have occurred to cause substantive changes in disposal facility operations, disposal facility performance, and PA assumptions or results (Table 1), therefore resulting in no additional cumulative effects.

Appendix A provides the history of the maintenance for this PA since its approval.

The composite analysis supporting this PA is reported in PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*; and PNNL-11800-Addendum-1, *Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*. The composite analysis is maintained separately under its own maintenance plan (DOE/RL-2000-29, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington*), and the concurrent annual status report for the composite analysis is provided in DOE/RL-2017-55, *Annual Status Report (FY 2017): Composite Analysis for Low Level Waste Disposal in the Central Plateau of the Hanford Site*.

3 Waste Receipts

This chapter includes the following sections:

- Facility overview (Section 3.1)
- Description of disposed inventory (Section 3.2)
- Summary of groundwater and inadvertent intruder dose estimates associated with disposed inventory (Section 3.3)
- Evaluation of compliance with other performance objectives (Section 3.4)
- Statement of progress towards satisfying PA conditional approval requirements (Section 3.5)
- Summary statement of conclusions about compliance with performance objectives (Section 3.6)

3.1 Facility Overview

Figure 1 shows the location of the 200 East Area LLBGs in relation to the 200 West Area LLBGs, the Central Plateau, and the Hanford Site. Two LLBGs in the 200 East Area (218-E-10 and 218-E-12B) (Figure 2) received low-level waste (LLW) and mixed low-level waste (MLLW) after September 26, 1988, and are, therefore, subject to the requirements of DOE O 435.1 Chg 1, *Radioactive Waste Management*.

WHC-SD-WM-TI-730 notes that the general type of disposal facility in the 200 East Area is a shallow, unlined trench of variable width (approximately 3 to 10 m [10 to 33 ft]), length (50 to 100 m [165 to 330 ft]), and depth (5 to 10 m [17 to 33 ft]). Waste is typically packaged in containers (metal drums or boxes; box materials include cardboard, wood, metal, and concrete) and then placed in trenches up to 2 to 3 m (7 to 10 ft) from the surface. When a trench is filled, a soil cover is placed over the waste. Types of waste include paper, plastic, wood, concrete rubble, activated metal, and sludge.

Except for the reactor compartment trench, trenches are typically arranged in parallel alignment, with the long axis running due north and south. The reactor compartments, which contained defueled compartments from decommissioned U.S. Navy submarines and cruisers, are typically large, cylindrical waste packages ranging from about 9 to 13 m (30 to 42 ft) in diameter and 11 m to 17 m (37 ft to 55 ft) in length. Trench 94 in the 218-E-12B Burial Ground is dedicated for disposal of the naval reactor compartments. To accommodate these large waste packages, the trench is about 15 m (50 ft) deep, 490 m (1,600 ft) long, and 120 m (400 ft) wide. Other than the naval reactor compartment waste, the majority of waste received in the 200 East Area LLBGs is from Hanford Site generators, including the Plutonium-Uranium Extraction Plant, B Plant, and tank farm operations.

Currently, LLW and MLLW may be disposed in the dedicated naval reactor compartment trench in the 218-E-12B Burial Ground (Trench 94). There are no plans to increase disposal capacity at the current burial grounds. Naval reactor compartment disposal at Trench 94 will continue until the waste stream is completely exhausted. Long-term needs for disposal of LLW and MLLW at the Hanford Site are evaluated in DOE/EIS-0391, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)*, which identifies three waste management alternatives for the proposed actions. The preferred alternative is Alternative 2 (continued treatment of onsite LLW and MLLW in a single facility [Integrated Disposal Facility-east)].

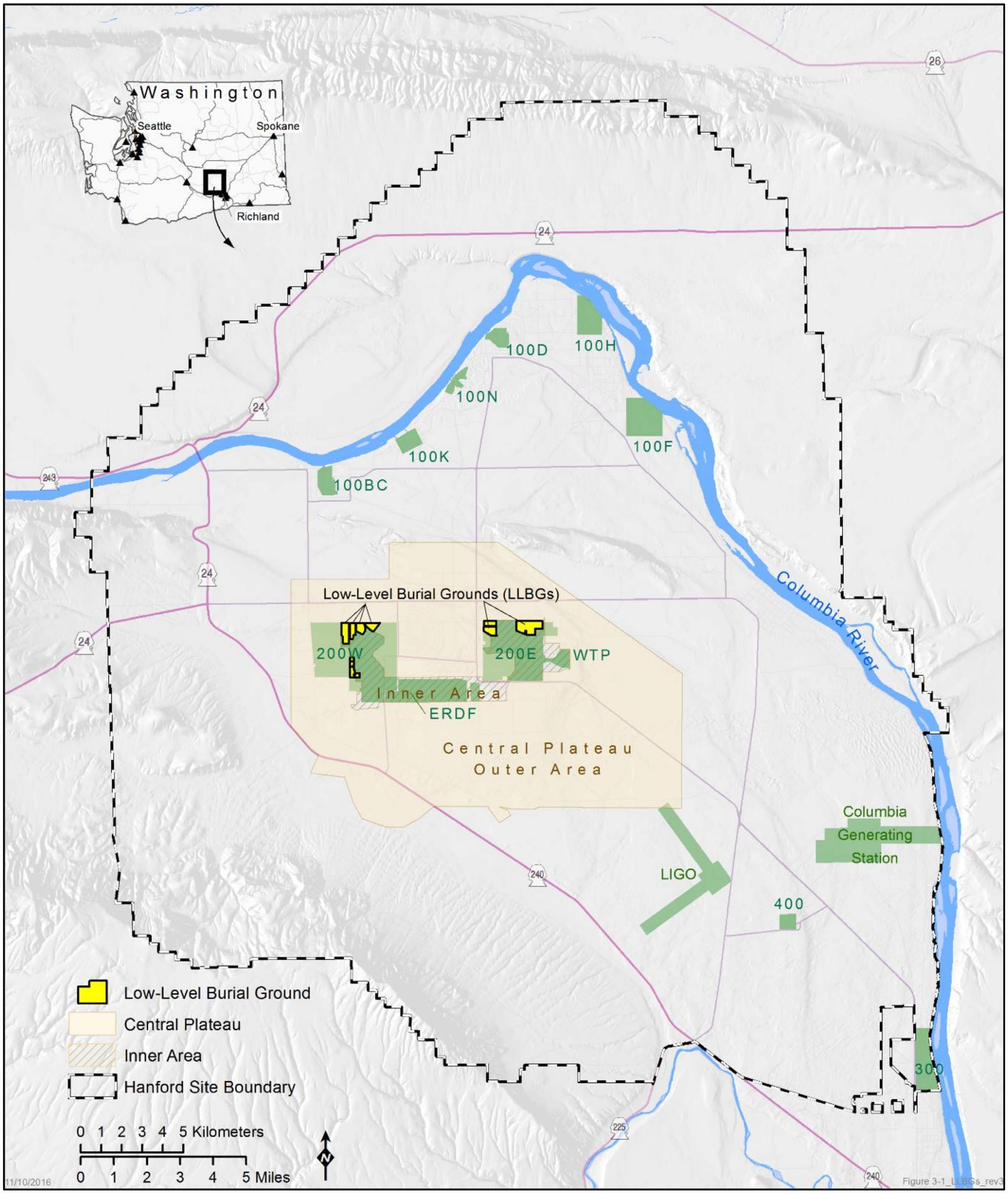


Figure 1. Location of the 200 East Area LLBGs

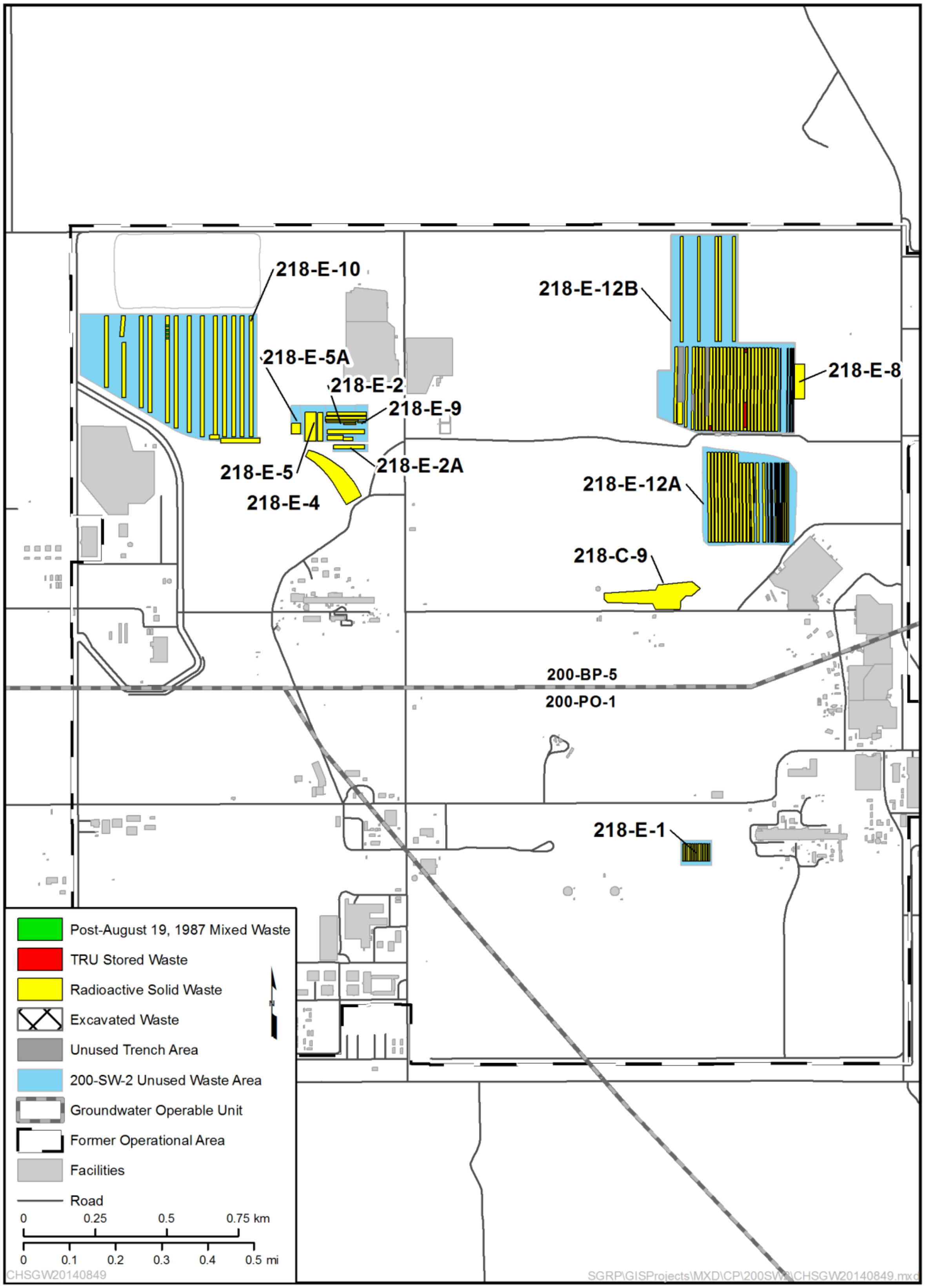


Figure 2. LLBGs and Other Solid Waste Burial Sites in the 200 East Area

3.2 Disposed Waste Receipt Description

During the reporting period (FY 2017, from October 1, 2016 through September 30, 2017), two naval reactor vessels were disposed in the 218-E-12B Burial Ground (Trench 94) (Figure 3), with a total volume of 2,276 m^3 (80,376.2 ft^3). Figure 4 shows the September 2017 offloading of one of the reactor compartments in north Richland, Washington, which was followed by land transport to the Hanford Site and disposal in Trench 94. The radiological inventory in the received naval reactor compartments is primarily from nickel-63 and cobalt-60 present as activated metals (Appendix B). The total volume of naval reactor compartments disposed to date is 117.2×10^3 m^3 (greater than 4.1 million ft^3). No additional inventory was disposed in the 218-E-10 Burial Ground during FY 2017. Table 2 summarizes the total waste receipt inventory for the 200 East Area LLBGs.

3.3 Projected Dose Estimates form the Disposed Waste to Evaluate Compliance with DOE O 435.1 Chg 1

Among the performance objectives defined in DOE O 435.1 Chg 1, the primary objective is the all-pathways dose limit of 25 mrem/yr to an individual residing 100 m (328 ft) downgradient of the disposal facility. In the PA analysis (WHC-SD-WM-TI-730), a multiple-exposure pathway agriculture scenario was used to generate dose estimates that were compared to the 25 mrem/yr limit. A single exposure groundwater consumption pathway was compared to a 4 mrem/yr drinking water limit. For all radionuclides (except chlorine-36), the dose calculations showed higher doses with respect to the 4 mrem/yr drinking water limit for the same inventory, making the drinking water limit more stringent; therefore, the drinking water dose results are presented in this report. Collective dose estimates for uranium and the combined inventories of mobile radionuclides are provided in Section 3.3.1 for comparison with the 25 mrem/yr all-pathways limit and the 4 mrem/yr drinking water limit.

The analyses also show that waste acceptance criteria in HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*, are satisfied; consequently, no special analyses or reviews were needed. For the all-pathways performance objective, waste acceptance criteria are defined for mobile radionuclides as specific inventory limits. These limits correspond to the inventory that is estimated to provide the maximum allowable dose when leached from the facility and transported to a 100 m (328 ft) downgradient well. The limits are expressed indirectly in the LLBG waste acceptance criteria (HNF-EP-0063) as trigger values (radionuclide-specific concentrations) that are calculated on a package-by-package basis. If a package contains any radionuclides exceeding this value, a review of the disposal criteria is initiated to determine if additional disposal requirements beyond normal requirements are needed. Annual summaries (such as this one) are then completed to show that the performance objective and inventory limits have not been exceeded.

Compliance demonstration is based on dose estimates for the entire facility, as it now exists. In the 200 East Area, inventories disposed in the two active LLBGs (218-E-10 and 218-E-12B) were considered separately because they are geographically separated, and previous analyses suggest that future contaminant plumes from each burial ground should not commingle. For this reporting period, other than the activated metal inventory from two naval reactor vessels, no other reportable waste was disposed in the 200 East Area LLBGs. The contribution from reactor compartments is negligibly small and not explicitly counted due to very slow corrosion rates of the activated metal waste (Appendix B). As a result, the dose estimates from the previous analysis (being cumulative) have been repeated.

Source: U.S. Department of Agriculture National Agriculture Imagery Program.

Figure 3. Images of Burial Ground 218-E-12B (Trench 94), CY 2015

Figure 4. Naval Reactor Compartment Offload in Preparation for Overland Transport to Trench 94, September 2017

Table 2. Waste Receipts

Disposal Facility/Unit	Waste Disposed to Date (m^3)	PA Estimated Disposal Capacity (m^3)	Percent Filled (%) Volume	Sum of Fractions	PA Impacts
218-E-10 (Trenches 9 and 14)	4,677	56,000[c]	8.3	1.29E-04[b]	None
218-E-E12B (Trenches 32, 36, 38, 42, 48, and 53)	27,309	168,000[c]	16	3.15E-04[b]	None
218-E-E12B (Trench 94)	117,200	N/A[a]	N/A[a]	N/A[a]	None

a. Trench 94 is designed for expansion and has no estimated disposal capacity.

b. Total fraction based on intruder dose fraction of Category 3 limit for cesium-137, strontium-90, and uranium.

c. Based on rough estimates of trench sizes (approximately 7 m deep, 8 m wide, and 500 m in length) in WHC-SD-WM-TI-730, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*, p. 2-20.

N/A = not applicable

PA = performance assessment

The next most significant compliance requirement in DOE O 435.1 Chg 1 is the inadvertent intruder limit. A dose limit of 100 mrem/yr from chronic exposure or 500 mrem/yr from acute exposure was defined for an inadvertent intruder who might be exposed to waste in the disposal facility. In the PA analysis (WHC-SD-WM-TI-730), it was shown that the 100 mrem/yr chronic dose limit was the more limiting alternative. Therefore, the chronic exposure standard was adopted for comparing dose results and establishing waste acceptance criteria. These criteria are quantified in the LLBG waste acceptance criteria (Table A-2 of HNF-EP-0063) as radionuclide-specific concentration limits (Ci/m^3) for two categories of waste (Category 1 and Category 3) and are compared against the average values for the disposed waste in a given trench. The waste acceptance criteria also specify that Category 3 waste, which contains radionuclides at higher concentrations, must be grouted or placed in high-integrity containers or equivalent. The trench-by-trench breakdown was not provided in the PA, but a total burial ground dose was provided in which radionuclide concentrations were calculated based on total burial ground inventory and total waste volume disposed.

Dose estimates are summarized and explained in the following sections for each of the primary criteria. The dose estimates assume that Category 3 conditions will ultimately be the end-state condition (e.g., a final burial ground cap is placed over the disposal trenches to create a 5 m [16.4 ft] layer over the waste and limit infiltration to no more than 0.5 cm/yr [0.2 in./yr]). Waste disposal configurations that have enhanced isolation from the hydrogeologic environment (primarily placement in high-integrity containers or equivalent) have also been incorporated into the calculations.

3.3.1 Groundwater Dose Estimates

In the PA analysis (WHC-SD-WM-TI-730), a methodology was developed to evaluate groundwater dose for any size disposal facility of interest within the boundaries of the collective burial grounds (Section 3.2.1.2 in WHC-SD-WM-TI-730). An assumption was made that any trench or set of trenches could be divided into a series of waste volume slices parallel to groundwater flow. Dose estimates from the waste configuration of interest were then derived from an average slice evaluation. This approach was taken to facilitate evaluating future changes in disposal facility size that cannot be predicted. All aspects of the disposal configuration continue to be represented adequately with this representation.

3.3.1.1 Burial Ground Drinking Water Dose Estimates

When calculating contaminant release and transport, it is necessary to make numerous averaging and simplifying assumptions because much of the environmental heterogeneity that is present cannot be characterized or modeled realistically. To calculate the groundwater drinking or all-pathways dose, a simplifying assumption of uniform radionuclide distribution across the disposal facility axis perpendicular to the general direction of groundwater flow was made, although it is acknowledged that specific waste volumes with much higher contaminant concentrations exist.

This approach does not explicitly model the current period in which the LLBGs are only covered with an interim cover that likely permits greater average recharge than that assumed for Category 3 conditions. Qualitative arguments have been made in the PA analysis (Section 3.2.3.1 of WHC-SD-WM-TI-730) that conservative assumptions used in the model accommodate this potentially non-conservative condition. Most waste packages used since September 26, 1988, are sufficiently sturdy to delay contact of infiltrating water with radionuclides through the operational period, so minimal release is expected before placement of the final cover several decades from now. This is particularly the case with Category 3 waste that is placed in sealed or grouted concrete boxes and contains the majority of the PA-sensitive inventory. In the composite analysis for the Hanford Site (PNNL-11800), a sensitivity case was considered in which an enhanced recharge rate of 7.5 cm/yr (3 in./yr) through the LLBGs was assumed during the operating period (approximately 40 years), followed by infiltration rates controlled by a final cover

(0.5 cm/yr [0.2 in./yr]). It was concluded that the brief period of increased infiltration did not have a significant effect on estimated downstream groundwater concentrations and, therefore, dose estimates.

In Table 3, the drinking water dose estimates are divided into two LLBG groups (the 218-E-10 Burial Ground and the 218-E-12B Burial Ground) and by two different periods and major contributors (uranium dose versus other radionuclides dose). The two different periods distinguish between inventory disposed from facility inception (September 27, 1988) through FY 2016 (September 30, 2015; prepared in the previous annual report, DOE/RL-2016-64, *Annual Status Report (FY 2016): Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*) versus the inventory disposed in FY 2017 (this reporting period). Summing the dose estimates from these two periods yields the total dose estimate for the LLBG groups that are also reported in Table 3. The contribution from reactor compartments is not explicitly counted in the dose estimate for the 218-E-12B Burial Ground because it is calculated to be very small (less than 0.0001 mrem/yr) relative to the 4 mrem/yr dose requirement, primarily due to very slow corrosion rates of the activated metal waste.

Table 3. Category 3 Groundwater Dose Estimates (mrem/yr) by Burial Ground for Disposed Inventory

Burial Ground	Uranium Dose	Mobile Radionuclide Dose		Estimated Total Dose[c]
		Reported[a]	Estimated[b]	
Dose from Waste Disposal from Inception through FY 2016 (September 27, 1988 to September 30, 2016)				
218-E-10	1.31E-03	0.00E+00	5.58E-03	6.89E-03
218-E-12B	5.27E-03	4.95E-05	6.79E-04	5.99E-03
Dose from Waste Disposal during FY 2016 (October 1, 2016 to September 30, 2017)				
218-E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00
218-E-12B	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose from Total Waste Disposal from Inception through FY 2017 (September 27, 1988 to September 30, 2017)				
218-E-10	1.31E-03	0.00E+00	5.58E-03	6.89E-03
218-E-12B	5.27E-03	4.95E-05	6.79E-04	5.99E-03

a. Reported dose is calculated for the reported inventory of mobile radionuclides.

b. Estimated dose is calculated for estimates of mobile radionuclide inventory that may be present in disposed waste at trace levels but have not been reported or measured, using a scaling factor derived from reactor production ratios of cesium-137 concentrations to other contaminants (WHC-SD-WM-TI-730, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*, Appendix B). The concept is that in lieu of direct characterization information, the unknown mobile radionuclide inventory can be conservatively estimated by assuming that reactor production ratios are maintained in waste.

c. Estimated total dose is the sum of uranium dose, reported mobile radionuclide dose, and estimated radionuclide dose.

Dose estimates from waste disposed during this reporting period are zero because no reportable waste other than the activated metals associated with two naval reactors was disposed during the period. The largest total dose (about 6.89×10^{-3} mrem/yr) results from the disposal of mobile radionuclides. The estimated dose values for mobile radionuclides listed in Table 3 were generated with the inclusion of estimates of mobile radionuclide inventory (not including uranium) for radionuclides that may be present in disposed waste at trace levels but have not been reported or measured. In the 200 East Area PA, a scaling factor was derived from reactor production ratios of cesium-137 concentrations to other contaminants (WHC-SD-WM-TI-730, Appendix A). The concept is that in lieu of direct characterization information, the unknown mobile radionuclide inventory can be reasonably estimated by assuming that reactor production ratios are maintained in waste. Using these scaling factors and disposed cesium-137 inventories during this reporting period, estimated inventories of mobile contaminants and associated doses were calculated. Dose contribution from disposed uranium has frequently been larger than that from disposed mobile radionuclides; however, during this reporting period, low disposal inventory reduced the estimated uranium dose to incidental levels.

The total dose for each burial ground group, when compared to a 4 mrem/yr limit, shows that compliance with the performance goal has been maintained. Groundwater drinking dose estimates were unchanged from FY 2016 (October 1, 2015, through September 30, 2016) because no reportable waste other than that associated with two naval reactors was disposed in current reporting period (FY 2017).

Dose estimates for the less-stringent, all-pathways scenario (not reported) show the same trends as the groundwater drinking scenario; in both cases, the total estimates fall below performance objective values of 25 mrem/yr and 4 mrem/yr, respectively. Table 3 shows the drinking water doses for comparison to the 4 mrem/yr limit.

3.3.2 Inadvertent Intruder Dose Estimates

Compliance with the inadvertent intruder waste acceptance limits is determined by comparing projected intruder dose from the trench waste volume and inventory with a 100 mrem/yr chronic dose limit. Occasionally, individual waste packages are received that approach or exceed the Category 3 limits. In these cases, written justification for alternative waste concentration averaging is provided to the waste disposal organization by the PA contact.

The likelihood that an inadvertent intruder would exhume a particular waste package with high-concentration inventory is considered very small; therefore, averaging based on trench volume is a reasonable approach to compliance evaluation. As with the groundwater dose evaluation, Category 3 conditions are assumed to exist in the post-closure period. Separate periods are not considered for these estimates because the calculated doses apply to cumulative inventories and waste volumes.

Table 4 provides the trench volumes, activities of the largest contributors, and dose fractions for the inadvertent intruder dose estimates. The intruder dose from other radionuclides is negligibly small. Dose estimates are 100 times the sum of fractions dose. In most trenches, dose estimates are less than 1 mrem/yr, which is far below the 100 mrem/yr limit. Where uranium is present in significant quantities, it usually provides the largest projected dose. In the 200 East Area trenches, cesium-137 and/or strontium-90 provide the largest dose.

The projected total burial ground inadvertent intruder doses provided in Table 4 are consistent with those provided in the PA analysis (WHC-SD-WM-TI-730) and are similar to individual trench dose estimates. On this scale of waste-volume averaging, the estimated doses for each burial ground are well below the compliance limit.

Table 4. Estimated Intruder Dose Fraction by Trench for Waste Disposed from 9/27/1988 through 9/30/2017

Burial Ground	Trench	Volume (m^3)	Inventory (Ci)			Concentration (Ci/m^3)			Fraction of Category 3 Limit			Total Dose Fraction
			Cs-137	Sr-90	U	Cs-137	Sr-90	U	Cs-137	Sr-90	U	
218-E-10	9	1,062	4.00E+02	6.18E+02	1.96E-02	3.77E-01	5.82E-01	1.85E-05	3.14E-05	1.08E-05	3.69E-05	7.91E-05
	14	3,615	2.15E-02	2.14E-02	9.02E-02	5.94E-06	5.91E-06	2.49E-05	4.95E-10	1.10E-10	4.99E-05	4.99E-05
218-E-12B	32	12,446	1.47E-02	1.14E-04	2.27E-02	1.18E-06	9.17E-09	1.83E-06	9.84E-11	1.70E-13	3.65E-06	3.65E-06
	36	1,741	1.04E-02	3.92E-03	1.03E-02	5.96E-06	2.25E-06	5.90E-06	4.97E-10	4.17E-11	1.18E-05	1.18E-05
	38	2,017	9.45E-03	3.32E-01	0.00E+00	4.69E-06	1.65E-04	0.00E+00	3.90E-10	3.05E-09	0.00E+00	3.44E-09
	42	8,146	3.83E+00	3.32E+00	2.15E-02	4.71E-04	4.08E-04	2.64E-06	3.92E-08	7.55E-09	5.28E-06	5.32E-06
	48	374	8.17E-01	1.36E+00	0.00E+00	2.18E-03	3.64E-03	0.00E+00	1.82E-07	6.73E-08	0.00E+00	2.49E-07
	53	2,585	1.01E+01	1.54E+01	3.79E-01	3.90E-03	5.96E-03	1.47E-04	3.25E-07	1.10E-07	2.93E-04	2.94E-04

3.4 Other Performance Objectives

Two other limits were considered in the PA analysis: air emissions dose limit (10 mrem/yr), and the radon flux limit (20 pCi/m2/s) (WHC-SD-WM-TI-730). Table 5 provides the estimated doses for comparison to these two limits, as well as a summary of the groundwater contamination and inadvertent intruder doses. In the PA analysis, potential sources of air contamination were concluded to be carbon-14 and hydrogen-3 (tritium). In the case of a Category 3 closure condition assumption (exposure at 500 years), it was concluded that the conditions needed for carbon-14 to provide an atmospheric dose (e.g., delayed beyond 100 years, followed by complete and instantaneous release) were unrealistic, and tritium would have decayed to trivial amounts (Section 4.3.1 of WHC-SD-WM-TI-730). Therefore, no dose from an atmospheric release was projected.

Table 5. Comparison of Dose or Flux Estimates with Performance Objectives

Performance Objective	Exposure Pathway	Estimated Dose or Flux*	
		200 East Area	
		218-E-10	218-E-12B
25 mrem/yr	Groundwater, all pathways	0.02	0.01
4 mrem/yr	Groundwater, drinking	0.007	0.006
100 mrem/yr at 500 years	Post-drilling intruder	0.006	0.003
20 pCi/m^2/s at 10,000 years	Radon emission	0.001	0.00009
10 mrem/yr	Air contaminant	0	0

* All estimates are made assuming Category 3 conditions as the final state of the low-level burial grounds. Potential doses from current and projected inventory are summed. Units of measure of dose/flux values are the same as the corresponding performance objective.

Other criteria in the LLBG waste acceptance criteria (HNF-EP-0063) address disposal in a physically stable configuration with minimal void space, minimal gas emission, and elimination of pyrophoric characteristics. These criteria are also used to minimize long-term subsidence. These requirements are being administered by LLBG operations and typically involve solidification or void-fill processes. As necessary, waste packages are grouted or placed in concrete boxes that are high-integrity containers or equivalent. Surveillance for local subsidence is performed routinely by LLBG staff, and any cavities that form are filled in with dirt or grout.

3.5 Conditional Approval Requirements

All conditional approval requirements have been completed (Scott, 2001, “Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities – Revision 2”).

3.6 Conclusions

This review concludes that as of September 30, 2017, disposal practices and waste inventories disposed in the active LLBGs comply with performance objectives. The current waste disposal procedures and waste management practices are sufficient to maintain compliance with the performance objectives. None of the information presented in this report indicates that the PA must be changed to demonstrate compliance with DOE O 435.1 Chg 1. However, information collected across the Hanford Site on key assumptions affecting performance estimates (e.g., engineered barrier control of infiltration, and rates and sorption of key radionuclides) over the past two decades suggests some substantially conservative assumptions in the currently approved version of the PA analysis (WHC-SD-WM-TI-730). Thus, improved facility performance is expected.

4 Monitoring

Monitoring of water and air for contaminants (both radiological and chemical) is an ongoing program across the Hanford Site. In certain locations, vadose zone characterization is also being conducted, primarily at remediation sites and soil columns contaminated by tank leaks. Groundwater monitoring wells and air sampling stations are located near the 200 East Area LLBGs and are routinely monitored for contaminants as part of the Hanford Sitewide monitoring program. With respect to the requirements of DOE O 435.1 Chg 1, particular attention is paid to the following mobile contaminants: technetium-99, uranium, iodine-129, and tritium. In this program, the 200 East Area LLBGs are divided into two monitoring groups, or low-level waste management areas (LLWMAs): LLWMA-1 (218-E-10) and LLWMA-2 (218-E-12B). Summary documents are issued annually that describe and interpret the collected information.

The latest summary of groundwater monitoring information (DOE/RL-2016-67, *Hanford Site Groundwater Monitoring Report for 2016*) describes data collected during calendar year (CY) 2016 (from January 1, 2016, through December 31, 2016). The groundwater monitoring program maintains a real-time database that is updated as samples are collected and analyzed. Data from these sources are summarized in the following subsections: LLWMA-1 (Section 4.1) and LLWMA-2 (Section 4.2). The groundwater monitoring program reporting period is by CY, so the following information reported for CY 2016 represents the latest available information for purposes of this FY 2017 annual summary report. Tables 6 and 7 summarize the compliance monitoring and performance monitoring evaluations.

Table 6. Compliance Monitoring

Disposal Facility/Unit	Monitoring Type	Monitoring Results and Trends	Performance Objective Measure or Other Regulatory Limit	Action Level	Action Taken	PA/CA Impacts
218-E-10	Groundwater	No indication of contamination from the LLBGs	DWS	None	None	None
218-E-12B	Groundwater	No indication of contamination from the LLBGs	DWS	None	None	None

CA = composite analysis
DWS = drinking water standard
PA = performance assessment
LLBG = low-level burial ground

Table 7. Performance Monitoring

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results and Trends	PA Expected Behavior	Action Taken	PA/CA Impacts
216-E-10	Radionuclide transport	Compliant	Compliant	None	None
216-E-12B	Radionuclide transport	Compliant	Compliant	None	None

CA = composite analysis

PA = performance assessment

4.1 Low-Level Waste Management Area 1

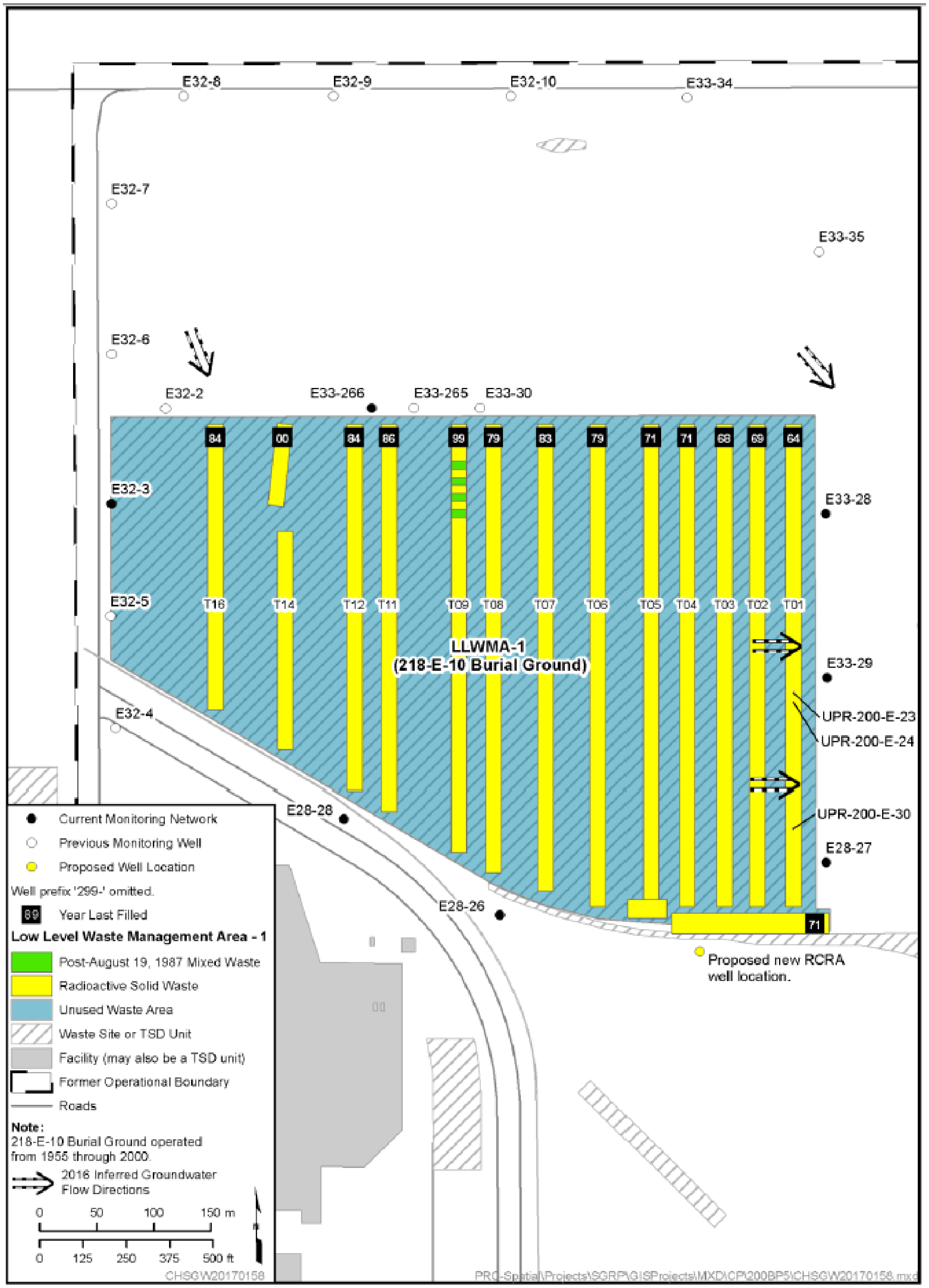
Groundwater monitoring of the well network at LLWMA-1 (Figure 5) in CY 2016 continued under *Resource Conservation and Recovery Act of 1976* (RCRA) and *Atomic Energy Act of 1954* (AEA) requirements. The LLWMA-1 monitoring network is designed to detect dangerous waste or dangerous waste constituents affecting groundwater from the 218-E-10 Burial Ground. The monitoring network encompasses the LLWMA-1 boundary to provide coverage for potential groundwater flow direction changes. The LLWMA-1 monitoring network consists of 18 wells screened in the upper portion of the aquifer at the water table. PA monitoring of radionuclides at LLWMA-1 complements the RCRA detection monitoring program. The current monitoring plan (DOE/RL-2000-72, *Performance Assessment Monitoring Plan for the Hanford Site Low-Level Burial Grounds*) includes groundwater monitoring of technetium-99, iodine-129, tritium, and uranium, which are deemed to be performance-related constituents of interest. These are co-sampled with the RCRA groundwater sampling schedule for the LLBG.

Groundwater gradient magnitudes and flow directions were determined using the 200 East Area low-gradient monitoring network for the northwest corner of 200 East Area. A 12-month rolling average calculation from October 2015 through September 2016 was used to derive the regional water table gradient. In addition, the local groundwater flow pathway was influenced by local groundwater pumping from October 2015 through September 2016 (Figure 5) The inferred pathway using modeling results indicated a southeast hydraulic gradient in the northwest corner and an east-sloping hydraulic gradient in the southern portion (Figure 5).

During 2016, the LLWMA-1 monitoring wells were sampled semiannually for indicator parameters as scheduled. Specific conductance, pH, total organic carbon (TOC), and total organic halides did not exceed critical mean values.

As with other LLWMAs, the U.S. Department of Energy (DOE) monitors for AEA radionuclides, as described in DOE/RL-2000-72; however, the 2016 monitoring results for AEA radionuclides were not reported in DOE/RL-2016-67. The following information for AEA radionuclides is based on the DOE Environmental Dashboard Application.[7]

[7] DOE Environmental Dashboard Application, U.S. Department of Energy, Richland, Washington; accessed on February 22, 2018. Available at https://ehs.hanford.gov/eda/.



Source: DOE/RL-2016-67, *Hanford Site Groundwater Monitoring Report for 2016* (Figure 9-50).

Figure 5. Groundwater Monitoring Well Locations at LLWMA-1

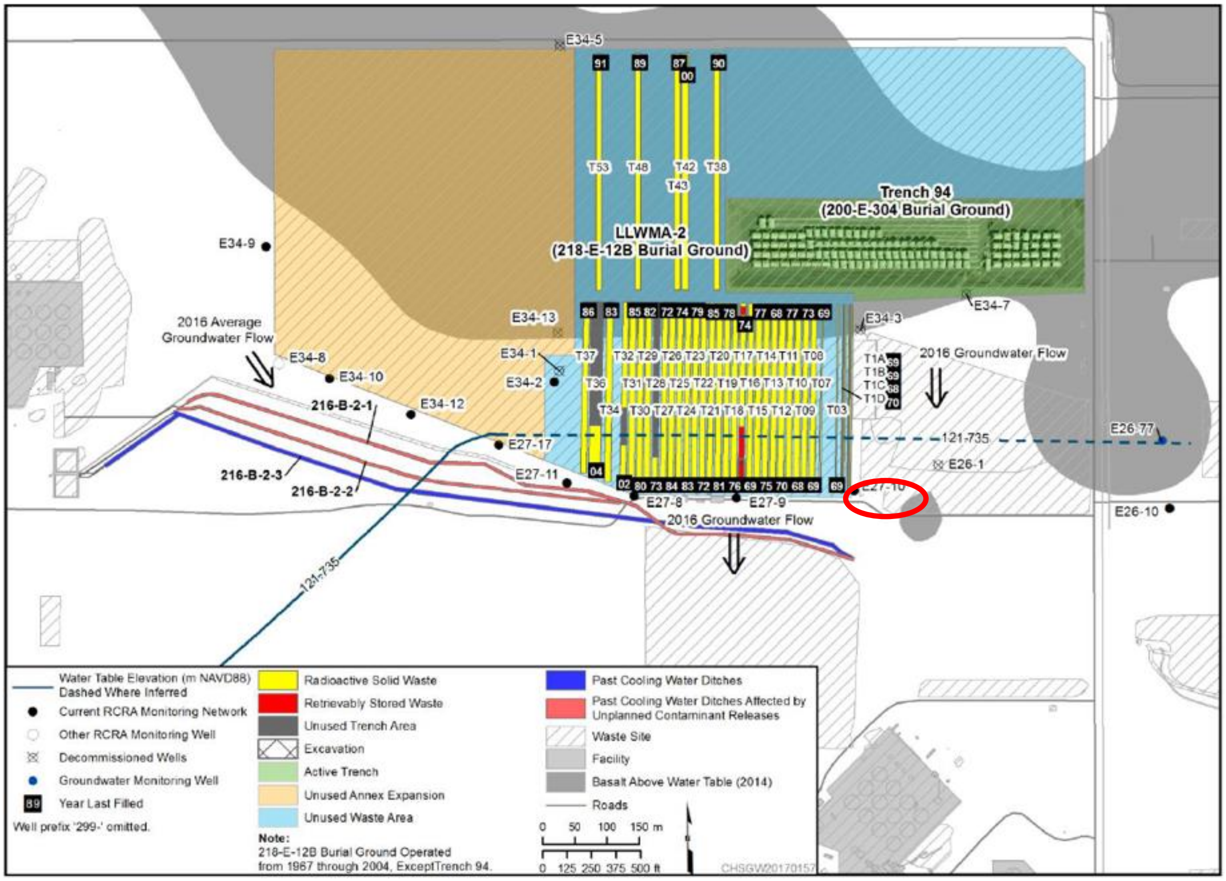
Iodine-129, technetium-99, tritium, and uranium were monitored semiannually in July for the seven RCRA monitoring wells for 218-E-10 Burial Ground (Figure 5). For upstream monitoring well 299-E32-3, iodine-129, technetium-99, and tritium were undetected for the July sampling event; however, uranium was detected at 3.73 µg/L. Iodine-129 was detected at very low levels, although the maximum concentration was measured in well 299-E33-28 (Figure 5) at 2.05 pCi/L in January then decreased to 1.23 pCi/L for the July sampling. The well 299-E33-28 iodine-129 measurements correspond with a regional iodine-129 plume and are not suspected to originate from LLWMA-1. Among the monitoring wells, 299-E33-28 (Figure 5) also had the maximum concentrations for technetium-99 (173.0 pCi/L) and tritium (1,640 pCi/L), and well 299-E28-27 had the highest measured uranium concentration (12.8 µg/L). Uranium, tritium, and technetium-99 measurements did not exceed their respective maximum contaminant levels (MCLs). The observed low levels for the AEA radionuclides is consistent with those reported in DOE/RL-2016-09, *Hanford Site Groundwater Monitoring Report for 2015*, and do not indicate contamination from LLWMA-1.

4.2 Low-Level Waste Management Area 2

Groundwater monitoring of the well network at LLWMA-2 (Figure 6) in CY 2016 continued under RCRA and AEA requirements. PA monitoring of radionuclides at LLWMA-2 complements the RCRA detection monitoring program. The current monitoring plan (DOE/RL-2000-72) includes technetium-99, iodine-129, tritium, and uranium. All wells were successfully sampled semiannually or annually during CY 2016. There were no confirmed critical mean exceedances in 2016. Well 299-E27-10 reported elevated TOC (9,860 µg/L) in April and elevated pH (8.35) was reported in well 299-E27-11 in October, but verification sampling results did not confirm the exceedances.

As with other LLWMAs, DOE monitors for AEA radionuclides, as described in DOE/RL-2000-72. However, the 2016 monitoring results for the AEA radionuclides were not reported in DOE/RL-2016-67. As with LLWMA-1, the following information for the AEA radionuclides is based on Environmental Dashboard Application.

Iodine-129, technetium-99, tritium, and uranium were monitored semiannually in October for the 10 RCRA monitoring wells (Figure 6). For upstream monitoring well 299-E34-9 (Figure 4-2), iodine-129 was undetected; technetium-99, tritium, and uranium concentrations were 694 pCi/L, 376 pCi/L, and 4 µg/L, respectively, for the October annual sampling. Iodine-129 was mostly detected at very low levels for the 10 monitoring wells (Figure 6) around the 218-E-12B Burial Ground, except wells 299-E27-10 and 299-E27-8 were above the MCL of 1.0 pCi/L. Well 299-E27-10 had the maximum iodine-129 concentration of 1.64 pCi/L for the April sampling, which decreased to 0.89 pCi/L in October. Similarly, well 299-E27-8 exhibited decreasing iodine-129 values from 1.17 to 0.79 pCi/L for the April and October samples, respectively. Among the 10 monitoring wells, 299-E34-9 (Figure 6) had the maximum concentrations for technetium-99 (708 pCi/L); 299-34-10 had the maximum tritium concentration (685 pCi/L); 299-E34-2 (Figure 6) had the maximum concentration for uranium (5.9 µg/L). None of the uranium, technetium-99, or tritium measurements exceeded their respective MCLs. The observed low level for the AEA radionuclides is consistent with those reported previously in DOE/RL-2016-09 and do not indicate contamination from LLWMA-2.



Source: DOE/RL-2016-67, *Hanford Site Groundwater Monitoring Report for 2016* (Figure 9-52).

Figure 6. Groundwater Monitoring Well Locations at LLWMA-2

5 Research and Development

During FY 2015, experiments were initiated to evaluate the effect of carbonation depth on contaminant migration. For these tests, concrete monoliths were carbonated by soaking them in heavily saturated sodium bicarbonate solutions for varying lengths of time. In FY 2016, petrographic and cracking analyses of the 6-month cores were completed to determine the actual carbonation depths and extents of macrocracking and microcracking. At the time of preparing the FY 2016 year-end project report (Golovich and Parker, 2016, *Radionuclide Migration Through Concrete*), the half-cell experiments for the 9-month carbonation period were not complete. Discussion of diffusion results from the carbonation half-cell experiments was deferred to FY 2017 to include diffusion results for all carbonation periods in this report. The measurements were compared to the petrographic analysis of the one-week and 3-month cores performed in FY 2015. Compressive strength measurements were also performed.

At the end of each carbonation period (one week, 3 month, 6 months, and 9 months), sediment-concrete half-cells were prepared with unsaturated sediment spiked with technetium, iodine, uranium, chromium, bromide, and nitrate to evaluate the bulk diffusion coefficient in the concrete. Diffusion of various species was quantified by sampling the half-cells and measuring respective concentrations in water extracts using inductively coupled plasma/mass spectrometry and optical emission spectroscopy.

The results of R&D work are summarized in in Table 8. No apparent trend was observed for calculated iodine diffusivities and the carbonated times. For technetium diffusivities, other than minor reduction due to iron content, no apparent trend was observed. These results will eventually be incorporated into an updated PA. In the meantime, this work provides additional context regarding uncertainty in the existing PA calculations.

Table 8. R&D Activities

Document Number	Results	PA/CA Impacts
PNNL-26938	Overall, the bulk diffusion coefficients ranged from 1.65×10^{-9} cm^2/s for technetium at 4% moisture content to 8.02×10^{-8} cm^2/s for nitrate at 4% moisture content. Previously reported bulk diffusion coefficients for technetium and iodine (PNNL-23841) exhibit higher values under similar experimental conditions (no carbonation and no iron) in FY 2006 and FY 2008 when compared to these newly reported values.	Uncertainty in PA inputs was reduced, indicating that the embedded assumptions are conservative.

References:

PNNL-23841 *Radionuclide Migration through Sediment and Concrete: 16 Years of Investigations*.

PNNL-26938, *Radionuclide Migration through Concrete: Carbonation and Tracer Tests*.

CA = composite analysis

FY = fiscal year

PA = performance assessment

6 Planned or Contemplated Changes

In accordance with DOE M 435.1-1 Chg 1, the purpose of this chapter is to identify any changes in facility operations, waste receipts, waste form behavior, monitoring data, R&D data, or land-use decisions during the reporting period that have affected PA assumptions and conclusions. If such changes exist, potential impacts are to be assessed, and recommended changes that are needed to address the impact of the reported changes are to be identified.

For this reporting period (FY 2017), no changes have occurred to cause substantive changes in disposal facility operations, disposal facility performance, and PA assumptions or results. Research efforts to understand the mobility of radionuclides in concrete encasement under unsaturated conditions continue to reduce uncertainty in PA inputs, indicating that the embedded assumptions are conservative. Groundwater monitoring activities will continue a routine basis. Despite the lack of change in significant impacts, the potential need for a revision to the PA analysis should be evaluated, given the length of time that has elapsed since completion and acceptance of the current PA analysis (WHC-SD-WM-TI-730). Through FY 2012, any revision of the LLBG PAs was deferred, awaiting the final TC & WM EIS (DOE/EIS-0391), which was issued on November 21, 2012. DOE issued formal direction (Williams, 2012, "Modeling to Support Regulatory Decisionmaking at Hanford") specifying how modeling may be performed to support regulatory compliance efforts at the Hanford Site under a phased approach meant to ensure consistency with the modeling that supports the final TC & WM EIS.

Similarly, two documents (RFSH, 1997, *Program Plan for Maintenance of Hanford Burial Ground Performance Assessment (PA) Analyses*; DOE/RL-2000-70, *Closure Plan for Active Low-Level Burial Grounds*) may also require updates given the length of time that has elapsed since completion and acceptance of the initial PA analysis (WHC-SD-WM-TI-730). Both maintenance and closure activities will be strongly affected by *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remediation efforts for past-practice burial grounds and trenches. This is particularly the case for the unlined trenches that received DOE O 435.1 Chg 1 waste, have been retired permanently, and could begin the closure process. These trenches are intermingled with past-practice trenches so their closure will be essentially directed by the CERCLA remediation process. Development of the CERCLA remediation process is ongoing and will eventually enter the public comment phase. Once the development process has matured and the effects of remediation decisions for past-practice units on unlined trench closure actions have been clarified, any necessary additional DOE O 435.1 Chg 1 closure actions can be identified, and the maintenance and closure plans will require updates.

During FY 2016, DOE requested that the Washington State Department of Ecology (Ecology) remove unused landfill areas, as defined in SGW-48278, *Investigation of Unused Landfill Areas: 218-W-4C, 218-W-6, 218-E-10 and 218-E-12B*. Within this PA, the unused areas are associated with landfills (218-E-10 annex and 218-E-12B [western portion]). Ecology agreed that the areas were unused (as documented) and that DOE may remove them from the Hanford Facility RCRA Permit (*Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended) Application Part A Form for the LLBGs operating unit group. The revised Part A Form will be submitted to Ecology as part of the permit application process. The proposed reduction in landfill area is very small compared to the 200 East Area LLBG footprint and, therefore, unlikely to change the PA calculations.

During this reporting period (FY 2017), there are no current outstanding information needs (e.g., data gaps and uncertainties) identified in the 200 East Area PA, subsequent addendum, or previous annual reviews. Table 9 summarizes the planned or contemplated changes.

Table 9. Planned or Contemplated Changes

Planned or Contemplated Changes	Change Basis	PA Impacts	Schedule
PA revision	An extended time period elapsed between the current annual status report and original PA	Because of several conservative assumptions used in the original PA, any embedded uncertainty in PA inputs will be reduced.	To be decided.
Maintenance and closure updates	Extended period of time between current annual status report and original PA	Impacted by CERCLA remediation efforts for past-practice burial grounds and trenches.	Ongoing.
Removal of 218-E-10 annex and 218-E-12B from Hanford RCRA Permit	Designation as an unused area associated with landfills by SGW-48278	Little impact to PA calculations due to relatively small area in comparison to the 200 East Area Low-Level Burial Ground footprint.	Ecology has agreed the areas are unused and the revised Part A Form will be submitted.

Table 9. Planned or Contemplated Changes

Planned or Contemplated Changes	Change Basis	PA Impacts	Schedule

References:

SGW-48278, *Investigation of Unused Landfill Areas: 218-W-4C, 218-W-6, 218-E-10 and 218 E 12B*.

Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste, Revision 8c, as amended.

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*

Ecology = Washington State Department of Ecology

PA = performance assessment

7 Status of Disposal Authorization Statement Conditions and Key and Secondary Issues

As indicated in Table 10, there are no outstanding issues that need resolution for the 216-E-10 and 216-E-12B LLBGs.

Table 10. Status of DAS Conditions and Key and Secondary Issues

Disposal Facility/Unit	Key/Secondary Issue or DAS Condition Number	Issue Description	Initial Resolutions Schedule Date	Projected Resolution Scheduled Date	Disposition Documentation and Date Completed	PA Impact
216-E-10	None	N/A	N/A	N/A	N/A	None
216-E-12B	None	N/A	N/A	N/A	N/A	None

DAS = disposal authorization statement

N/A = not applicable

PA = performance assessment

8 Certification of the Continued Adequacy of the Performance Assessment

Chapter 1 of this annual status report outlines that no changes have occurred to cause substantive changes in disposal facility operations, disposal facility performance, and PA assumptions or results (Table 1), resulting in no additional cumulative effects. In summary, the information reviewed in this annual status report resulted in no change to the PA or the disposal authorization statement for the 216-E-10 and 216-E-12B Burial Grounds.

8.1 Certification by the Field Element Manager or Designee

I certify, to the best of my knowledge, that information in this annual status report is true, accurate, and complete and that any proposed or implemented changes associated with the 200 East Area Low-Level Burial Grounds provide a reasonable expectation that the performance objectives/measures identified in DOE O 435.1 Chg 1 will be met.

D. Shoop, Manager, U.S. Department of Energy, Richland Operations Office	4/4/18 Date

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Appendix A

History of Performance Assessment Maintenance

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Table

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A History of Performance Assessment Maintenance

Two guidance documents (DOE M 435.1-1 Chg 1, *Radioactive Waste Management Manual*; DOE, 1999, *Maintenance Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses*) define the primary components of performance assessment (PA) maintenance. A primary component of the PA maintenance effort is an annual review of the PA analysis. This annual review of the 200 West Area PA analysis is the latest in a series of annual reviews prepared and issued since 1997 (Table A-1) to maintain these PAs. In accordance with DOE M 435.1-1 Chg 1, the primary function of this review is to evaluate the continued compliance of disposal actions during the previous year with the performance objectives and continued relevance of critical PA assumptions. A discussion of supporting research and development and monitoring results relevant to the PA analysis and disposal facility performance is also required.

Table A-1. Maintenance Documents for the Low-Level Burial Grounds Performance Assessments

Reporting Period*	Document
FY 1997	RFSH, 1997, *Program Plan for Maintenance of Hanford Burial Ground Performance Assessment (PA) Analyses*; transmitted in RFSH-9755566, "Transmittal of Program Plan for Maintenance of Hanford Burial Ground Performance Assessment (PA) Analyses, that Fulfills Performance Agreement WM 1.8.1"
	HNF-1561, *1996-1997 Annual Review of the 200 West and 200 East Area Performance Assessments*
FY 1998	HNF-3762, *1997-1998 Annual Review of the 200 West and 200 East Area Performance Assessments*
FY 1999	HNF-7561, *1998-1999 Annual Review of the 200 West and 200 East Area Performance Assessments*
FY 2000	HNF-7562, *1999-2000 Annual Review of the 200 West and 200 East Area Performance Assessments*
FY 2001	FH-0105097, "Performance Assessment Review Report, 2000-2001 Annual Review of the 200 West and 200 East Area Performance Assessments"
FY 2002	FH-0204558, "Performance Assessment Review Report, 2001-2002 Annual Review of the 200 West and 200 East Area Performance Assessments"
FY 2003	FH-0304003, "Performance Assessment Review Report, 2002-2003 Annual Review of the 200 West and 200 East Area Performance Assessments"
FY 2004	FH-0501152, "Performance Assessment Review Report, 2003-2004 Annual Review of the 200 West and 200 East Area Performance Assessments"
FY 2005	FH-0600899, "Performance Assessment Review Report, 2004-2005 Annual Review of the 200 West and 200 East Area Performance Assessments"
CY 2005 (partial); CY 2006	FH-0700959, "Performance Assessment Review Report, Annual Review of the 200 West and 200 East Area Performance Assessments (12/1/2005-12/31/2006)"
CY 2007	FH-0802190, "Performance Assessment Review Report, Annual Review of the 200 West and 200 East Area Performance Assessments (1/1/2007 - 12/31/2007)"

Table A-1. Maintenance Documents for the Low-Level Burial Grounds Performance Assessments

Reporting Period*	Document
CY 2008	DOE/RL-2009-99, *Annual Review of the 200 West and 200 East Area Performance Assessments (January 1, 2008 – December 31, 2008)*
CY 2009 (partial)	DOE/RL-2009-134, *Annual Review of the 200 West and 200 East Performance Assessments (January 1, 2009 – September 30, 2009)*
FY 2010	DOE/RL-2010-120, *Annual Review of the 200 West and 200 East Performance Assessments (FY 2010)*
FY 2011	DOE/RL-2011-110, *Annual Review of the 200 West and 200 East Performance Assessments (FY 2011)*
FY 2012	DOE/RL-2012-57, *Annual Review of the 200 West and 200 East Performance Assessments (FY 2012)*
FY 2013	DOE/RL-2013-41, *Annual Status Report (FY 2013): 200 West and 200 East Performance Assessments*
FY 2014	DOE/RL-2014-47, *Annual Status Report (FY 2014): 200 West and 200 East Performance Assessments*
FY 2015	DOE/RL-2015-68, *Annual Status Report (FY 2015): 200 West and 200 East Performance Assessments*
FY 2016	DOE/RL-2016-64, *Annual Status Report (FY 2016): 200 West and 200 East Performance Assessments*

* Reporting period has changed from FY to CY and back to FY basis during the maintenance history of these performance assessments in response to U.S. Department of Energy directions; this is reflected by the maintenance documents listed in this table.

CY = calendar year

FY = fiscal year

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Appendix B

Trench 94 (Naval Reactor Compartments) Inventory in the 200 East Area Low-Level Burial Grounds Performance Assessment

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Contents

Table

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B Trench 94 (Naval Reactor Compartments) Inventory in the 200 East Area Low-Level Burial Grounds Performance Assessment

This appendix provides further comparison of the waste inventory received to date in Trench 94 in the 200 East Area Low-Level Burial Grounds to the inventory analyzed in the 200 East Area performance assessment (WHC-SD-WM-TI-730, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*). The Solid Waste Information and Tracking System database was queried for total disposed inventory to date for each radionuclide listed in Table 2-5 of WHC-SD-WM-TI-730. After evaluating the relevant radionuclides, several inventories exceed performance assessment (PA) inventory, including americium-241, curium-243, curium-244, cesium-137, plutonium-238, plutonium-239, plutonium-240, plutonium-241, and strontium-90 (Table B-1).

The PA does not indicate an assumed closure date for Trench 94. Furthermore, it is unclear if the estimated inventory analyzed in the PA is decay-corrected to an assumed closure date.

Table B-1. Trench 94 Inventory Comparison to PA

Radionuclide	Estimated Inventory Analyzed in the PA (Ci)[a]	Inventory Disposed from Inception to 9/30/2017 (Ci)[b]	Fraction of PA Inventory Disposed to Date
Am-241	6.50E-01	2.27E+00	349%
Am-243	4.80E-05	4.32E-06	9%
Be-10	1.30E-06	1.28E-06	98%
C-14	6.40E+02	1.31E+02	21%
C-14 ACTIV. METAL	—	2.20E+02	—
Cl-36	6.00E-03	5.56E-03	93%
Cm-242	1.90E-06	2.94E-03	154,737%
Cm-243	2.20E-08	5.11E-07	2,322%
Cm-244	8.50E-06	3.12E-04	3,674%
Co-60	3.00E+06	1.03E+06	34%
Co-60 ACTIV. METAL	—	1.93E+05	—
Cs-137	1.30E+01	5.06E+01	389%
H-3	2.50E+03	1.12E+03	45%
I-129	6.30E-03	2.94E-03	47%
Mo-93	1.50E-01	6.90E-02	46%
Nb-93m	1.20E+00	5.61E-01	47%
Nb-94	9.90E+01	1.50E+01	15%
Nb-94 ACTIV. METAL	—	3.16E+01	—
Ni-59	2.90E+04	5.12E+03	18%
Ni-59 ACTIV. METAL	—	2.35E+02	—
Np-237	4.80E-05	1.56E-08	0%
Pu-238	1.30E+00	2.03E+00	156%
Pu-239	3.40E-04	1.95E-01	57,318%
Pu-240	3.60E-04	1.08E-01	29,939%
Pu-241	2.20E+01	6.25E+01	284%

Table B-1. Trench 94 Inventory Comparison to PA

Radionuclide	Estimated Inventory Analyzed in the PA (Ci)[a]	Inventory Disposed from Inception to 9/30/2017 (Ci)[b]	Fraction of PA Inventory Disposed to Date
Pu-242	8.50E-07	4.05E-07	48%
Se-79	3.00E-03	2.31E-05	1%
Sr-90	8.50E+00	2.02E+01	238%
Tc-99	4.10E+00	8.08E-01	20%
Zr-93	1.20E+00	5.61E-01	47%

a. The PA does not indicate the assumed closure date. It is also unclear if Table 2-5 of WHC-SD-WM-TI-730, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*, is decay-corrected to an assumed closure date.

b. The sum of annual waste receipts as queried from the Solid Waste Information and Tracking System database without decay correction.

PA = performance assessment

B1 Trench 94 Dose Estimate Summary

Both the intruder scenario and groundwater contamination pathways were deemed significant projected dose pathways in PA evaluations, as described in Section 3.3 in the main text of this annual status report. Primary radionuclides contributing to the intruder scenario include cesium-137 and strontium-90, both of which have disposed inventories greater than PA analyzed inventory (Table B-1). Although the PA calculated drilling through the naval reactor compartments, it is not viewed as a credible scenario due to the extreme hardness of the vessel metal. Furthermore, it is highly unlikely for a drill used for wells in sandy soil to penetrate the reactor material. Regarding the groundwater contamination pathway, the radionuclides contributing to projected dose in the PA include iodine-129, uranium, technetium-99, and selenium-99. Of these primary radionuclide groundwater contamination contributors, none have inventories exceeding the estimated PA inventory. Furthermore, none of the radionuclides exceeding estimated PA inventories were evaluated to be significant dose contributors.

B2 References

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